SCIENTIFIC AQUATIC SERVICES

Freshwater Ecosystem Assessment

AS PART OF THE ENVIRONMENTAL AUTHORISATION (EA) AND WATER USE AUTHORISATION (WUA) PROCESSES FOR THE PROPOSED CONSTRUCTION OF A BRIDGE CROSSING OVER THE RIETSPRUIT RIVER, IN OLIEVENHOUTBOSCH, MIDRAND, GAUTENG

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed upgrading of an existing bridge crossing (hereafter 'the study area') over the Rietspruit River near Olievenhoutbosch north of Midrand, Gauteng Province.

To assess all possible freshwater related impacts associated with the proposed crossing, a 500 m radius (hereafter referred to as the 'investigation area') around the study area was used as the area beyond the study area within which regulated zones of freshwater ecosystems occur, in accordance with Government Notice 4167 (GN 4167) of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as amended (NWA).

Following on from desk-based investigation of freshwater features in the investigation area, a field assessment was undertaken on the 17th of March 2026 to verify the characteristics of the affected reach of the Rietspruit River. Although historically the system most likely displayed characteristics consistent with those expected in a channelled valley bottom wetland system, the pressures exerted on the system over a period of several decades, including agricultural practices and urbanisation, have led to the gradual formation of strongly confined flows within a defined channel and the establishment of associated riparian habitat. Therefore, for the purposes of this investigation the Rietspruit was characterised and assessed accordingly. The outcome of the assessment indicates that the system is largely to seriously modified (Present Ecological State (PES) Category D/E) and of greatly diminished ecological importance and sensitivity (EIS), with the system's capacity for ecological service provisioning accordingly reduced.

Following the freshwater ecosystem assessment, the Department of Water and Sanitation (DWS) Risk Assessment Matrix (2023) (RAM) was applied to determine the significance of perceived impacts of the proposed road upgrading activities on the receiving freshwater environment. Taking into consideration the decreased ecological integrity and lowered EIS of the Rietspruit, as well as the intention of the proponent to undertake instream construction activities during the low-flow winter period, the proposed activities are anticipated to pose an overall 'low' risk significance to the system. Moreover, provided that the mitigation measures outlined in this report (Section 5.1) are strictly implemented, not only can the significance of the expected short-term negative impacts be reduced, but a long-term positive outcome can be achieved through improving hydraulic connectivity and geomorphological stability.

If all mitigation measures as stipulated in Section 5.1 of this report are implemented to prevent any edge effects and cumulative impacts from occurring on the freshwater ecosystem habitat, it is the opinion of the freshwater specialist that the proposed bridge upgrade may be considered positively for authorisation by the respective authorities.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed upgrading of an existing bridge crossing over the Rietspruit River near Olievenhoutbosch north of Midrand, Gauteng Province.

To assess all possible freshwater related impacts associated with the proposed crossing, a 500 m radius (the 'investigation area') around the bridge crossing was used as the area beyond the proposed bridge crossing upgrade footprint within which regulated zones of freshwater ecosystems may occur, in accordance with Government Notice 4167 (GN 4167) of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as amended (NWA).

The purpose of this report is to characterise the freshwater ecosystem associated with the proposed upgrade activities and the associated investigation area, in accordance with Government Notice 4167 (GN 4167) of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as amended (NWA) in terms of freshwater characteristics. Furthermore, the freshwater ecosystem was assessed in terms of characteristics and ecological condition.

The assessment took the following approach:

- A desktop study was conducted, in which the extent of freshwater ecosystem habitat within the investigation area was identified for on-site investigation, and relevant national and provincial databases were consulted;
- The field assessment was undertaken in March 2026 to ground-truth the freshwater ecosystem;
- The freshwater ecosystem was classified according to the Ollis *et al.* (2013) classification system; and
- The characteristics of the freshwater ecosystem were defined, including the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS), Recommended Ecological Category (REC), Recommended Management Objective (RMO) and Best Attainable State (BAS).

The results of the field assessment for the freshwater ecosystem assessment are presented in Section 5 of this report, and are summarised in the table below:

Table A: Summary of results of the field assessment as discussed in Section 3.4.2.

Present Ecological State (PES)	Ecoservice provision	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Category (REC) / Recommended Management Objective (RMO) / Best Attainable State (BAS)
Category: D/E (Largely to Seriously Modified)	Demand: Very High to Low Supply: Moderate to Very Low	Low/Marginal	**REC:** D; **RMO:** Improve; **BAS:** D

Following the freshwater ecosystem assessment, the Department of Water and Sanitation (DWS) Risk Assessment Matrix (2023) (RAM) was applied to determine the significance of perceived impacts of the proposed bridge upgrading activities on the receiving freshwater environment. Taking into consideration the decreased ecological integrity and lowered EIS of the Rietspruit, as well as the intention of the proponent to undertake instream construction activities during the low-flow winter period, the proposed activities are anticipated to pose an overall 'low' risk significance to the system. Moreover, provided that the mitigation measures outlined in this report (Section 5.1) are strictly implemented, not only can the significance of the expected short-term negative impacts be reduced, but a long-term positive outcome can be achieved through improving hydraulic connectivity and geomorphological stability.

If all mitigation measures as stipulated in Section 5.1 of this report are implemented to prevent any edge effects and cumulative impacts from occurring on the freshwater ecosystem habitat, it is the opinion of the freshwater specialist that the proposed bridge upgrade may be considered positively for authorisation by the respective authorities. A summary of the risk assessment is presented in Table B.

Table B: Summary of the DWS Risk Assessment outcome.

Phase	No.	Activity	Impact		Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
CONSTRUCTION	1	Site preparation for civil works within the delineated extent of the Rietspruit and associated floodlines and ecological buffers, including: • Removal of vegetation and associated disturbances to soil; • Stockpiling of construction equipment and storage of materials, vehicles and machinery; and • Possible indiscriminate vehicle movement through the non-marginal zones.	• Dust generation from exposed soil potentially leading to the smothering of riparian vegetation and biota, and altering surface water quality; • Potential soil destabilisation leading to further sedimentation, or conversely, soil compaction leading to increased surface runoff into downstream / downgradient freshwater ecosystem; • Potential further spread of alien and invasive plant species (AIPs) from disturbed soil; and • Contaminant spillage into the freshwater ecosystem from machinery and vehicle operation.		80%	**9,6**	**L**	High
	2	Clearing of vegetation within the repair site footprint area including stripping of topsoil within the riparian habitat.	• Exposure of soil, leading to increased runoff and erosion, and thus increased likelihood for sedimentation of the freshwater ecosystem; • Loss of riparian habitat and ecological structure resulting in impacts to biota; • Increased sedimentation, potentially leading to further smothering of vegetation in the downstream reaches; • Further proliferation or spread of alien and/or invasive vegetation as a result of disturbances; and • Potential for further decreased ecoservice provision of the freshwater ecosystem.		80%	**11,2**	**L**	High

Phase	No.	Activity	Impact		Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
	3	Groundbreaking and excavations within the freshwater ecosystem as part of the activities to prepare suitable foundations for the placement of culverts, construct outlet / drainage structures and provide protection works, and install gabion retaining wall with erosion protection (if required), which may include infilling and cut and fill of side slopes, excavation of areas for the erosion protection measures.	• Excess soil being removed within the road surface and falling into the riparian habitat adjacent to the road resulting in altered pattern flow and timing of water in the freshwater ecosystem; • Disturbances of soil leading to ponding of water as a result of over compaction of soil in some areas, increased AIP proliferation, and in turn altered riparian habitat and runoff patterns; • Altered runoff patterns, leading to increased erosion and sedimentation of the downstream riparian habitat; and • Potential erosion and formation of preferential flow paths as a result of disturbed soil and inappropriate slopes (i.e. too steep) resulting in additional sedimentation of the freshwater ecosystem.		100%	**16**	**L**	High
	4	In-channel re-construction work, entailing, *inter alia*: - Temporary diversion of flow while construction of new infrastructure and decommissioning of existing, damaged infrastructure takes place; - Placement of *either* ten 3.0 x 2.4 m box culverts, or 34 x 1500 mm diameter pipe culverts across the width of the active channel; - Construction of culvert inlet and outlet structures, consisting of concrete apron slabs, wingwalls and gabion mattresses; - Re-construction of road surface, involving concrete works and placement of guide-blocks; - Removal of existing damaged culverts and concrete aprons.	• Minor removal of instream and marginal riparian vegetation; • Movement of construction machinery within channel, leading to benthic disturbance including potential damage to aquatic biota egg banks, instream sediment disturbance, and compaction of bank and bed soil; • Disturbances of soil as a direct result of removal of damaged infrastructure and replacement with new culverts, leading to localised ponding of water as a result of earthworks, over-compaction of soil due to movement of machinery, damage to fish and macroinvertebrate egg banks, potential for increased AIP proliferation (instream and riparian), and in turn altered instream and riparian habitat, flow patterns and sediment		100%	**18**	**L**	Medium

Phase	No.	Activity	Impact		Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
			distribution; • Altered runoff patterns, leading to increased erosion and sedimentation of the downstream riparian and instream habitat; and • Potential erosion and formation of preferential flow paths as a result of disturbed soil, and inappropriate slopes (bank and stream bed) resulting in altered sediment distribution and altered benthic characteristics affecting aquatic fauna and flora.					
	5	Post-construction embankment side slope protection, installation of municipal services infrastructure, and resurfacing / overlay of road surface, entailing *inter alia*: **Side slope protection:** - sloping of side slopes at 1:2 (not preferred) to 1:3 (preferred); - Placement of top soil on road surface and hydro-seeding according to ecologist specifications; - Implementation of additional erosion controls (non-degradable or Armorflex blocks). **Roadway construction:** -Construction of layer works in accordance with construction method statement prepared by Civil Concepts (2026). **Installation of municipal infrastructure:** - Water pipes, data cabling, sleeves and electrical cabling to be installed within the earthfill of the bridge crossing, in accordance with the construction method statement prepared by Civil Concepts (2026).	• Exposure of soil, leading to increased runoff and erosion, and thus increased likelihood for further sedimentation of the freshwater ecosystem; • Loss of riparian habitat and ecological structure within the section of the river that will be traversed, resulting in impacts to biota; • Increased sedimentation of the freshwater ecosystem, leading to smothering of vegetation in the downstream reaches of the freshwater ecosystem; • Potential impacts on water quality and contamination of soil within the freshwater ecosystem; • Potential further proliferation / spread of AIPs as a result of disturbances; and • Potential decreased capacity of the ecoservice provision of the freshwater ecosystem.		100%	**14**	**L**	High

Phase	No.	Activity	Impact		Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
	6	Construction of a temporary bypass road using fill material, and potential surfacing of the temporary road using surfacing seal including: • Excavation within the Rietspruit River for the installation of a throughflow structure; and • Placement of temporary pipe culverts.	• Earthworks could be potential additional sources of sediment, which may be transported as runoff into the downstream reach of the system; • Exposure of soils, leading to increased runoff, and erosion, and thus further increased sedimentation of the downstream reach of the system; • Increased sedimentation, leading to smothering of instream vegetation and/or further proliferation of ruderal and AIP species within the system; • Further proliferation of AIPs as a result of disturbances in turn transforming habitat further; • Potential impacts to water quality and contamination of soil in the system; and • Soil contamination and potential oil and hydrocarbon spills originating from construction vehicles.		80%	**11,2**	**L**	Medium
	7	Rehabilitation of the impacted reaches of the freshwater ecosystems including: • Resloping, reprofiling and revegetation of the river banks to prevent future erosion; and • AIPs removal.	• Exposure of soils, leading to increased runoff and erosion which can lead to increased sedimentation of the freshwater ecosystem; • Potentially altering surface water quality through increased turbidity from increased suspension loads and contamination from oils and hydrocarbons; • Soil compaction of the embankment; • Potential temporary disruption to the hydrological processes of the freshwater ecosystem; and • Damage and or removal of indigenous vegetation.		80%	**11,2**	**L**	High

Phase	No.	Activity	Impact		Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
OPERATIONAL	8	• Operation and maintenance of the culvert bridge and road crossing. • Operation and maintenance of municipal services infrastructure.	• Impact on water quality from possible leakages and spillage of hydrocarbons from vehicles using the road; • Impact on water volumes in the event of leaks from water pipelines; • Flow concentration and potentially erosion at concentration points i.e. culverts within the freshwater ecosystem; • Altered runoff patterns and increased water inputs to the freshwater ecosystem, further contributing to altered flow regime and subsequent impacts on the riparian vegetation; and • Potential increased loss of indigenous vegetation and the further proliferation of alien floral species due to disturbances.		80%	**11,2**	**L**	High
	9	Monitoring of structural integrity of the culvert bridge and road crossing including: • Proactive monitoring to ensure structural integrity is maintained and to identify early signs of erosion due to potential blockage or breakages.	• No direct impacts perceived.		40%	**4**	**L**	High
	10	Ongoing AIPs removal (where required).	• Compaction of soil and loss of habitat as a result of ongoing disturbance from vehicles and equipment; • Impacts to water quality as a result of the application of herbicides; and • Disturbance of soil which could lead to erosion.		80%	**11,2**	**L**	High

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 G
2.2	Description of the preferred development site, including the following aspects-	Section 1
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 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 and Section 7
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 3.2
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 4
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 5, 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 5, 8
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	Section 5, 8
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 5, 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 5, 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 5, 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 5, 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 5, 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 8
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 G
3.2	A signed statement of independence by the specialist;	Appendix G
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 and 2
3.4	The methodology used to undertake the impact assessment and site inspection, including equipment and modelling used, where relevant;	Appendix C
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 1.2
3.6	Areas not suitable for development, to be avoided during construction and operation (where relevant);	Section 8
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
3.8	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted protocol;	Section 7.2
3.9	Impact management actions and impact management outcomes proposed by the specialist for inclusion in the EMPr;	Section 8
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	NA
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.	Section 8 and Section 9

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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
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 soil).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soil 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.
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
RAMSAR:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
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 soil, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

AIPCP	Alien and Invasive Species Control Plan
ASPT	Average Score Per Taxon
ºC	Degree Celsius
CBA	Critical Biodiversity Area
BAS	Best Attainable State
DEA	Department of Environmental Affairs
DO	Dissolved Oxygen
DFFE	Department of Forestry, Fisheries and 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	Electrical Conductivity
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
EPL	Ecosystem Protection Level
ES	Ecological Sensitivity
ESA	Ecological Support Area
ETS	Ecosystem Threat Status
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Areas
GA	General Authorisation
GDARD	Gauteng Department: Agriculture and Rural Development
GEMF	Gauteng Environmental Management Framework
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
IAIA	International Association of Impact Assessors
IHAS	Invertebrate Habitat Assessment System
LoM	Life of Mine
m.a.m.s.l	Metres above mean sea level
MAP	Mean Annual Precipitation
MOD	Modified
mm	Millimetre
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NEMBA	National Environmental Management: Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
RAM	Risk Assessment Matrix
REC	Recommended Ecological Category
RMO	Resource Management Objective
RQIS	Research Quality Information Services
RWQO	Resource Water Quality Objectives
SACNASP	South African Council for Natural Scientific Professions
SAIAB	South Africa Institute of Aquatic Biodiversity
SAIIAE	South Africa Inventory of Inland Aquatic Ecosystems
SANBI	South African National Biodiversity Institute

SA RHP	South Africa River Health Programme
SAS	Scientific Aquatic Services
SASS	South African Scoring System
SH	Small Holdings
SQR	Sub quaternary catchment reach
subWMA	Sub-Water Management Area
SWSA	Strategic Water Source Areas
TDS	Total Dissolved Solids
UCVB	Unchanneled Valley Bottom
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WMS	Water Management System
WRC	Water Research Commission
WRMP	Water Resource Management Plan
WUA	Water Use Authorisation
ZoR	Zone of Regulation

1. INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed upgrading of an existing bridge crossing over the Rietspruit River near Olievenhoutbosch north of Midrand, Gauteng Province.

To assess all possible freshwater related impacts associated with the proposed crossing, a 500 m radius (the 'investigation area') around the bridge crossing was used as the area beyond the proposed bridge crossing upgrade footprint within which regulated zones of freshwater ecosystems may occur, in accordance with Government Notice 4167 (GN 4167) of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as amended (NWA). The location and the extent of the bridge crossing and associated investigation area are depicted in Figures 1 and 2 below.

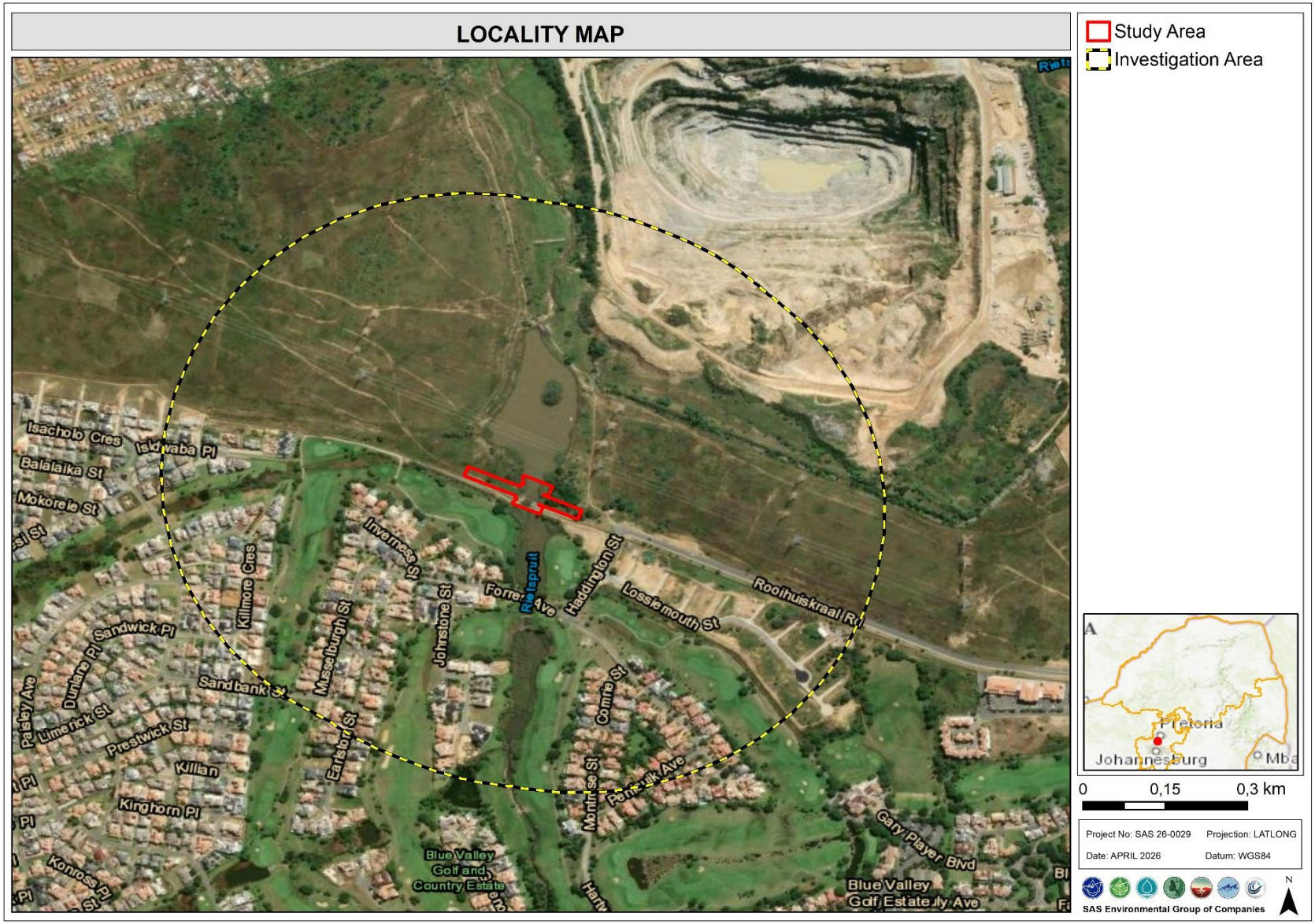


Figure 1: The location of the proposed crossing over the Rietspruit River and associated investigation area.

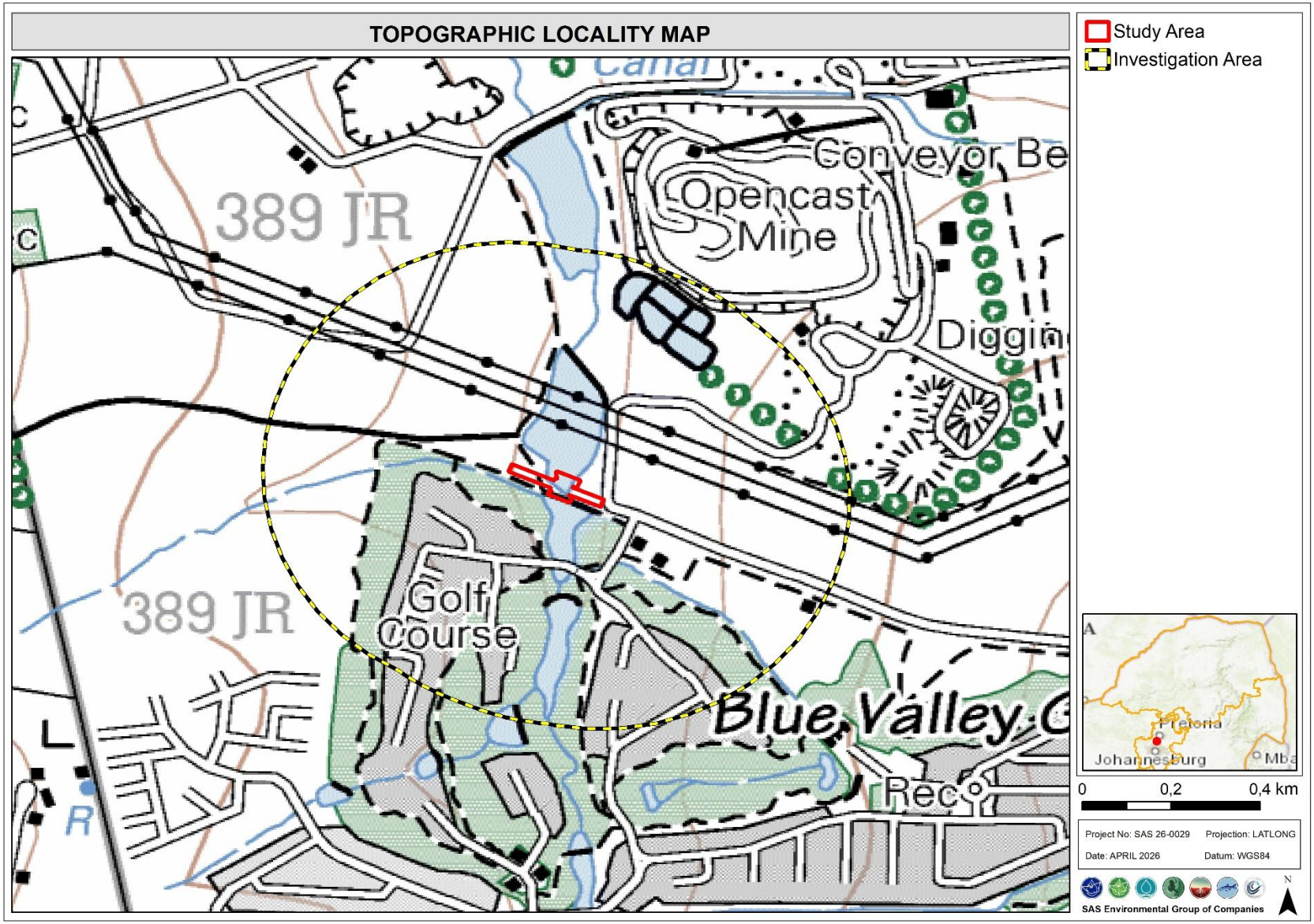


Figure 2: The proposed crossing over the Rietspruit River and associated investigation area depicted on a topo-cadastral map of the area.

1.1 Scope of Work

1.1.1 Freshwater Ecosystem Assessment

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 Research Quality Information Services (DWS RQIS PES/EIS), (2014) database, National Biodiversity Assessment (NBA) National Wetland Map 6 (2024), and the Gauteng Conservation Plan V4.0 (2024) were undertaken to aid in defining the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the relevant freshwater ecosystem in the investigation area;
- A **literature review** of previous specialist studies undertaken for the proposed mixed use development (known as Kosmosdal Ext 92) on the Remainder of Portion 2 of the Farm Olievenhoutbosch 389 JR undertaken by Terrasoil Science in April 2015 and by SAS in 2016, provided limited albeit useful historical context to the study;
- The freshwater ecosystem associated with the investigation area was **delineated** using desktop methods in accordance with GN 4167 of 2023 as it relates to activities as stipulated in the National Water Act, 1998 (Act No. 36 of 1998), as amended, and verified in the field according to the "Department of Water Affairs and Forestry (DWAF)[1] (2008)[2]: A practical field procedure for identification of wetlands and riparian areas". Aspects such as soil morphological characteristics and wetness along with vegetation types were used to verify the freshwater ecosystem boundaries;
- The **freshwater ecosystem classification** assessment was undertaken according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);
- The **Present Ecological State (PES)** of the freshwater ecosystem was assessed according to the resource directed measures guideline as advocated by Kotze *et al.* (2008);
- The **Ecological Importance and Sensitivity (EIS)** of the freshwater ecosystem was determined according to the method described by Rountree and Kotze, (2013);

[1] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA) and subsequently as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.
[2] Even though an updated manual is available since 2008 (Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas), this is still considered a draft document currently under review.

- The **Ecoservices provision** of the freshwater ecosystem was assessed according to "A technique for rapidly assessing ecosystem services supplied by wetlands" (Kotze *et al.,* 2020);
- On-site testing of **basic water quality parameters** including pH, electrical conductivity (EC), dissolved oxygen concentration (DO) and temperature was undertaken at a single location. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF, 1996 volume 7) as well as the Resource Water Quality Objectives (RWQO) of South Africa;
- The freshwater ecosystem boundaries and **legislated zones of regulation** were depicted for the freshwater ecosystem, where applicable;
- The Department of Water and Sanitation (DWS) **Risk Assessment Matrix** (2023) (RAM) was applied to identify potential impacts that may affect the freshwater ecosystem within the investigation area as a result of the proposed upgrade activities and to aim to quantify the significance thereof; and
- To present **management and mitigation measures** which must be implemented during the construction and operation of the proposed upgrade activities to assist in minimising the impact of the proposed activities on the receiving environment.

1.2 Assumptions and Limitations

The following assumptions and limitations are applicable to the freshwater component of the report:

- The previous specialist studies undertaken by Terrasoil Science (2015) and SAS (2016) provided useful background information which was expanded upon in this study. It is important to note that the assessment matrices utilised to determine the Ecostatus of the affected reach of the Rietspruit River during both prior assessments are currently considered outdated, and as such, current best-practice methods were utilised. This has not led to a significant change in the outcome of the Present Ecological State (PES) or Ecological Importance and Sensitivity (EIS) assessments, but is nevertheless noted as some small discrepancies may occur;
- Further to the above, whilst the system may have historically displayed characteristics most commensurate with those representative of valley bottom wetlands such as mottled soil, dominance by obligate floral species and diffuse, lateral water disbursement through the system, ongoing pressures exerted on the system relating to rapid urbanisation within the catchment have led to the transformation of the system such that the assessed reach was, at the time of assessment in 2026, characterised by strongly channelled flows, alluvial soil and woody species dominance within the marginal and non-marginal zones. Thus, the assessed reach was characterised and

assessed as a river with riparian characteristics, rather than as a channelled valley bottom (indicating significant decline of Ecostatus);

- Some discrepancies may occur between the delineations and buffer zones provided by the desktop databases, and those generated in this study. The delineation and associated buffer zones derived from the field-based assessment must, however, take precedence as this is considered the most accurate version of the freshwater ecosystem delineation, given that the data is more recent (gathered within the last year) and has been verified in the field;
- It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases reviewed used do not always provide an entirely accurate indication of the actual site characteristics within the investigation area at the scale required to inform the EA 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.

2. ASSESSMENT APPROACH

2.1 Freshwater Ecosystem Definition

For the purposes of this investigation, the definitions of a watercourse, riparian 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 a watercourse.
*****and a reference to a watercourse includes where relevant, its bed and banks.

The National Water Act, 1998 (Act No. 36 of 1998) further provides definitions of wetland and riparian habitats as follows:

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 the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

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

2.2 Consideration of the Department of Forestry, Fisheries and the Environment Screening Tool

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.

As part of the process of background information gathering, the screening tool was applied to the associated investigation area. 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.

2.3 Freshwater Ecosystem Field Verification

Where limitations to on-site delineations were experienced, use was made of historical and current digital satellite imagery, topographic maps and available provincial and national databases to aid in the delineation of the freshwater ecosystem following the site assessment. The following were taken into consideration when utilising the above desktop methods:

- **Linear features:** since water flows/moves through the landscape, freshwater ecosystems often have a distinct linear element to their signature which makes them discernible on aerial photography or satellite imagery;
- **Vegetation associated with freshwater ecosystems:** a distinct increase in density as well as shrub size near flow paths;
- **Hue:** with water flow paths often showing as white/grey or black and outcrops or bare soils displaying varying chroma created by varying vegetation cover, geology and soil conditions. Changes in the hue of vegetation, with freshwater ecosystem vegetation often indicated on black and white images as areas of darker hue (dark grey and black). In colour imagery, these areas mostly show up as darker green and olive colours or brighter green colours in relation to adjacent areas, where there is less soil moisture or surface water present; and
- **Texture:** with areas displaying various textures which are distinct from the adjacent terrestrial areas, created by varying vegetation cover and soil conditions within the freshwater ecosystems.

The site assessment was undertaken on the 12th of February 2026 (mid-summer, wet season), to delineate and undertake a detailed freshwater ecosystem assessment of the affected freshwater ecosystem associated with the proposed road upgrade activities. The delineation of the freshwater ecosystem took place as far as possible, according to the method presented in the “Updated manual for the identification and delineation of wetland and riparian resources” (DWAF, 2008).

As noted in Section 1.2, the freshwater ecosystem assessment was limited to the investigation area outlined in this report. During the site assessment, the following indicators were used to delineate the boundaries of the freshwater ecosystem:

- **Soil wetness indicators**, duration and frequency of saturation in the soil profile is a diagnostic indicator since it influences the colour change in the soil. Low chroma (grey and muted colours) as well as mottles are more prominent in soil which have higher saturation frequency. Soil displaying signs of hydromorphism also indicates an increased hydroperiod and thus the potential presence of hydromorphic characteristics;

- **Vegetation** was utilised as far as possible as a secondary indicator to identify and define the freshwater ecosystems;
- **Terrain setting** indicators were used as an additional, confirmatory indicator. Terrain was utilised to provide an indication of low-lying areas where water is likely to collect and/or move through the landscape; and
- The **presence of moisture** was utilised as a further confirmatory indicator.

In addition to the delineation process, a detailed assessment of the ecological state, sensitivity and functionality of the delineated freshwater ecosystem was undertaken. Factors affecting the integrity of the freshwater ecosystem were taken into consideration and aided in the determination of the functioning and the ecological and socio-cultural services provided by the freshwater ecosystem. A detailed explanation of the methods of assessment undertaken is provided in **Appendix C** of this report.

3. ASSESSMENT RESULTS

3.1 Application of the Department of Forestry, Fisheries and the Environment Screening Tool

The findings of the site sensitivity verification report regarding the sensitivity rating of the investigation area indicate that the majority of the investigation area is of 'low' aquatic biodiversity sensitivity; however, the bridge to be upgraded traverses an area indicated to be of 'very high' biodiversity sensitivity (Figure 3). The area indicated as such correlates with the wetlands indicated by the National Biodiversity Assessment (NBA) wetlands databases (2018; 2024) as detailed in Table 1, Section 3.2 and illustrated in Figure 5.

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 very high aquatic biodiversity sensitivity, an Aquatic Biodiversity Assessment must be produced.

Please refer to Appendix G for the Site Sensitivity Verification Report.

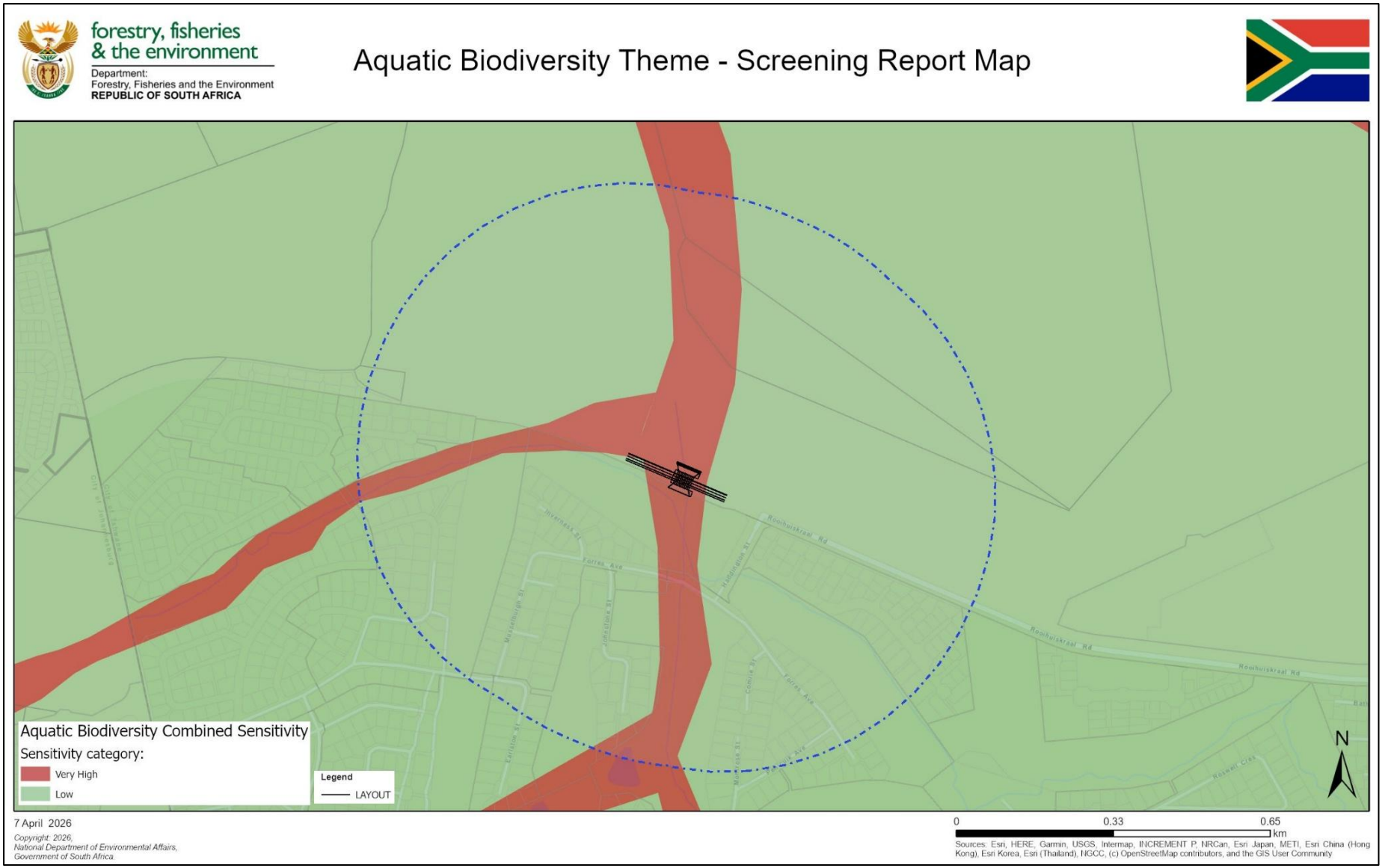


Figure 3: Areas indicated to be of 'very high' and 'low' aquatic biodiversity sensitivity according to the DFFE screening tool (2020; accessed April 2026).

3.2 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.

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 proposed development’s actual site characteristics at the scale required to inform the environmental authorisation and/or water use licencing processes. This data was used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance**. It is important to note that some discrepancies may occur between the delineations and buffer zones provided by the desktop databases, and those generated in this study. The delineation and associated buffer zones derived from the field-based assessment must however take precedence as this is considered the most accurate version of the freshwater ecosystem delineation given that the data is more recent (gathered within the last year) and have been verified in the field.**

Table 1: Desktop data indicating the characteristics of the freshwater ecosystems associated with the crossing and investigation area [Quarter Degree Square (QDS) 2528CC].

Aquatic ecoregion and sub-regions in which the study area is located	
Ecoregion	Highveld
Catchment	Limpopo
Quaternary Catchment	A21B
WMA	Crocodile (West) and Marico
subWMA	Upper Crocodile
Dominant characteristics of the Highveld Ecoregion (11.01) (Kleynhans *et al.*, 2007)	
Dominant primary terrain morphology	Plains; Low Relief
Dominant primary vegetation types	Rocky Highveld Grassland Mixed Bushveld
Altitude (m a.m.s.l)	1300-1900
MAP (mm)	500 to 700
Coefficient of Variation (% of MAP)	20 to 34
Rainfall concentration index	55 to 64
Rainfall seasonality	Early to mid-summer
Mean annual temp. (°C)	14 to 18
Winter temperature (July) (C)	0 – 20
Summer temperature (Feb)C)	12 – 30
Median annual simulated runoff (mm)	20 to 60
National Web-Based Environmental Screening Tool (2020, Accessed April 2026)	
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 residential development footprint to avoid sensitive areas.	
The areas of the study area and investigation area associated with the freshwater features per the NBA (2018) Database, along which the infrastructure is proposed, are indicated as features of the **very high aquatic** sensitivity (See Figure 12 below). The remainder of the study area and investigation area are indicated as being **of low aquatic biodiversity sensitivity.** The trigger features for the very high sensitivity are proximity to channelled valley bottom and seep wetlands.	

Details in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database	
FEPA CODE	The entire investigation area is located within a Phase2FEPA (FEPA Code 3) catchment. Phase2FEPAs were identified in moderately modified rivers, only in cases where it was not possible to meet biodiversity targets for river ecosystems in rivers that were still in good condition. The condition of these rivers should not be degraded further, as they may in future be considered for rehabilitation once FEPAs in good condition are considered fully rehabilitated and well managed.
Wetland Vegetation Type	The study and investigation area is located within the Dry Highveld Grassland Group 3 Wetland Vegetation (WetVeg) type. The WetVeg is considered to be in a Least Threatened (LT) ecological threat status according to Mbona *et al.* (2015).
NFEPA Rivers	According to the NFEPA database (2011), there are no rivers located in the study area and the associated investigation area.
NFEPA Wetlands (Figure 4)	According to the NFEPA database (2011), there are four (4) patches of channelled valley bottom wetlands, including one within the study area, and one (1) seep wetland in the southern section of the investigation area. All wetlands are indicated as Heavily to Critically Modified (Class Z) ecological Condition.
National Biodiversity Assessment (2018): South African Inventory of Inland Aquatic Ecosystems (SAIIAE) Rivers, Artificial Wetlands, and Draft Wetland Map 6 (2024**) -** Map 5 included for condition (Figure 5)	
According to the NBA (2018): SAIIAE database, a channelled valley bottom (CVB) wetland along which the study area is indicated, traversing the study area and investigation. The database also indicates two (2) seep wetlands within the investigation area. The wetlands are indicated by the database as Largely to Critically Modified (WETCON D/E/F) ecological condition, and the Ecosystem Threat Status (ETS) is Critically Endangered. The Ecosystem Protection Level (EPL) of the CVB wetland is currently Not Protected, while the seep wetlands are Poorly Protected. According to the NBA Rivers database (2018), there are no rivers located in the study area or associated investigation area. According to the NBA (2018) Artificial Database, there are five (5) dams and one (1) Large Reservoir within the investigation area.	

Strategic Water Source Areas (SWSA) (2017 & 2021)	
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 2021 MTPA-CSIR database (Lötter, M.C. and Le Maitre, D) was used for surface water, while the WRC 2017 (Le Maitre, D.C. *et al.*) database was used for the underground SWSAs.	
According to the Strategic Water Source Area Databases, the study area and investigation area are not located within a surface water or underground SWSA.	
Details of the study area in terms of the Gauteng Environmental Management Framework (EMF, 2021) (**Figure 6**)	
According to the EMF (2021), the majority of the study and investigation area falls within the **Urban Development Zone (EMF Zone 1),** while the perennial river feature, as indicated by the Gauteng C-Plan Database and scattered sections in the investigation area are indicated to be within the **High Control Zone within the Urban Development Zone (EMF Zone 2**). EMF Zone 1. (Urban development zone): This zone intends to streamline urban development activities in it and to promote development infill, densification and concentration of urban development, in order to establish a more effective and efficient city region that will minimise urban sprawl into rural areas. EMF Zone 2: (High Control Zone within the Urban Development Zone): This zone is sensitive to development activities. Only conservation should be allowed in this zone. Related tourism and recreation activities must be accommodated in areas surrounding this zone.	
Details of the study area in terms of the Gauteng Conservation Plan (C-Plan V4, 2024), C-PLAN Buffers (2024), and DWS Gauteng Rivers (2021)	
Critical Biodiversity Area (CBA) (Figure 7 to Figure 9)	The majority of the study area is indicated to have an overall CBA 1: Irreplaceable Site, and the study area in the northern half of the investigation area is classified as a CBA 1 biodiversity conservation classification. A small patch of the investigation area, west of the study area, is indicated as a CBA2: Optimal Site. The triggering features for the CBA classification are for being **within important vegetation** (determined through the Marxan Mean Summed Solution for the CBA 1 classification and the Marxan Best Solution assessment for the CBA 2 classification), with 30 percent (%) natural vegetation within the study area indicated by the database. CBAs are areas included in the C-Plan Map because of their biodiversity importance and contribution to achieving conservation targets. They should be maintained in a natural state, with no further loss of habitat and no deterioration in ecological condition. **CBA1: Irreplaceable Sites**: Mandatory sites required to meet conservation targets where there are no other options to meet these targets (i.e., the remaining extent of the biodiversity feature is at or less than the conservation target). Typically, CBA1 sites include Critically Endangered and Endangered Ecosystems and known populations of threatened species. **CBA2: Optimal Sites:** Best sites selected to meet conservation targets where there are spatial options to meet these targets (i.e., the remaining extent of the biodiversity feature is more than the conservation target). Some CBAs are degraded or irreversibly modified but are still required for achieving specific targets, such as cultivated lands for threatened species foraging area or maintaining ecological connectivity in the landscape.
Ecological Support Area (ESA) (Figure 11)	The areas indicated as CBAs above are also indicated as ESA 1 areas by the database for being **within an Aquatic Ecosystem Life Zone.** ESAs are included in the C-Plan Map because of their role in supporting various ecological processes. They should be maintained in their current condition and land use, and intensification of land use or reduction of ecological condition is discouraged. ESA sites are excellent targets for restoration programmes. **ESA1:** Natural and near-natural sites: These are sites in a natural or near-natural condition important for supporting ecological processes. **ESA2**: Sites with no natural habitat remaining: These are sites that are intensively modified and are non-natural, including cultivated land and small holdings, but are important for supporting ecological processes. These areas are included as they provide critical linkages in the ecological corridor network or provide buffers to CBA areas.

Gauteng Freshwater Buffers (Figure 12)	According to the Gauteng C-Plan, two (2) non-perennial river buffers confluence with a perennial river buffer in the investigation area. The perennial river buffer flows along the areas where the infrastructure is proposed (corresponding with the NBA (2024) CVB). There are no wetland buffers located within the investigation area. Two (2) artificial waterbodies are indicated in the investigation area, north of the study area.
DWS Gauteng Rivers (Figure 12)	The DWS Rivers database indicates two (2) non-perennial unnamed tributaries that confluence with a perennial river. The perennial river is indicated by the database as the Rietspruit and traverses the study area. The perennial and non-perennial rivers are indicated to be within a developed landscape. This is where the river passes through a landscape that is generally transformed.
Details of the area in terms of the Land Type Data (Job et al., 2019)	
The entire study and investigation areas fall within the Bb1 land type. Analysis of the data sheet for this land type indicates that soil forms typically associated: with shallow soils in the form of Mispah (characterised by orthic A over hard rock), and Glenrosa (characterised by orthic A over lithocutanic B) and free-draining soils in the form of Hutton (characterised by orthic A over red apedal B), Avalon,(characterised by orthic A, yellow-brown apedal B and soft plinthic B), Wasbank (characterised by a hard plinthic B horizon) and Longlands (characterised by albic and soft plinthic B diagnostic horizons) are likely to occur on the development site thus suggesting that interflow processes are taking place in the crest and midslope positions. The presence of diagnostic hydromorphological horizons suggests the potential presence of seep wetlands recharging downstream valley bottom wetland soils. Wetland habitat in the form of the Kroonstad Soil Forms (characterised by diagnostic albic and gleyic horizons) followed by Dundee and Westleigh (characterised by orthic over stratified alluvium horizons/ soft plinthic B, respectively) are likely to be present within the valley bottom/valley floor terrain unit thus suggesting that wetland habitat is likely to be present in the certain parts of the valley bottom terrain units within the Bb1 land type area. On the footslope terrain unit, Kroonstad Westleigh Longlands (characterised by albic and soft plinthic B diagnostic horizons) and Wasbank (characterised by a hard plinthic B horizon) are described. Thus, indicating that wetland habitat is likely to occur in some parts of the footslope terrain unit of the land type.	

CBA = Critical Biodiversity Area; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; m.a.m.s.l = Metres Above Mean Sea Level; MAP = Mean Annual Precipitation; NBA = National Biodiversity Assessment; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State; SAIIAE = South African Inventory of Inland Aquatic Ecosystems; WMA = Water Management Area.

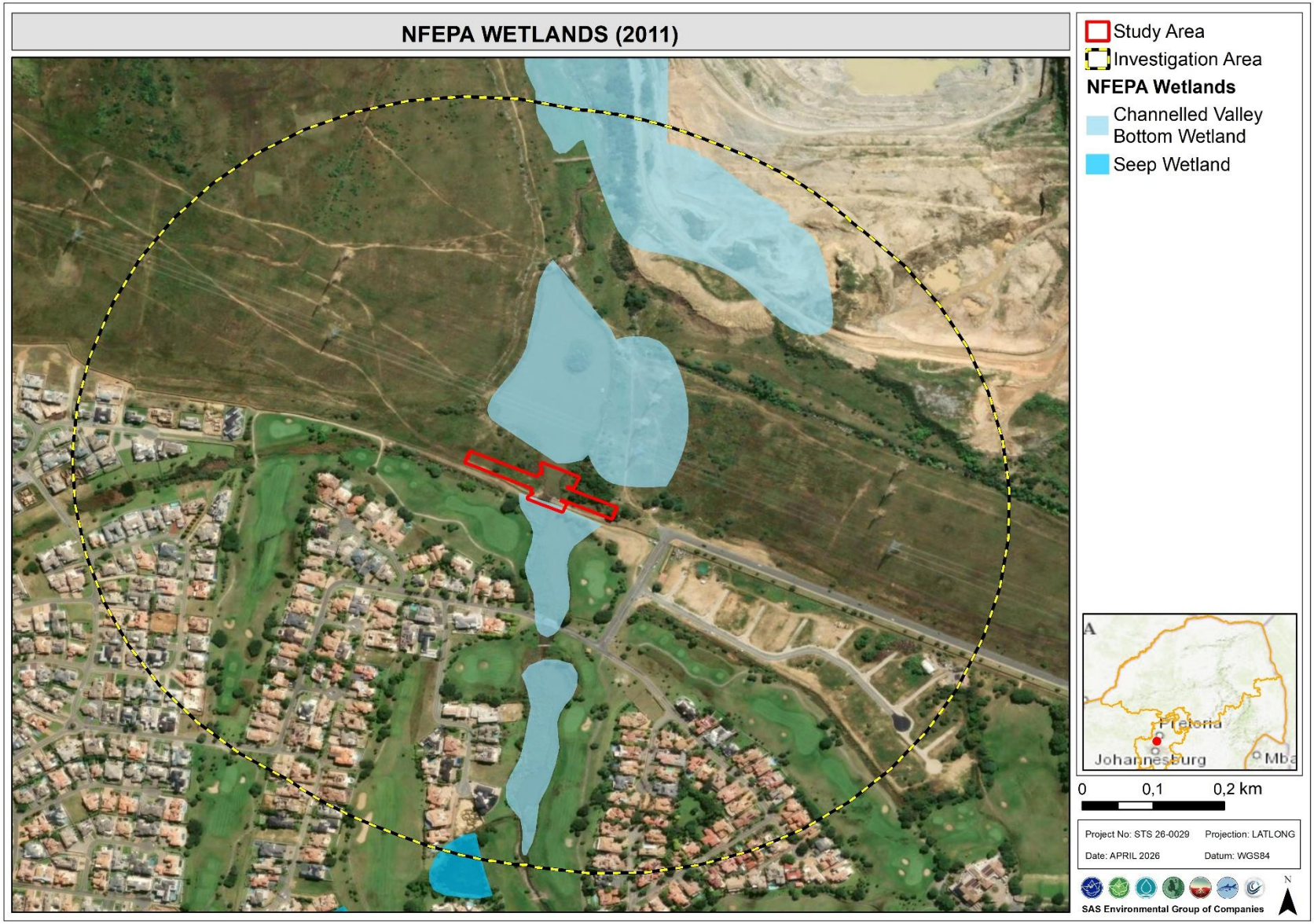


Figure 4: Wetland features associated with the study and associated investigation area according to the NFEPA Database (2011).

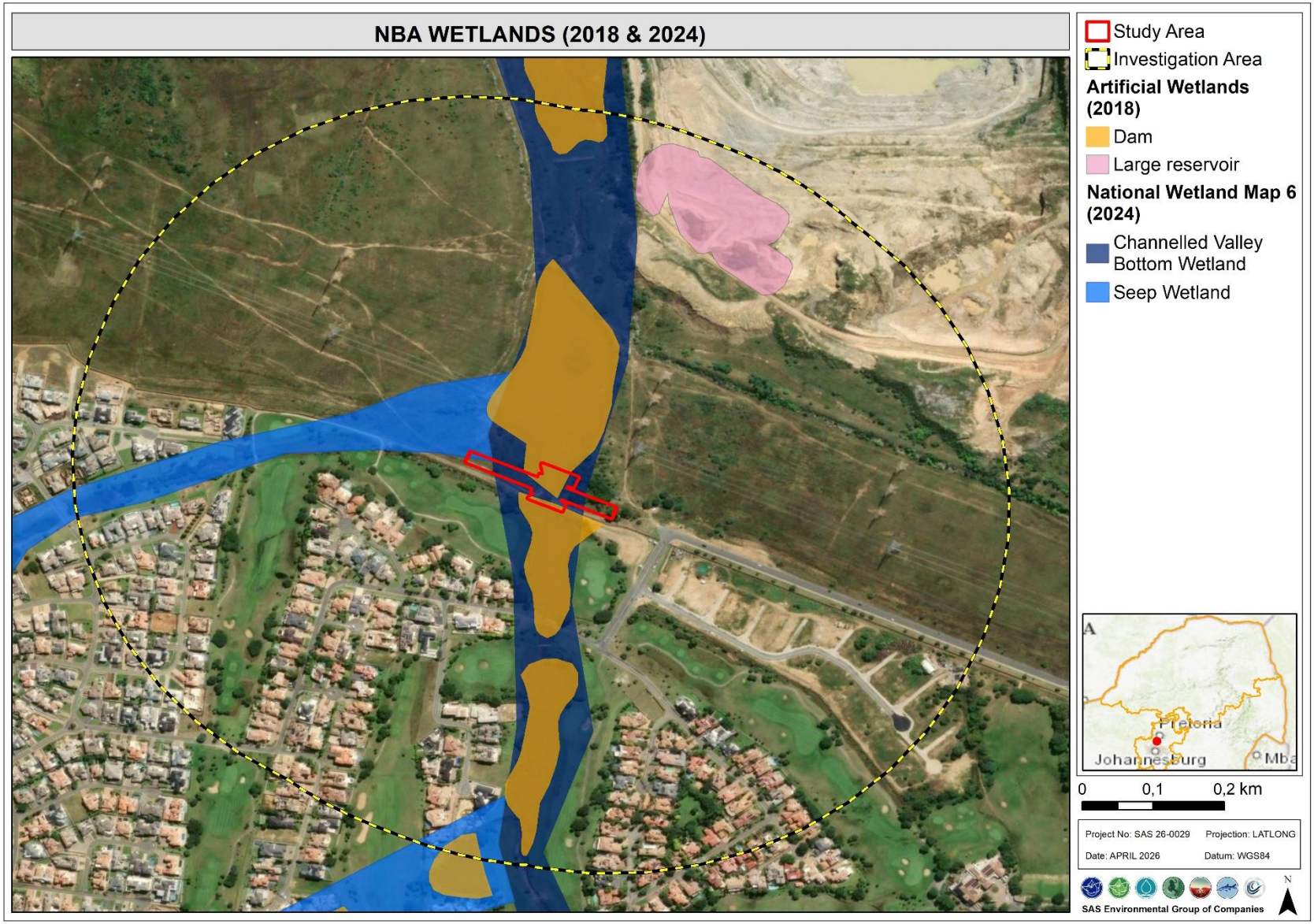


Figure 5: Wetland features associated with the study and associated investigation area according to the NBA Database (2018 and 2024 databases).

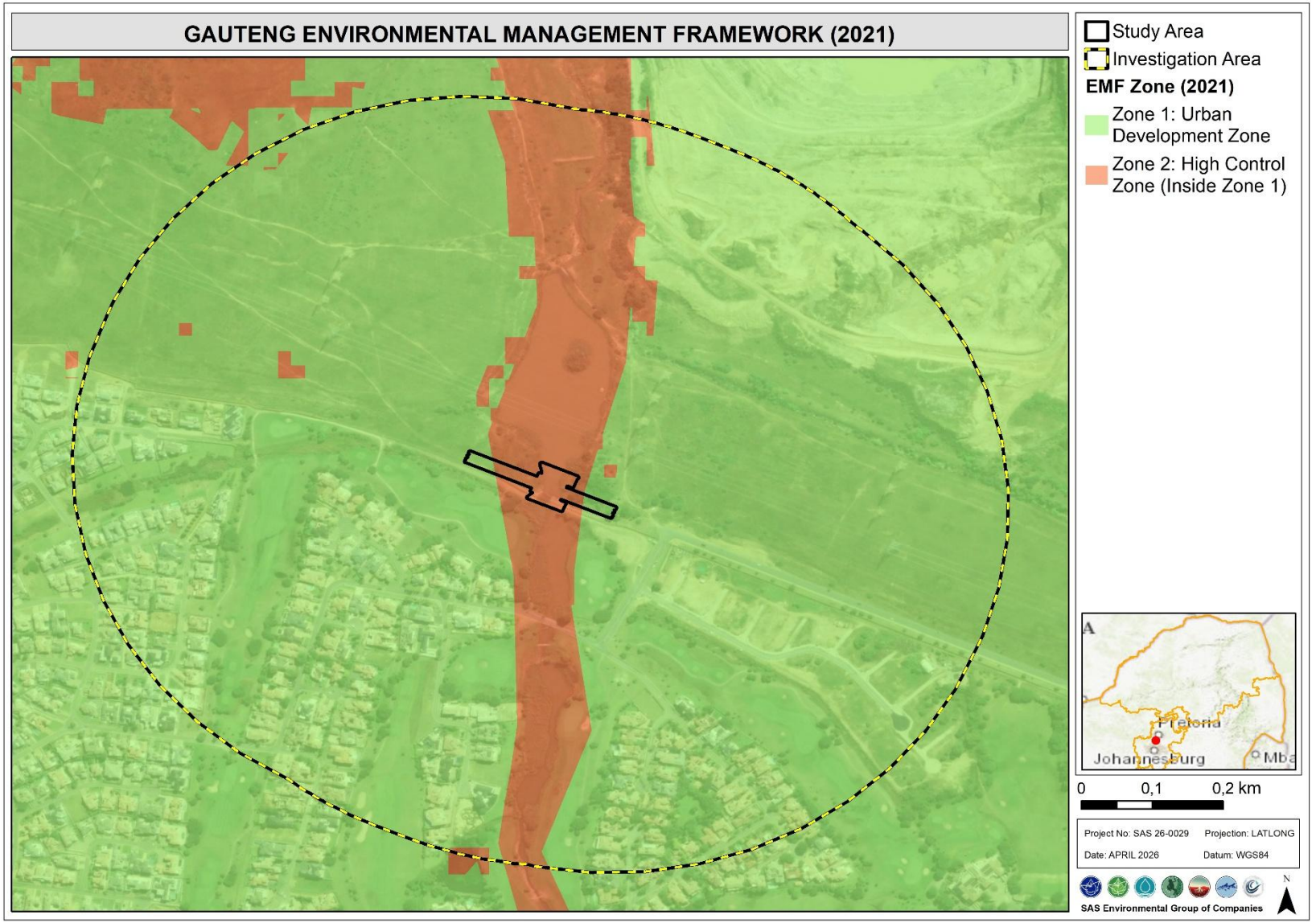


Figure 6: The zoning associated with the study and associated investigation areas according to the Gauteng Environmental Management Framework (2021).

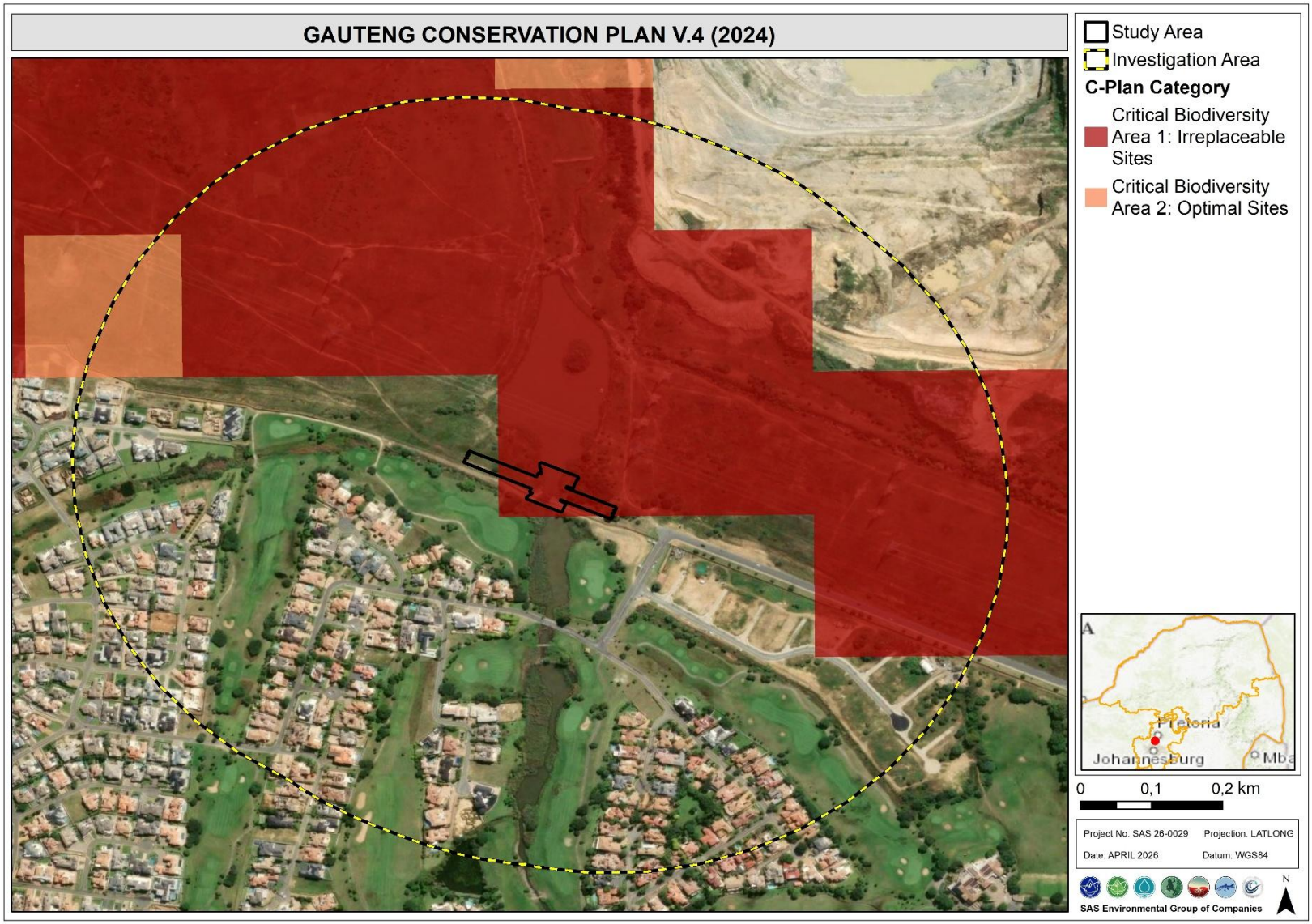


Figure 7: Areas of ecological importance associated with the study area and associated investigation area according to the Gauteng Conservation Plan (2024).

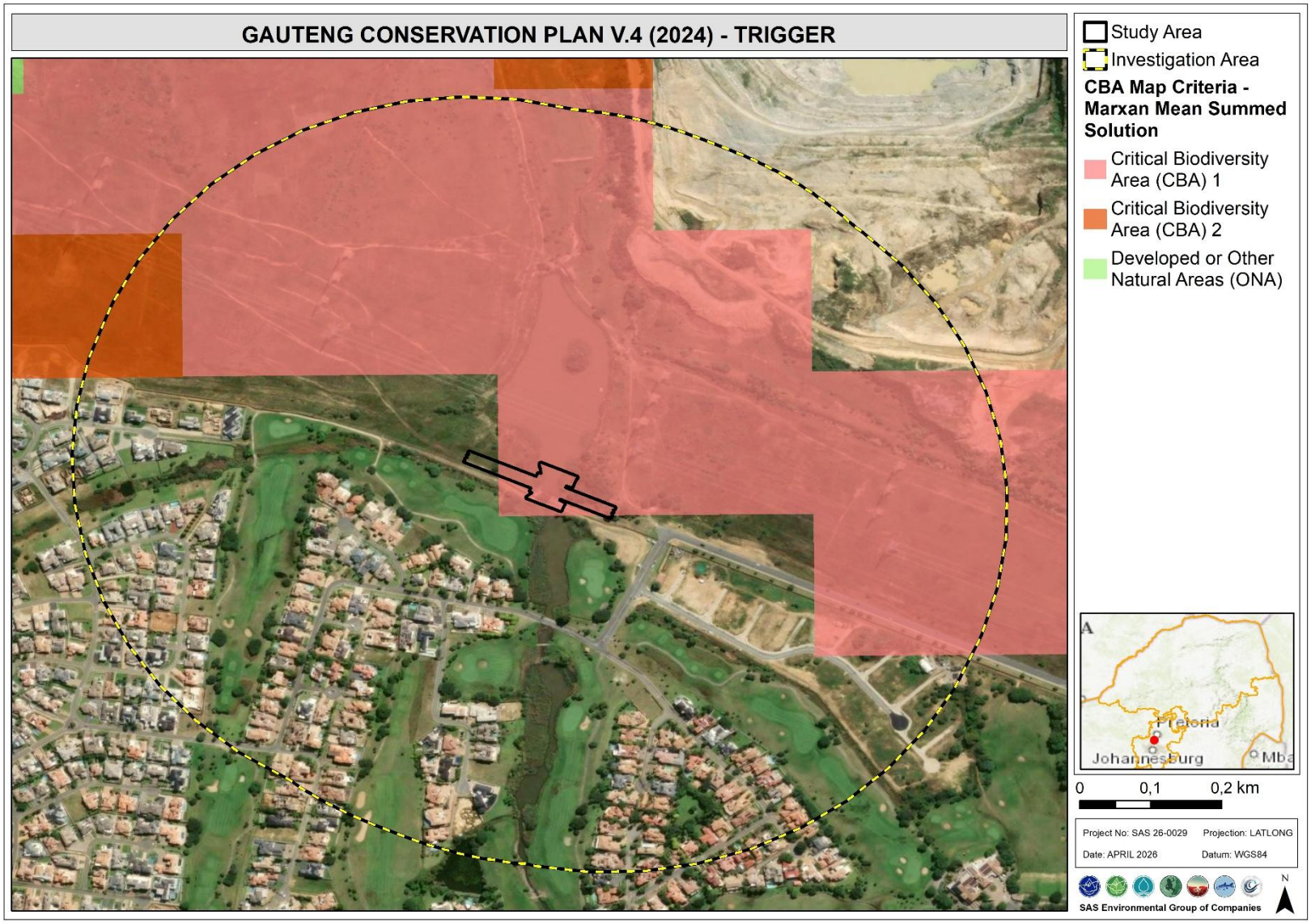


Figure 8: Areas of CBA 1 ecological importance associated with the study area and associated investigation area according to the Gauteng Conservation Plan (2024).

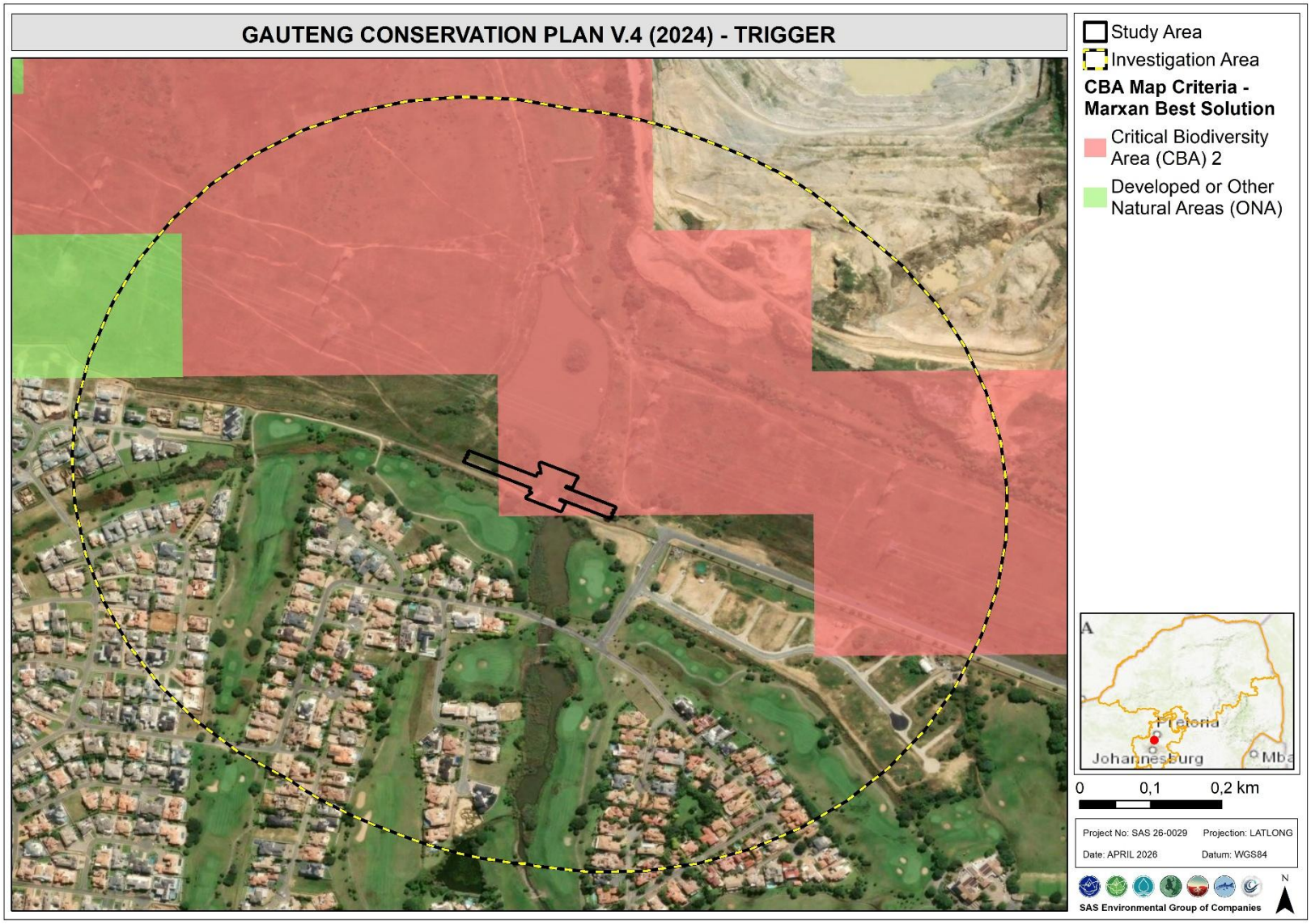


Figure 9: Areas of CBA 2 ecological importance associated with the study area and associated investigation area according to the Gauteng Conservation Plan (2024).

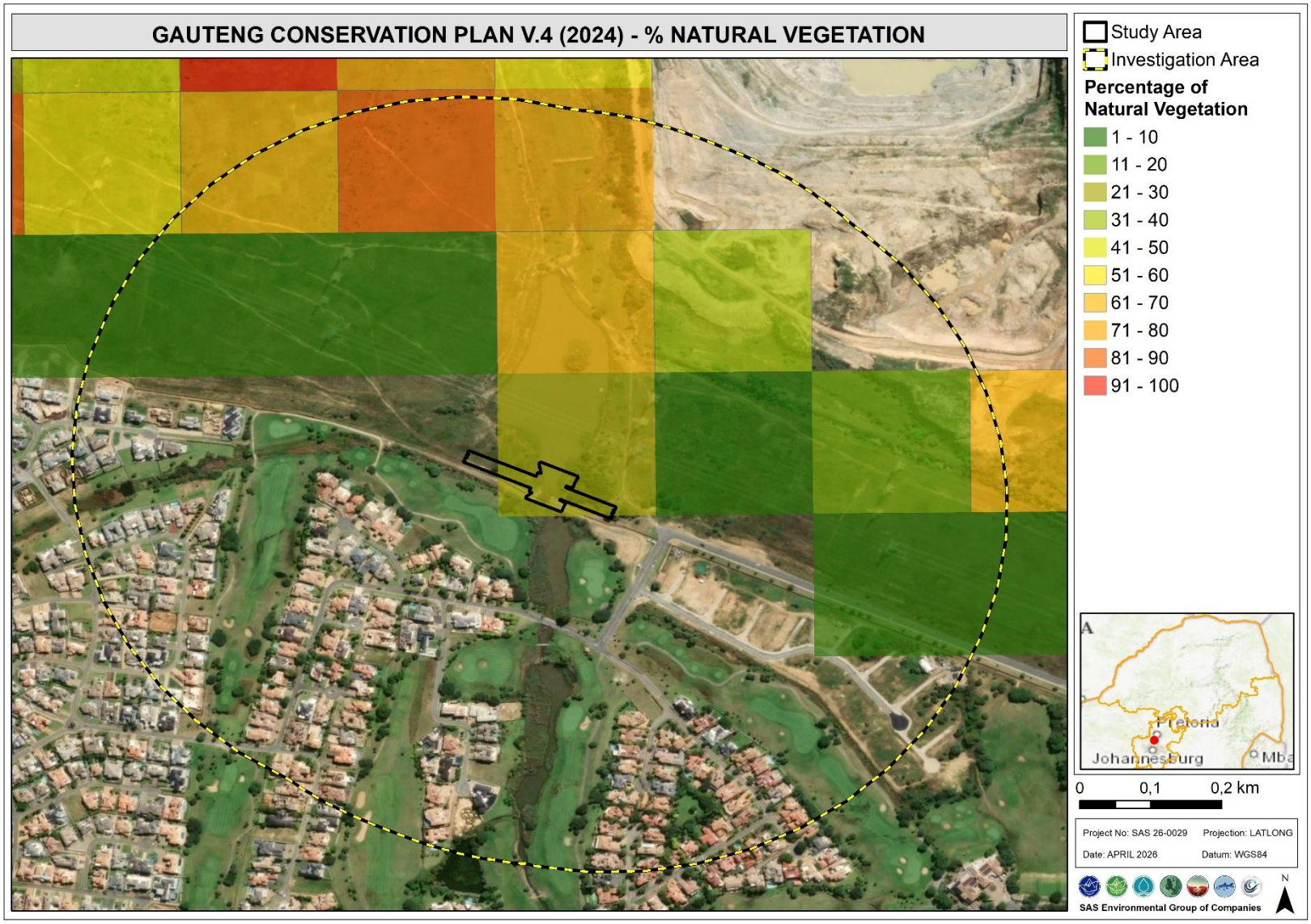


Figure 10: Percentage of natural vegetation associated with the study area and associated investigation area according to the Gauteng Conservation Plan (2024).

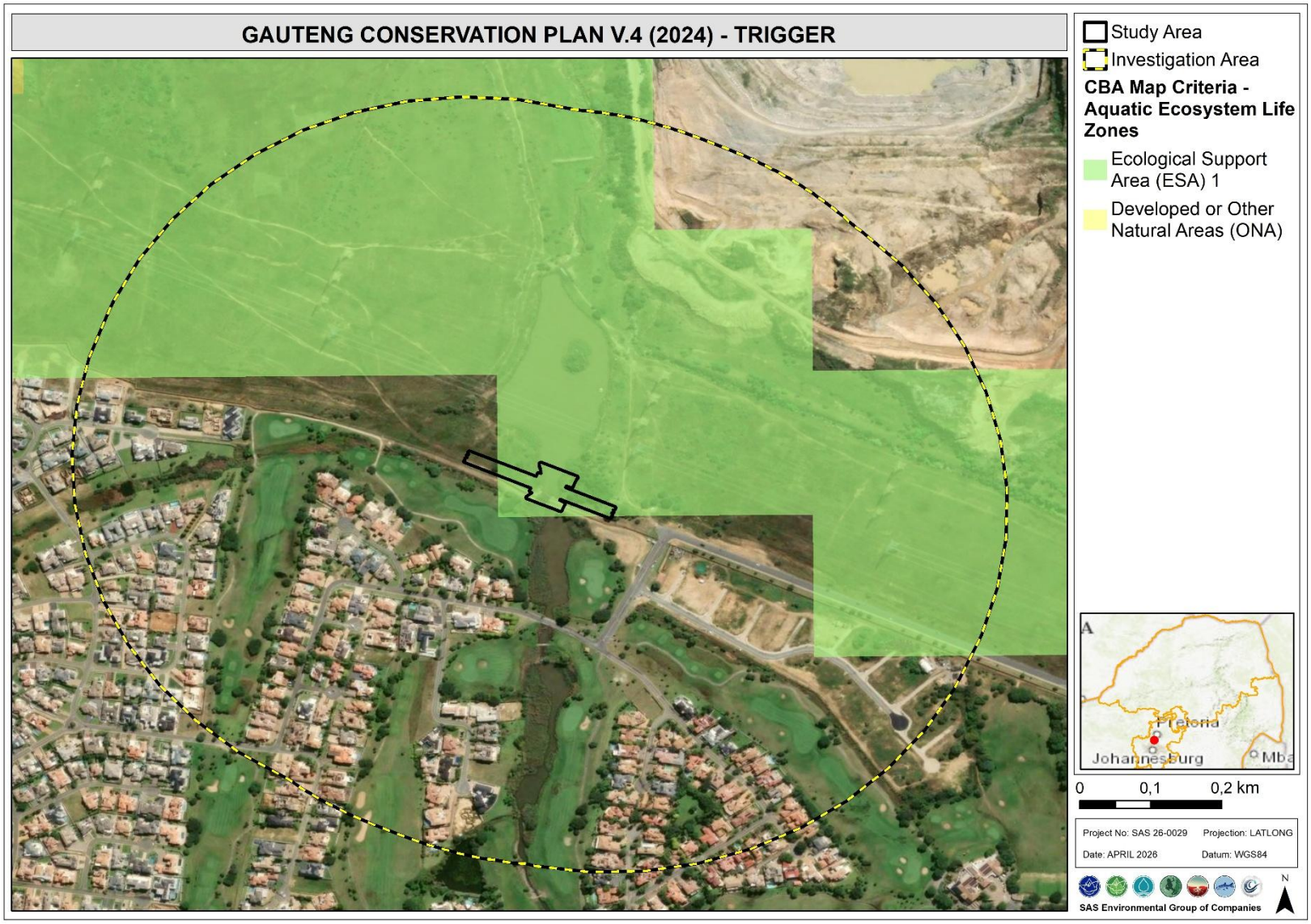


Figure 11: Areas of ESA ecological importance associated with the study area and associated investigation area according to the Gauteng Conservation Plan (2024).

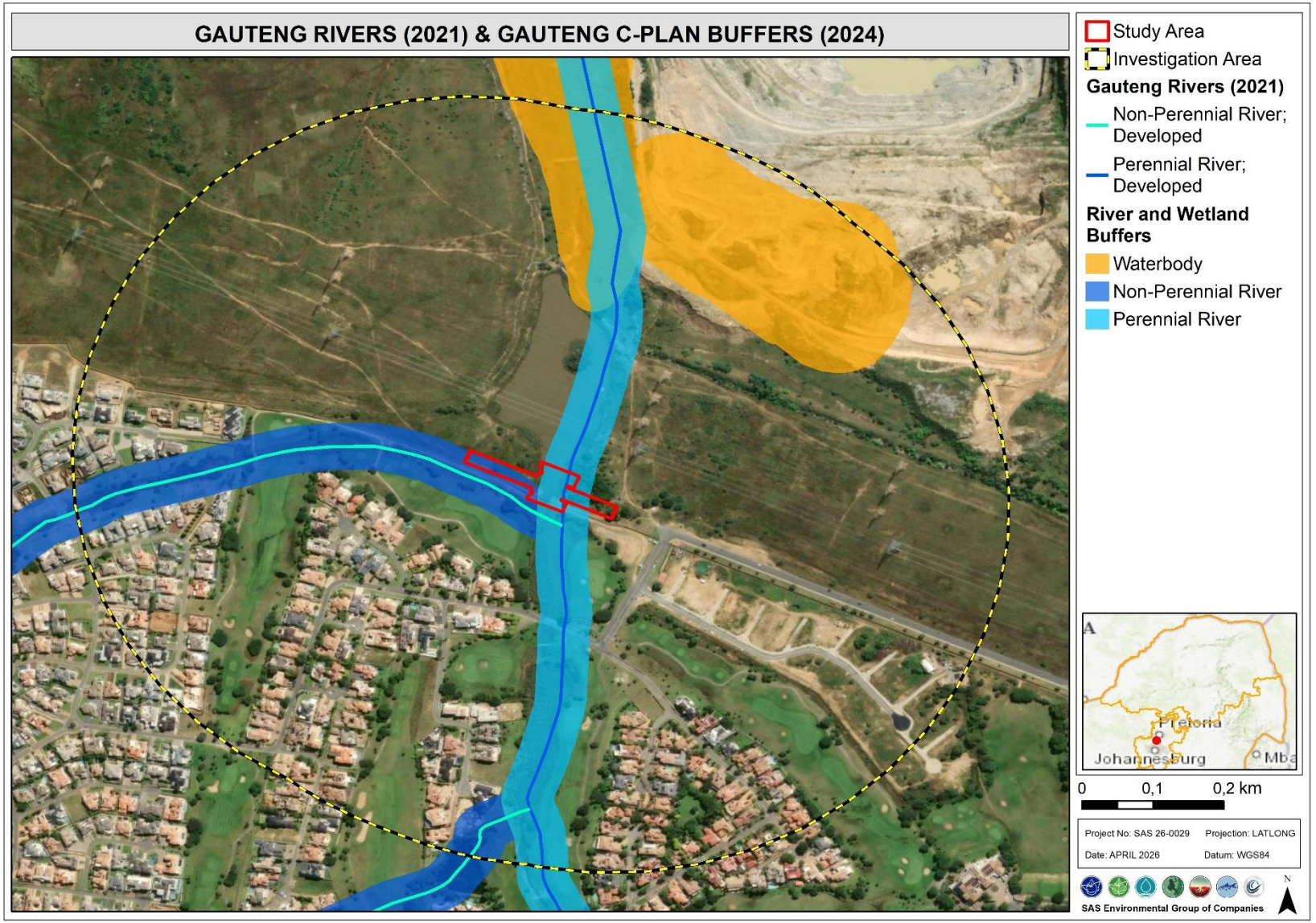


Figure 12: Freshwater buffer areas associated with the study area and associated investigation area according to the Gauteng Conservation Plan (2024) and Gauteng rivers according to the DWS Gauteng Rivers database (2021).

3.3 Literature Review of Previous Specialist Studies

Two previous specialist freshwater ecological assessment reports (Terrasoil Science, 2015 and SAS, 2016) were considered and reviewed as part of the background information gathering. Whilst neither report focused solely on the bridge which is the focus of this report, both assessed a larger area which included a reach of the Rietspruit River (i.e. the freshwater ecosystem traversed by the bridge).

The investigation undertaken by Terrasoil Science (2015) notes that numerous anthropogenically-driven modifications to the river have occurred, including *inter alia* agricultural activities, impoundment of the system, loss of recharge due to the diversion of a tributary to the east (to circumvent the granite quarry immediately adjacent to the river), the introduction of large volumes of sediment from the catchment, and notable transformation of the floral communities associated with the Rietspruit River. These impacts will be discussed in further detail in Section **Error! Reference source not found.** of this report, however, it is worth noting that over time, the pressures exerted by these modifiers on the receiving freshwater environment have led to a transformation of the key characteristics of the system such that there is a noticeable reduction in the occurrence and extent of wetland characteristics.

Both Terrasoil Science (2015) and SAS (2016) concluded that the Rietspruit River, having been subjected to various impacts over the course of several decades, was at the time considered 'critically modified' (PES Category F) indicating an almost complete loss of habitat and biota. While SAS (2016) ascertained that the river was considered of moderate ecological importance and sensitivity, this was attributed predominantly to the conservation threat status and protection level of the applicable WetVeg type, as ecological integrity and functioning had been severely compromised. Ecological service provision was deemed to be 'intermediate'. A summary of the results obtained by SAS (2016) is presented in the table below.

Table 2: Summary of the results obtained by SAS (2016).

Rietspruit River	Present Ecological State (PES) Category	Ecological function and service provision	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Class (REC)
	F	Intermediate	C	D

3.4 Site Verification Results

3.4.1 Freshwater Ecosystem Characterisation

The primary drainage system associated with the proposed bridge construction is a reach of the Rietspruit River (also referred to in this report as 'the Rietspruit'). Although unchannelled valley bottom wetland and non-perennial drainage line hydrogeomorphic (HGM) units were identified immediately south of the bridge, these HGM units are located upstream of the proposed activities and as such is not deemed to be at risk from the proposed activities. Similarly, the non-perennial drainage line flowing into the impounded portion of the Rietspruit (refer to Figure 13 overleaf) is not deemed to be at risk due to the direction of flow, and the anticipated buffering effects of the impoundment. Thus, only the affected reach of the Rietspruit, which is impounded, was assessed and is discussed further in this report.

The reach of the Rietspruit River within the investigation area was classified according to the Classification System (Ollis *et al.*, 2013) as an Inland System. The wetland falls within the Dry Highveld Grassland Group 3 Wetland Vegetation (WetVeg) Type, indicated as Least Threatened (LT) by Mbona et al. (2015). At Levels 3 (Landscape Unit) and 4 (HGM Type) of the Classification System, the system was classified as per the summary in Table 3, below.

Table 3: Characterisation at Levels 3 and 4 of the Classification System (Ollis *et al*., 2013) of the wetlands associated with the project investigation area.

Level 3: Landscape unit	Level 4: HGM Type
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 delineated freshwater ecosystem is conceptually depicted in Figure 13 overleaf in relation to the crossing area and investigation area.

3.4.2 Freshwater Ecosystem: Site Verification Results

Following the site verification, the assessments outlined in Section 1.1.1 were applied. The results of the assessments are discussed in the dashboard style report which follows (Table 4), and the details thereof are presented in **Appendix E**.

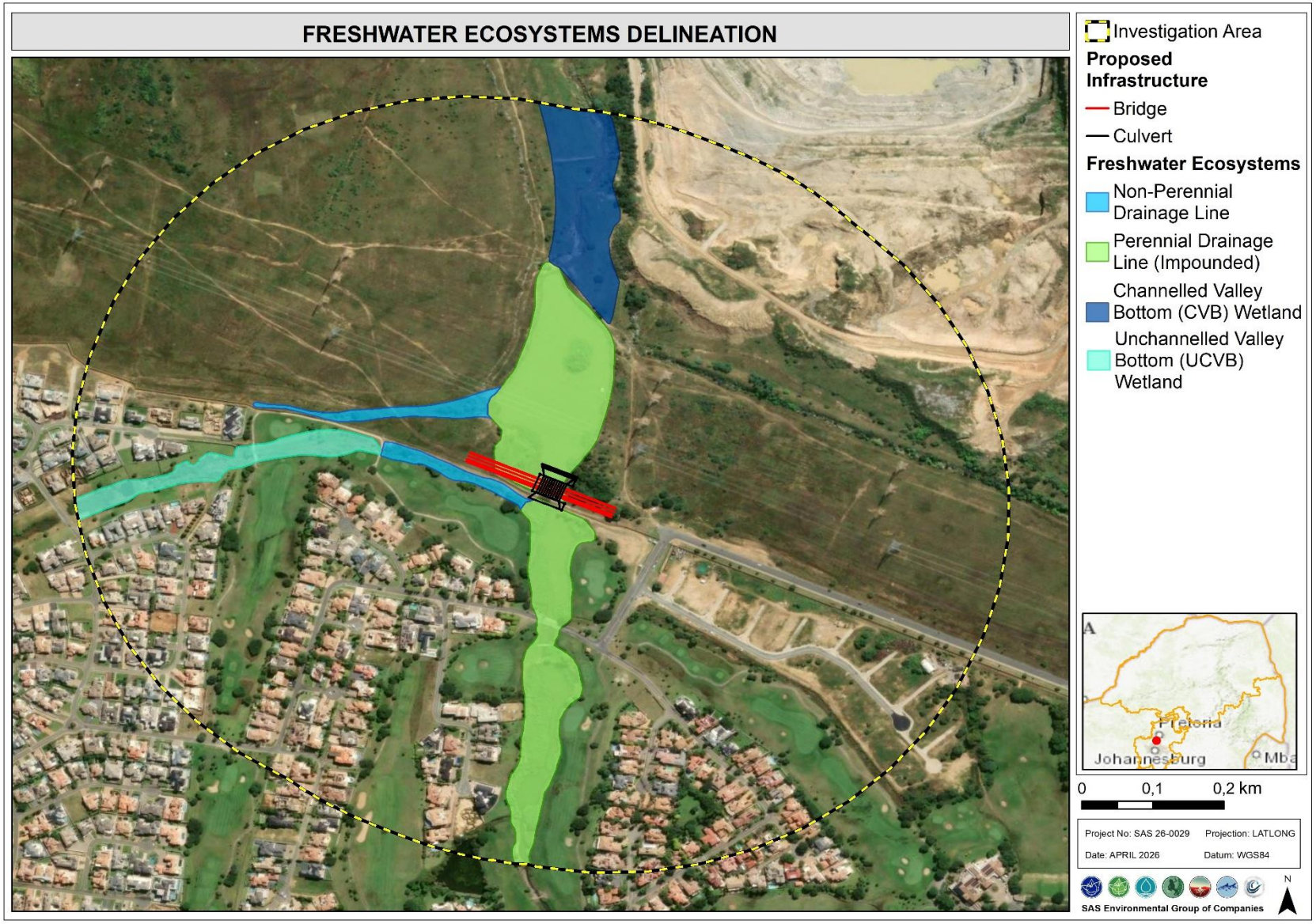
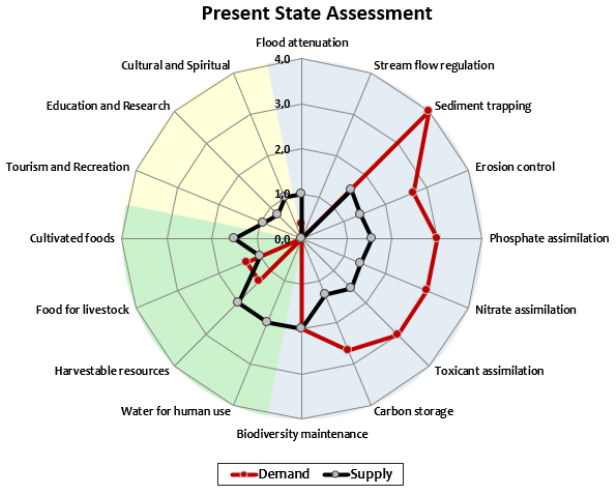


Figure 13: Location of the field-verified reach of the Rietspruit River in relation to the proposed crossing upgrade.

Table 4: Summary of the assessment of the reach of the Rietspruit River within the investigation area.

<table>
<tr><td colspan="2">Ecological & socio-cultural service provision graph
 
</td><td colspan="2"> 

Photographic Notes: Representative photographs of the crossing to be upgraded (left), and a section of the Rietspruit River to the north of the crossing.</td></tr>
<tr><td>Ecoservice provision</td><td colspan="3">Demand: Very High to Low
Supply: Moderate to Very Low
Demand for provision of ecological services such as sediment trapping, erosion control and assimilation of nutrients and toxicants is considered elevated due to the urbanised catchment and associated land uses. However, capacity to provide such services is greatly diminished as a result of the compromised ecological integrity. Conversely, the demand for socio-cultural services is significantly diminished (due to the urban setting), although capacity to provide limited benefits such as water, harvestable resources and recreational functions is considered low to moderate.</td></tr>
<tr><td>PES discussion</td><td colspan="3">PES Category: D/E (Largely to Seriously Modified)
The assessed reach of the Rietspruit River has been subjected to various pressures relating to agriculture and urban development over the course of several decades. These have not only led to diminished ecological functioning and integrity, but most notably have resulted in a change in the characterisation of the system, i.e. from that of a channelled valley bottom wetland to a strongly channelled riverine system possessing riparian habitat. Impacts include impoundment, erosion and bank incision, increased sedimentation, altered water quality, increased water inputs as result of catchment hardening and transformation of the floral community associated with the system.</td></tr>
<tr><td>EIS discussion</td><td colspan="3">EIS Category: Low/Marginal
Ecological importance and sensitivity is considered decreased, and this is attributed to the lowered ecological integrity of the system. As a consequence, the system is unlikely to provide valuable faunal habitat, with only the most tolerant biota likely to occur. Subsequent to the assessment of the system undertaken by SAS in 2016, the conservation threat statuses of the various WetVeg types were revised, thus this aspect which previously contributed to an increased EIS rating is no longer valid.</td></tr>
<tr><td>REC, RMO & BAS Category</td><td colspan="3">REC: D; RMO: D Improve; BAS: D
Although the strict application of the method (outlined in Appendix C) indicates that the RMO is to maintain the system in its present state, since a PES Category E is considered unacceptable (Malan and Day, 2012), a default REC class D is allocated and by inference, the management objective is to improve the Ecostatus of the system. However, taking into consideration the landscape setting of the watercourse outside protected areas, in an environment highly transformed by urbanisation, mining and agriculture, it will take the effort of multiple responsible stakeholders at a local, municipal and provincial level to realistically improve the PES of the system. Notwithstanding this, responsibility rests on the proponent to ensure that the proposed bridge upgrade does not create additional stressors on the receiving reach of the Rietspruit River. To aid in this objective, multiple mitigation measures are provided in Section 5 of this report and must be strictly implemented to ensure avoidance or minimisation of impacts.</td></tr>
</table>

Freshwater ecosystem drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):

The assessed reach of the Rietspruit River has undergone multiple impacts over the course of several decades. As demonstrated by Terrasoil Science (2015), it is likely that the system historically displayed characteristics consistent with those of a channelled valley bottom wetland, although according to Terrasoil Science (2015), few such characteristics remained at the time of that assessment. The findings of SAS during the current (2026) assessment supports this assertion, as the assessed reach has developed characteristics commensurate with those of a defined river channel, and a floral community resembling riparian, rather than wetland, habitat.

The hydraulic and geomorphological regimes have been significantly impacted through extensive land use changes in the catchment: urban and industrial development, development of road networks, indiscriminate disposal of solid waste (such as rubble) and infilling of the freshwater ecosystems including the Rietspruit River, historical agricultural practices which led to increased availability of sediment and granite quarrying in a tributary of the Rietspruit approximately 300 m north (and upstream) of the bridge crossing. Terrasoil Science (2015) noted significant inputs of sediment to the system, leading to long-term bed and bank incision (thus also contributing to sediment inputs and changes in sediment dynamics) as well as contributing to changes to flow dynamics and allowing for the establishment of vegetation where it may not otherwise have occurred. The incision and impoundment of the channel has likely led to a reduction in over-bank topping and in turn, reduction in wetland characteristics as well as reduced recharge to downstream reaches. Flows within the system are further inhibited and altered by the presence of instream infrastructure such as culverts and bridge crossings, affecting instream biota as oxygen saturation is likely to have been affected by such changes.

The floral assemblages have been significantly transformed over time, changing from communities typically expected in Highveld grassland (dominant graminoid layer with sparsely distributed forb species) to a more savanna-like structure (dominant graminoid layer, but with an increased occurrence of woody species). In addition to altered structure, the vegetation community is now dominated by Alien and Invasive Plant (AIP) species, such as *Acacia cf. dealbata, Cestrum parqui, Erigeron sumatrensis, Lespedeza cuneata, Paspalum urvillei, Salvia tiliifolia, Verbena brasiliensis* and *Xanthium strumarium*. Woody species recorded within the riparian zone included *Searsia lancea, S. pyroides* and *A. dealbata*. While the transition to riparian habitat does not necessarily remove faunal habitat, it will affect the faunal assemblages as wetland-dependent fauna becomes displaced as species more suited to the riparian structure encroach on the system. Notwithstanding this, it is postulated that due to the urbanisation of the catchment and related anthropogenic disturbances, only faunal species tolerant of such disturbance and pollution are likely to utilise the Rietspruit River.

Diatom analysis and water quality considerations:

Diatom sampling was undertaken and basic water quality parameters (temperature, Dissolved Oxygen (DO), pH and Electrical Conductivity (EC)) recorded at a single site adjacent to the bridge; the outcome of this sampling effort indicates organic contamination of the site, which is consistent with visual and olfactory observations during the site assessment as well as consideration of the urban setting. Although the water temperature can be considered normal for the time of day and season of sampling and the pH of 7.9 and EC of 22,8 mS/m are both in line with the ideal range limit according to DWAF (2011), the diatom analysis revealed moderate to high (meso-eutrophic) nutrient content, elevated electrolyte conditions, and extremely contaminated conditions. The results of the diatom analysis are summarise below; the detailed results are provided in Appendix F.

Table 5: Ecological and Biological traits summary of diatom samples.

Parameter	S1		
Dominant Taxa	*Nitzschia* sp., *Fragilaria biceps*, *Nitzschia linearis*, *Nitzschia palea*, *Gomphonema affine*, *Cymbella aspera*, *Aulacoseira granulata*	**SPI**	9.1 – Poor quality (Category D)
Functional Groups	Mix of benthic motile, attached/stalked, and planktonic centric taxa.	**%PTV**	28.3 – Some evidence of organic contamination.
Ecological Guilds	High-profile guild dominant with motile taxa present and some planktonic taxa.	**Diversity**	3.56 – High
Size Classes	Wide range of size classes including small motile and larger attached taxa.	**Evenness**	0.91 – High

Extent of modification anticipated	**Low** The proposed upgrade of the bridge crossing over the Rietspruit is expected to lead to some initial short-term impacts, however, it is not expected to result in long-term, spatially significant modification. Moreover, with the strict implementation of the mitigation measures provided in this report, the potential exists for improvement of local-scale conditions around the bridge crossing, and as such, the proposed upgrade is supported by the specialist.

Risk Assessment Outcome and Business Case:

Low	Taking into consideration the decreased ecological integrity and lowered EIS of the Rietspruit, as well as the intention of the proponent to undertake instream construction activities during the low-flow winter period, the proposed activities are anticipated to pose an overall 'low' risk significance to the system. Moreover, provided that the mitigation measures outlined in this report (Section 5.1) are strictly implemented, not only can the significance of the expected short-term negative impacts be reduced, but a long-term positive outcome can be achieved through improving hydraulic connectivity and geomorphological stability; therefore, the proposed bridge upgrade is supported by the specialist.

4. LEGISLATIVE REQUIREMENTS AND APPLICATION OF BUFFER ZONES.

The following legislative requirements were considered during the assessment. A detailed description of these legislative requirements is presented in **Appendix B** of this report:

- The Constitution of the Republic of South Africa, 1996[3];
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) (as amended);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA) (as amended); and
- Government Notice 4167 as published in the Government Gazette 49833 of 2023 as it relates to the NWA, as amended).

4.1 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 Water Use Authorisation 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 per Table 6 below.

Table 6: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Water Use License Application for water uses as stipulated in Section 21(c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998) (as amended).	**Government Notice 4167 as published in the Government Gazette 49833 of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)** In accordance with GN4167 of 2016 as it relates to the National Water Act, 1998 (Act 36 of 1998), a regulated area of a watercourse in terms of water uses as listed in Section 21c and 21i is defined as: • **the outer edge of the 1 in 100 year flood line and/or delineated riparian habitat**, **whichever is the greatest distance**, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; • in the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench**;** or • a 500 m radius from the delineated boundary (extent) of any wetland or pan in terms of this regulation.

[3] Since 1996, the Constitution has been amended by seventeen amendments acts. The Constitution is formally entitled the 'Constitution of the Republic of South Africa, 1996". 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.

Regulatory authorisation required	Zone of applicability
Listed activities in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA Regulations (2014), as amended. **Department of Environment, Forestry and Fisheries (DEFF).** To be determined by the EAP in conjunction with the applicable regulating authority.	**Activity 4** of Listing Notice 3 of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended): The development of a road wider than 4 metres with a reserve less than 13,5 metres. c. Gauteng ***iv. Sites identified as Critical Biodiversity Areas (CBAs) or Ecological Support Areas (ESAs) in the Gauteng Conservation Plan or in bioregional plans.*** **Activity 18** of Listing Notice 3 of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended): The widening of a road by more than 4 metres, or the lengthening of a road by more than 1 kilometre.* c. Gauteng ***iv. Sites identified as Critical Biodiversity Areas (CBAs) or Ecological Support Areas (ESAs) in the Gauteng Conservation Plan or in bioregional plans.*** **Activity 14** of Listing Notice 3 of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended): *The development of:* *(xii) Infrastructure or structures with a physical footprint of 10 square meters or more.* *Where such development occurs—* *a) Within a watercourse;* *b) In front of a **development setback**; or* *c) **If no development setback has been adopted, within 32 meters of a watercourse**, measured from the edge of a watercourse.* c. Gauteng ***iv. Sites identified as Critical Biodiversity Areas (CBAs) or Ecological Support Areas (ESAs) in the Gauteng Conservation Plan or in bioregional plans.***
GDARD Requirements for Biodiversity Assessments, Version 3 (2014).	The GDARD Requirements for Biodiversity Assessments, Version 3 (2014) specifies buffer widths for sensitive features. For rivers (non-perennial / perennial) riparian zones and wetlands, buffer zones must be designated as sensitive according to the following mapping rules. • The riparian zone/wetland must be delineated according to "DWAF, 2003: A Practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". • **A 32 m buffer zone from the edge of the riparian zone for rivers/streams within urban areas must apply.** • A 100 m buffer zone from the edge of the riparian zone for rivers/streams outside urban areas must apply. The Guidelines highlight that these buffer zones are essential to ensure healthy functioning and maintenance of aquatic ecosystems and function as wildlife corridors and refugia.

***Note that Activity 18 of Listing Notice 3 may not be applicable, if the road crossing is not to be widened.**

Taking the above into consideration, the following Zones of Regulations may be applicable:

- A **32 m** zone of regulation in line with National Environmental Management Act, 1998 (Act 107 of 1998) (Figure 14); and
- A **500 m** zone of regulation in line with Government Notice 4167 as published in the Government Gazette 49833 of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (Figure 15).

In addition, a 32 m GDARD buffer zone may be applicable (not depicted due to the setback overlapping with the NEMA ZoR).

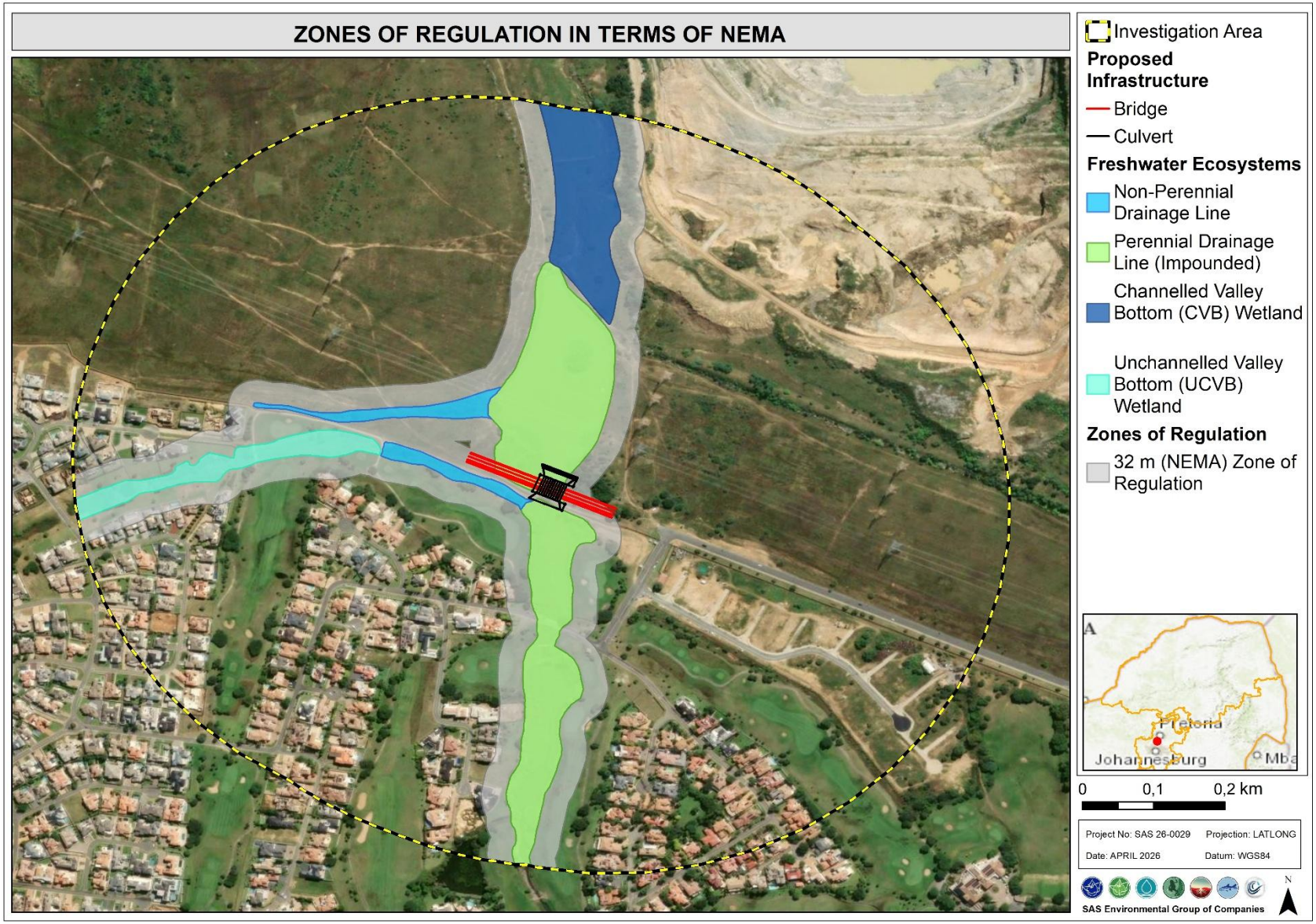


Figure 14: Conceptual presentation of the Zones of Regulation as it relates to the National Environmental Management Act (NEMA) (Act 107 of 1998).

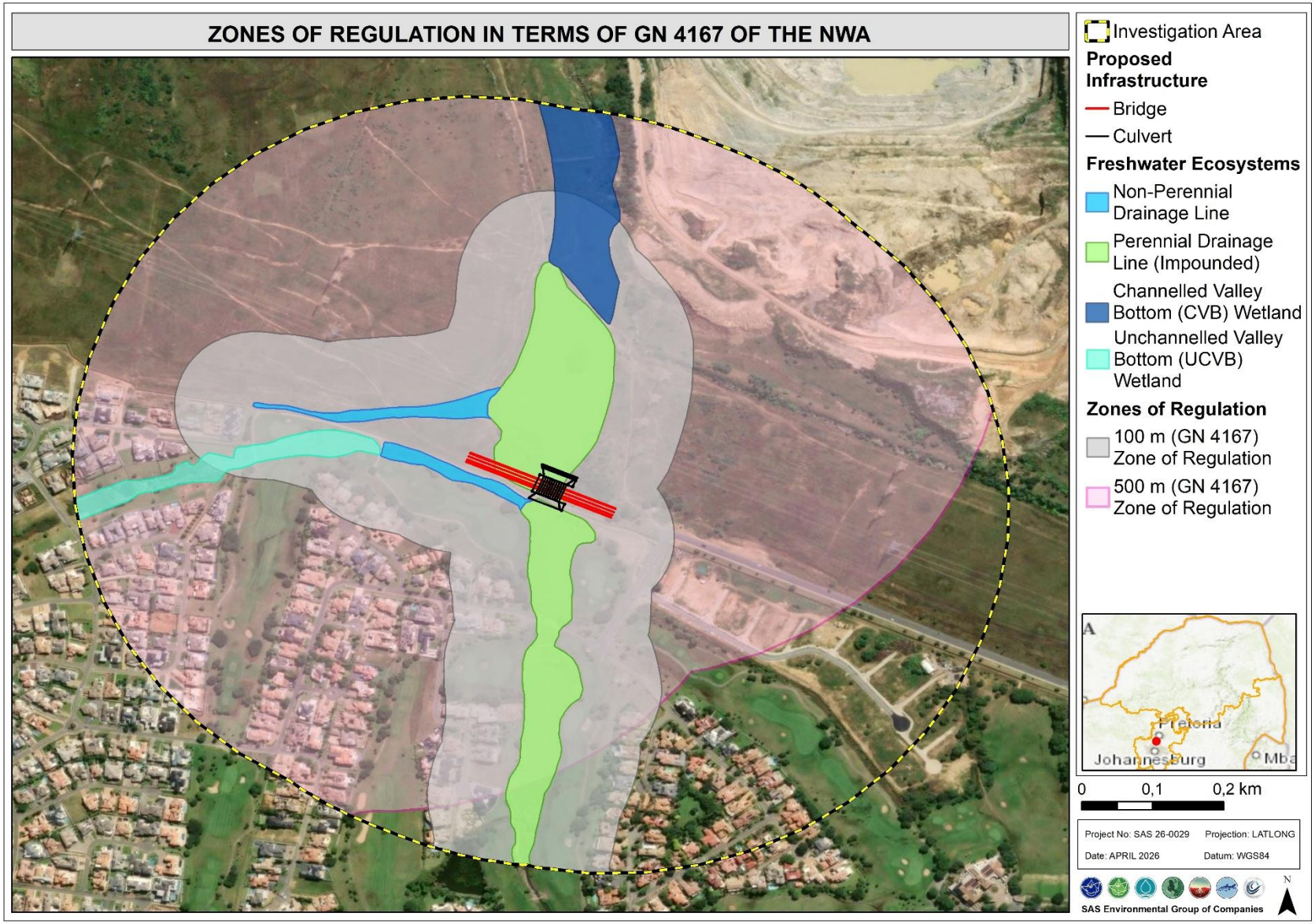


Figure 15: Conceptual presentation of the Zone of Regulation in terms of GN 4167 as it relates to the National Water Act, 1998 (Act No. 36 of 1998).

4.2 Site-specific Ecological Buffer Zones

To offer a measure of protection to the freshwater habitat in the investigation area, buffer areas are necessary to be designated around the freshwater ecosystem affected by the proposed crossing upgrade. According to Macfarlane & Bredin (2017a), 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 & Bredin 2017a). 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 & Bredin 2017a).

The scientific Buffer Guideline Tool (Macfarlane & Bredin 2017b) was applied to the reach of the Rietspruit River associated with the proposed crossing upgrade. The buffer guideline provides an Excel™ based Buffer Zone Tool to determine suitable buffer zone requirements. The tool includes a rapid desktop tool for determining potential aquatic impact buffer zone requirements together with a site-based tool for determining buffer zone requirements for rivers, wetlands and estuaries. Central to the tool is a buffer model, which is populated automatically from the data inputted. This is based on best available science and is used to generate buffer zone recommendations as part of the assessment process. Figure 16 below outlines an overview of the step-wise assessment process for buffer zone determination as applied through the tool. The buffer assessment was determined using site-based parameters using data collected for the (on-site) detailed assessment of freshwater ecosystems in the study area. Table 7 details the results of the refined buffer assessment.

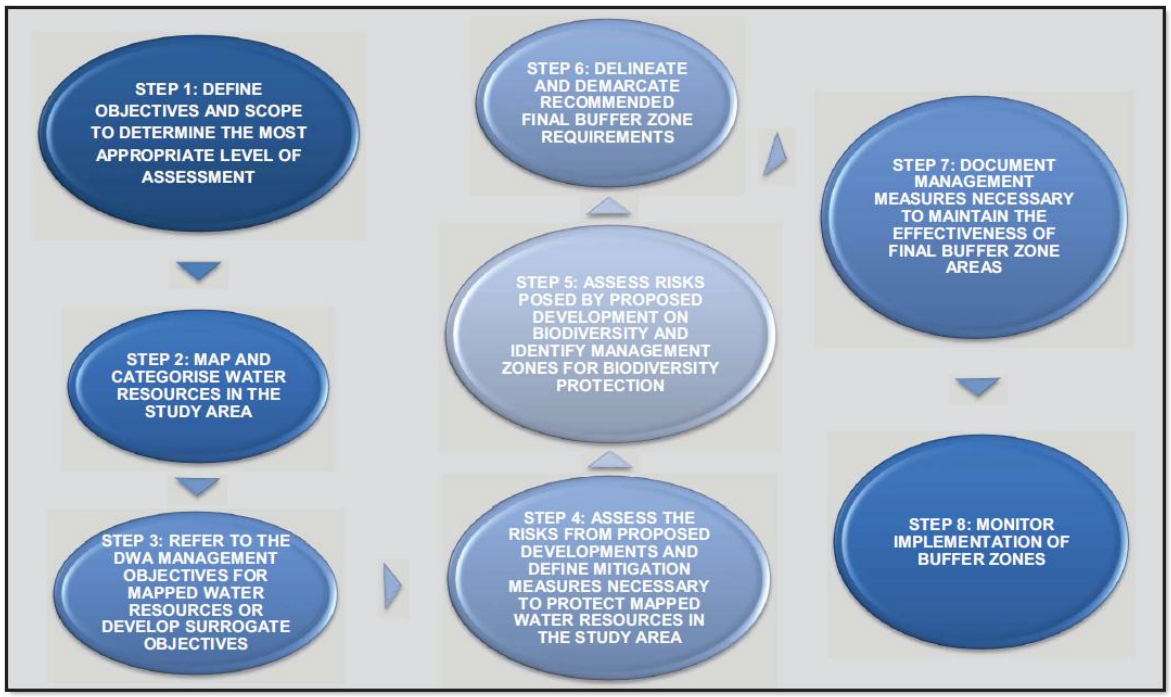


Figure 16: Overview of the step-wise assessment process for buffer zone determination as applied through the buffer tool.

Table 7. Buffers as recommended by the buffer tool for the assessed reach of the Rietspruit affected by the proposed road crossing.

Freshwater Ecosystem	Construction phase buffer	Operational Phase buffer	Final aquatic impact buffer
Reitspruit River	15 m	15 m	**15 m**

The ecological buffer area is illustrated in Figure 17 overleaf. 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.

Note that the 15 m buffer assigned is not intended to be a complete exclusion buffer (i.e. a no-go zone) as the nature of the proposed project necessitates some activities inside the delineated extent of the freshwater ecosystem itself, and within the terrestrial buffer area. Rather, the buffer must be viewed as a selective exclusion area, within which certain activities must be avoided. These include the **preparation and operation of contractor facilities, ablution facilities and discard of waste related to the upgrading activities**. All these activities must therefore occur outside the 15 m buffer area. The buffer area must also form part of the **area to be actively rehabilitated after construction is complete**. Please refer to Section 5 for further details in this regard.

In addition to the ecological buffer, a 5 m construction Right of Way (RoW) may be implemented if required on the southern, i.e. upstream, side of the proposed bridge to allow for ease of access.

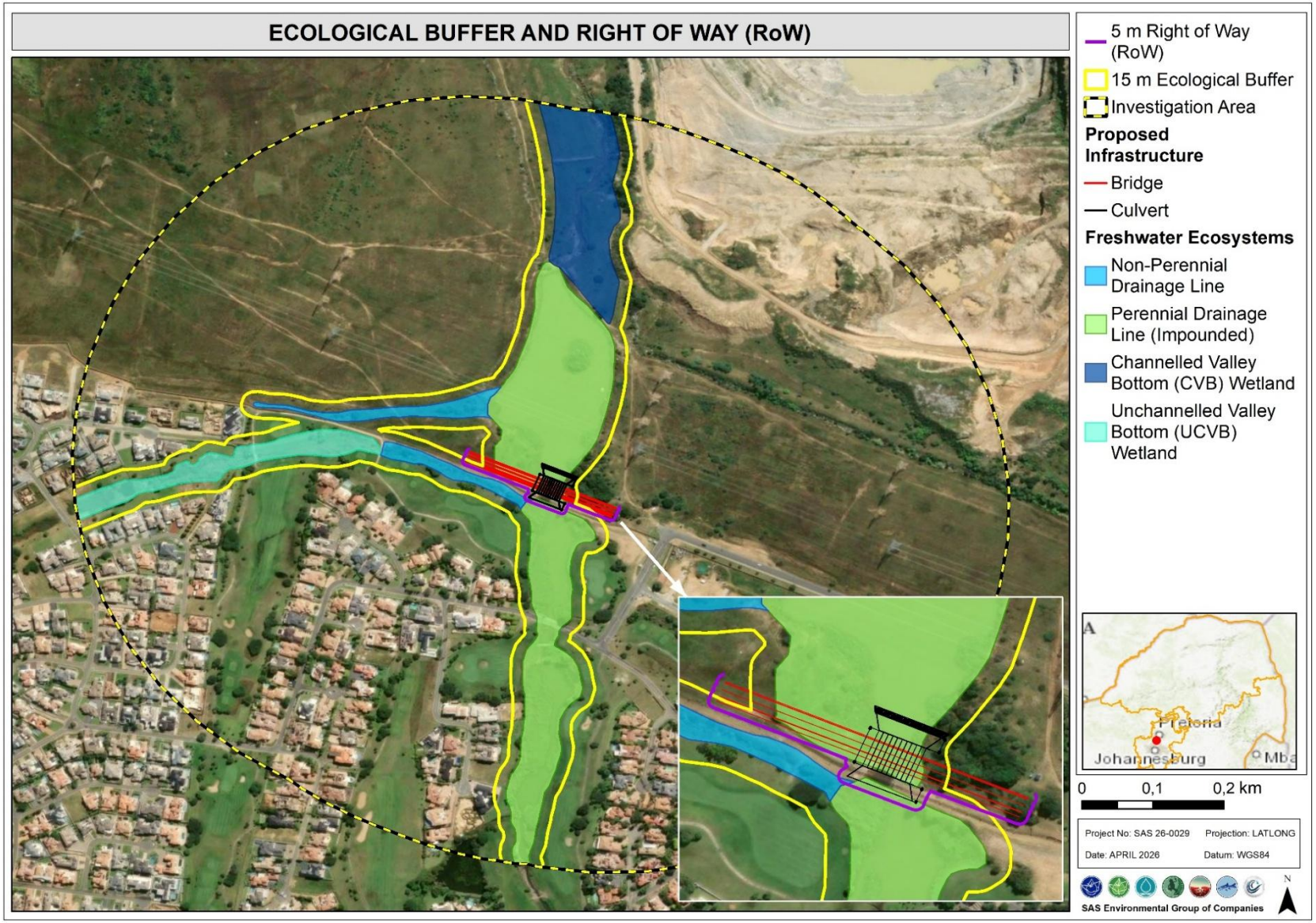


Figure 17: Conceptual representation of the ecological buffer and construction Right of Way associated with the study area.

5. RISK ASSESSMENT

This section presents the results of the DWS approved Risk Assessment Matrix (RAM) as promulgated in 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) that was applied to assess potential risks to the ecology of the wetland within the investigation area. In addition, this section indicates the required mitigatory measures needed to minimise the perceived impacts on the receiving environment and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented.

5.1 Risk assessment analysis

The RAM was applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of the receiving freshwater environment and was based on the project footprint area as provided by the proponent.

The activities assessed in the RAM were limited to the construction / installation of the following:

- Stormwater culvert bridge;
- Road crossing over the Rietspruit;
- Municipal service infrastructure (water, data, electrical).

The civil services information report Civil Concepts (2026) provides detail pertaining to the anticipated construction methods and engineering design details of the above, and is not repeated here but was considered in the compilation of the RAM.

The points below summarise the considerations undertaken as part of the risk assessment:

- The risk assessment was applied assuming that a high level of mitigation is implemented, thus the results of the risk assessment provided in this report presents the perceived impact significance ***post-mitigation***;
- In applying the risk assessment, it was assumed that the mitigation hierarchy as advocated by the DEA *et al.* (2013) would be followed, i.e. the impacts would be avoided, minimised if avoidance is not feasible, rehabilitated as necessary and offset if required;

- Based on the information provided by Civil Concepts (2026), the RAM was applied on the assumption that the construction activities within the active channel of the Rietspruit would be undertaken during the dry winter period as far as possible, to minimise the impact on the flow regime due to the temporary diversion thereof. Should it not be feasible to undertake the construction activities during the dry season, the risk significance associated with those activities may potentially increase due to anticipated higher flow volumes and the associated greater risk of impacts such as erosion, mobilisation of sediment, etc.;
- The ecological state and EIS of freshwater ecosystems are directly included in the determination of the risk significance, and the results of the ecological assessment as presented in Section 3.4.2 were taken into consideration since the anticipated significance of impact is likely linked to the ecological integrity and overall ecological importance and sensitivity thereof;
- The activities and the associated risks they pose are all site-specific, not of a significant extent relative to the freshwater ecosystems and therefore have a limited spatial extent (i.e. within the investigation area). The exceptions are risks of water contamination during construction (e.g. during concrete mixing) and from the operation of road crossings over the freshwater ecosystem including potential blockages or structural failures;
- Most impacts are considered easily detectable; and
- The duration of the activities associated with the operational phase is considered to be long term (ceases with operational life of the infrastructure) and as such the impacts associated with these activities are also considered to be long term.

Provided that the mitigation hierarchy is followed, potential impacts to the freshwater ecosystems in the landscape can be avoided. The mitigation measures provided in this report have been developed with the mitigation hierarchy in mind, and the implementation and adherence to these measures will assist in minimising the significance of impacts on the receiving environment.

A summary of the DWS Risk Assessment Matrix applied to the proposed activities is provided in Table 13 below along with a suite of mitigation measures to assist in reducing the significance of any potential edge effects.

Table 8: Summary of the results of the DWS Risk Assessment matrix.

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
CONSTRUCTION	**1**	Site preparation for civil works within the delineated extent of the Rietspruit and associated floodlines and ecological buffers, including: • Stockpiling of construction equipment and storage of materials, vehicles and machinery; and • Possible indiscriminate vehicle movement through the non-marginal zones of the riparian corridor.	• Dust generation from exposed soil potentially leading to the smothering of riparian vegetation and biota, and altering surface water quality; • Potential soil destabilisation leading to further sedimentation, or conversely, soil compaction leading to increased surface runoff into downstream / downgradient freshwater ecosystem; • Potential further spread of alien and invasive plant species (AIPs) from disturbed soil; and • Contaminant spillage into the freshwater ecosystem from machinery and vehicle operation.		**4**	1	1	**6**	**2**	**12**	80%	**9,6**	**L**	High	1. It is assumed that access to the site will be from existing access roads as far as feasible; nonetheless this must be reiterated to construction personnel, to avoid indiscriminate driving through the freshwater ecosystems; 2. The 15 m ecological buffer must be implemented and demarcated on site where practical (taking into consideration dense vegetation cover and potential safety concerns related to the terrain), for the duration of the construction works for the proposed repairs in order to mitigate edge effects. Where dense indigenous vegetation provides a natural buffer, the demarcation of the buffer (and RoW) may be implemented at the discretion of the Environmental Control Officer (ECO). The outer boundary of the 5 m construction RoW must be clearly demarcated (where feasible) using a suitable barrier or material (e.g. Figure A) by an ECO and both the buffer area and the construction RoW are to be marked as 'no-go' areas to ensure that construction activities do not encroach into the freshwater environment and associated buffer area except where essential. Only authorised construction personnel may be permitted to enter these 'no-go' areas as part of the construction and subsequent rehabilitation activities, where required, to prevent excessive compaction of the soil within the freshwater ecosystems.

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
															 **Figure A: Example of a barrier fence used to demarcate the no-go area outside of the 15 m ecological buffer of the freshwater ecosystems, where applicable and 5 m construction RoW.** 3. Contractor laydown areas, vehicle re-fuelling areas and material storage facilities to remain outside of the 15 m ecological buffer of the freshwater ecosystems and preferably the 32 m NEMA ZoR, where possible. A designated contractor laydown area must be approved by an independent ECO prior to use; 4. Stockpiles must be placed outside the delineated freshwater ecosystems, the associated 15 m ecological buffer and preferably the 32 m NEMA ZoR (the latter where practical); 5. Site clearing activities (including for contractor laydown areas) are to remain within the authorised footprint and vegetation clearing is to be limited to what is absolutely essential within that active footprint, with the exception of alien vegetation which may be carefully removed; 6. Avoid unnecessary trampling of vegetation irrespective of the vegetation being associated with the freshwater

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
															ecosystems or the surrounding terrestrial area; 7. Retain as much indigenous vegetation as possible (riparian / wetland and terrestrial); 8. Dust suppression measures must be implemented throughout construction to prevent excessive dust which may smother freshwater vegetation; and 9. In all events all machinery and vehicles used during construction must be maintained and equipped with drip trays to prevent oil, petrol or diesel leaks. If breakdowns occur these must be towed offsite site to the designated areas/workshops. The proposed control measures will ensure that incidental oil spills and leakage are minimised onsite and thus limit any opportunities of water contamination and water quality deterioration.
	2	Clearing of vegetation within the repair site footprint area including stripping of topsoil within the riparian habitat.	• Exposure of soil, leading to increased runoff and erosion, and thus increased likelihood for sedimentation of the freshwater ecosystem; • Loss of riparian habitat and ecological structure resulting in impacts to biota; • Increased sedimentation, potentially leading to further smothering of vegetation in the downstream reaches;		**4**	1	2	**7**	**2**	**14**	80%	**11,2**	L	High	1. No indiscriminate movement of vehicles through the freshwater ecosystem may be permitted. All vehicles must remain outside of the 15 m ecological buffer, unless required as part of specific construction activities for a short period of time. This must also be limited to the drier summer season, where possible, to reduce risk significance; 2. Topsoil excavated from construction areas must be stored separately and may not be contaminated. The topsoil is to be reused on completion of construction for rehabilitation; 3. Control alien vegetation, specifically invasive and pioneer species which are already well-established and may find a niche to encroach disturbed areas. Ensure AIPs are managed post construction until suitable basal cover is achieved; and 4. Once all vegetation clearing is completed, all AIP and any removed excess material must be disposed of at a licensed refuse facility and may not be mulched or burned on site.

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
			• Further proliferation or spread of alien and/or invasive vegetation as a result of disturbances; and • Potential for further decreased ecoservice provision of the freshwater ecosystem.												
	3	Groundbreaking and excavations within the freshwater ecosystem as part of the activities to prepare suitable foundations for the placement of culverts, construct outlet / drainage structures and provide protection works, and install gabion retaining wall with erosion protection (if required), which may include	• Excess soil being removed within the road surface and falling into the riparian habitat adjacent to the road resulting in altered pattern flow and timing of water in the freshwater ecosystem; • Disturbances of soil leading to ponding of water as a result of over compaction of soil in some areas, increased AIP proliferation, and in turn altered riparian habitat and runoff patterns; • Altered runoff patterns, leading to increased erosion and sedimentation of the		**4**	2	2	**8**	**2**	**16**	100 %	**16**	L	High	1. The construction footprint must be limited to the proposed repairs footprint and 5 m construction RoW (i.e. the authorised development footprint area) only; 2. Limit construction equipment within the riparian ecosystems to what is essential; and 3. All proposed activities will potentially result in bank destabilisation, particularly the construction of the temporary bypass road, and an increase in bank incision and sedimentation of the freshwater ecosystems. Therefore, sediment control devices must be constructed in-situ prior to construction activities. Refer to control measures of Activities 4 and 5 for additional information. **Control measures specific to concrete works:** Concrete and cement-related mortars can be toxic to aquatic life. Proper handling and disposal should minimise or eliminate discharges into the assessed watercourses. High alkalinity associated with cement can dramatically affect and contaminate both soil and ground water. The following measures must be adhered to: o Fresh concrete and cement mortar should not be mixed near the riparian ecosystems. Mixing of cement may be

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
		infilling and cut and fill of side slopes, excavation of areas for the erosion protection measures.	downstream riparian habitat; and • Potential erosion and formation of preferential flow paths as a result of disturbed soil and inappropriate slopes (i.e. too steep) resulting in additional sedimentation of the freshwater ecosystem.												done within the construction camp, however it may not be mixed on bare soil, and must be within a lined, bound or bunded portable mixer. Consideration must be taken to use ready mix concrete; o No mixed concrete shall be deposited directly onto the ground or within the riparian ecosystems. All concrete must be brought in via a cement mixing truck which must remain within the proposed development footprint and associated 5 m construction RoW, and cement must be piped down to the proposed road footprint area. Any areas that require manual application of cement require that the mixed road surfacing materials be placed on a batter board or other suitable platform/mixing tray until it is deposited; o A washout area must be designated outside of the riparian ecosystems, and wash water should be treated on-site or discharged to a suitable sanitation system; o At no point may batter boards/mixing trays or cement trucks be rinsed off on site and run-off water be allowed into the riparian ecosystems; o Cement bags (if any) must be disposed of in the demarcated hazardous waste receptacles and the used bags must be disposed of through the hazardous substance waste stream; and o Spilled or excess concrete must be disposed of at a suitable landfill site. Chain of custody documentation must be provided.
	4	In-channel re-construction work, entailing, *inter alia*: - Temporary	• Minor removal of instream and marginal riparian vegetation; • Movement of construction machinery		**6**	1	2	**9**	**2**	**18**	100 %	**18**	**L**	High	1. Refer to control measures applicable to Activity 3. 2. Water must be diverted into the downstream reaches, around the construction area (similar in concept to the use of a coffer dam, although a coffer dam may not be required or implemented). Water must be allowed to recharge the

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
		diversion of flow while construction of new infrastructure and decommissioning of existing, damaged infrastructure takes place; - Placement of *either* ten 3.0 x 2.4 m box culverts, or 34 x 1500 mm diameter pipe culverts across the width of the active channel; - Construction of culvert inlet and outlet structures, consisting of concrete apron slabs, wingwalls and gabion mattresses; - Re-construction of road surface, involving	within channel, leading to benthic disturbance including potential damage to aquatic biota egg banks, instream sediment disturbance, and compaction of bank and bed soil; • Disturbances of soil as a direct result of removal of damaged infrastructure and replacement with new culverts, leading to localised ponding of water as a result of earthworks, over-compaction of soil due to movement of machinery, damage to fish and macroinvertebrate egg banks, potential for increased AIP proliferation (instream and riparian), and in turn altered instream and riparian habitat, flow patterns and sediment distribution;												downstream reaches at all times, although sediment traps must be installed around any activities located upgradient of the river (e.g. construction camps, stockpiles etc) to ensure that volumes of sediment entering the river are minimised. Sediment traps are to be inspected daily and accumulated sediment to be removed by hand on a weekly basis; 3. Sediment traps must be installed either every 15 m downstream for any works for a length of 100 m, or, if this is not feasible (due to flow volumes, channel width, topography or spatial restriction of the authorised area within which work may occur), then sediment traps must be installed around the downgradient boundary of the construction work. The determination of appropriate placement of such sediment traps may be at the discretion of the ECO. This is of specific importance given the already compromised condition of the Rietspruit and thus any sediment laden run-off can further impact the ecological condition of the system (see Figure B below). 4. Ensure that the creation of the diversion does not result in a significant water level difference upstream or downstream of the construction site; 5. It is recommended that a suitably qualified freshwater specialist and ECO monitor any flow diversions as well as sediment traps at least bi-monthly during the construction period to monitor the conditions of the freshwater ecosystems during construction and after flows are re-directed through the new infrastructure;

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
		concrete works and placement of guide-blocks; - Removal of existing damaged culverts and concrete aprons.	• Altered runoff patterns, leading to increased erosion and sedimentation of the downstream riparian and instream habitat; and • Potential erosion and formation of preferential flow paths as a result of disturbed soil, and inappropriate slopes (bank and stream bed) resulting in altered sediment distribution and altered benthic characteristics affecting aquatic fauna and flora.												 **Figure B: Examples of silt traps to be used during the construction phase, to limit additional sediment from entering the downstream reaches of the freshwater ecosystems.** 6. Temporary access crossings (if required) must intersect the river at a right angle (perpendicular) to minimise disturbance to the riparian ecosystems; 7. The area outside the 5 m construction RoW of the proposed repairs must be demarcated as a no-go area. No vehicles or personnel are permitted within this area; 8. Material to be used as part of the proposed repairs must be stockpiled outside the 32 m NEMA ZoR of the river to prevent additional 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 should be protected from wind and precipitation using tarpaulins or a suitable geotextile; and 9. Any remaining soil following the completion of the proposed repairs are to be spread out thinly in an area within the riparian zone to aid in the natural reclamation process.
	5	Post-construction embankment	• Exposure of soil, leading to increased runoff and erosion, and		**4**	1	2	**7**	**2**	**14**	100 %	**14**	**L**	High	1. Refer to the control measures of Activity 1 and measures 1 to 3 of Activity 3.

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
		side slope protection, installation of municipal services infrastructure, and resurfacing / overlay of road surface, entailing *inter alia*: **Side slope protection:** - sloping of side slopes at 1:2 (not preferred) to 1:3 (preferred); - Placement of top soil on road surface and hydro-seeding according to ecologist specifications; - Implementation of additional erosion controls (non-degradable or Armorflex blocks). **Roadway**	thus increased likelihood for further sedimentation of the freshwater ecosystem; • Loss of riparian habitat and ecological structure within the section of the river that will be traversed, resulting in impacts to biota; • Increased sedimentation of the freshwater ecosystem, leading to smothering of vegetation in the downstream reaches of the freshwater ecosystem; • Potential impacts on water quality and contamination of soil within the freshwater ecosystem; • Potential further proliferation / spread of AIPs as a result of disturbances; and • Potential decreased capacity of the ecoservice provision of											

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
		construction: -Construction of layer works in accordance with construction method statement prepared by Civil Concepts (2026). **Installation of municipal infrastructure:** - Water pipes, data cabling, sleeves and electrical cabling to be installed within the earth fill of the bridge crossing, in accordance with the construction method statement prepared by Civil Concepts (2026).	the freshwater ecosystem.												

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
	6	Construction of a temporary bypass road using fill material, and potential surfacing of the temporary road using surfacing seal including: • Excavation within the Rietspruit River for the installation of a throughflow structure; and • Placement of temporary pipe culverts.	• Earthworks could be potential additional sources of sediment, which may be transported as runoff into the downstream reach of the system; • Exposure of soils, leading to increased runoff, and erosion, and thus further increased sedimentation of the downstream reach of the system; • Increased sedimentation, leading to smothering of instream vegetation and/or further proliferation of ruderal and AIP species within the system; • Further proliferation of AIPs as a result of disturbances in turn transforming habitat further; • Potential impacts to water quality and contamination of soil in the system; and		**4**	1	2	**7**	**2**	**14**	80%	**11,2**	**L**	High	1. Mitigation measures applicable to Activities 1 to 4 above, and to Activity 7 below, are applicable to this activity and must be implemented accordingly.

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
			• Soil contamination and potential oil and hydrocarbon spills originating from construction vehicles.												
	7	Rehabilitation of the impacted reaches of the freshwater ecosystems including: • Resloping, reprofiling and revegetation of the river banks to prevent future erosion; and • AIPs removal.	• Exposure of soils, leading to increased runoff and erosion which can lead to increased sedimentation of the freshwater ecosystem; • Potentially altering surface water quality through increased turbidity from increased suspension loads and contamination from oils and hydrocarbons; • Soil compaction of the embankment; • Potential temporary disruption to the hydrological processes of the freshwater ecosystem; and • Damage and or removal of indigenous vegetation.		**4**	1	2	**7**	**2**	**14**	80%	**11,2**	**L**	High	1. Refer to control measures 1 to 3 of Activity 1 regarding movement in the delineated extent of the freshwater ecosystem. Careful planning of all construction equipment must be undertaken beforehand to ensure that the minimum impact on the freshwater ecosystem occurs; 2. Rehabilitation of the impacted reaches of the freshwater ecosystem and the associated 15 m ecological buffers must be undertaken. This must include clearing of all AIPs and reinstatement of indigenous wetland/riparian vegetation within the disturbed footprint; 3. Where applicable for the AIPs, care must 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 and that water contamination is avoided; and 4. Following construction of the proposed road repairs a suitable alien invasive management plan must be developed by an appropriately qualified specialist, and must be implemented accordingly to ensure that AIPs do not become established within the areas disturbed by construction and/or decommissioning activities.

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
OPERATIONAL	8	• Operation and maintenance of the culvert bridge and road crossing. • Operation and maintenance of municipal services infrastructure.	• Impact on water quality from possible leakages and spillage of hydrocarbons from vehicles using the road; • Impact on water volumes in the event of leaks from water pipelines; • Flow concentration and potentially erosion at concentration points i.e. culverts within the freshwater ecosystem; • Altered runoff patterns and increased water inputs to the freshwater ecosystem, further contributing to altered flow regime and subsequent impacts on the riparian vegetation; and • Potential increased loss of indigenous vegetation and the further proliferation of alien floral species due to disturbances.		**2**	1	4	**7**	**2**	**14**	80%	**11,2**	**L**	High	1. Routine maintenance of the road must be undertaken to ensure that no concentration of flow and subsequent erosion occurs due to the road crossing over the system or due to inadequate drainage from the road. Such maintenance activities must especially be undertaken after high rainfall events; 2. Stormwater runoff from the road crossings should be monitored (by the Operation and Maintenance (O&M) Manager), so it does not result in erosion of the freshwater ecosystem. Stormwater should be allowed to diffusely spread across the landscape, by ensuring adequate surface roughness in the freshwater ecosystem (through vegetation and rocky areas); 3. Maintenance vehicles must make use of dedicated access roads and no indiscriminate movement in the freshwater ecosystem may be permitted; 4. During periodic maintenance activities of the roads, monitoring for erosion (particularly at tie-in points) must be undertaken; and 5. Should erosion be noted that was 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 obtained from the surrounding area to infill any area prone to erosion, as a natural dispersal mechanism.
	9	Monitoring of structural	• No direct impacts perceived.		**2**	1	2	**5**	**2**	**10**	40%	**4**	**L**	High	1. Should the culverts require replacing and/or concrete works, all control measures as stipulated in Activity 3 as

Phase	No.	Activity	Impact		Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of	Significance (max = 100)	Risk Rating	Confidence level	Mitigation measures
		integrity of the culvert bridge and road crossing including: • Proactive monitoring to ensure structural integrity is maintained and to identify early signs of erosion due to potential blockage or breakages.													applicable above must be implemented to ensure no negative impacts to the receiving freshwater environment occur; 2. See control measures of Activity 1 with regards to movement within the freshwater ecosystem; 3. Sediment traps must be installed downstream of where any maintenance works are being undertaken; and 4. Any vegetation clearing (as part of the road maintenance and upkeep) must be undertaken by hand within the freshwater ecosystem crossing. No machinery is allowed to operate within the freshwater ecosystem.
	10	Ongoing AIPs removal (where required).	• Compaction of soil and loss of habitat as a result of ongoing disturbance from vehicles and equipment; • Impacts to water quality as a result of the application of herbicides; and • Disturbance of soil which could lead to erosion.		**4**	1	2	**7**	**2**	**14**	80%	**11,2**	**L**	High	1. Refer to control measures 1 to 3 of Activity 1 with regards to movement with the freshwater ecosystem; 2. Refer to control measures of Activity 7; 3. Ensure AIPs are managed post construction until suitable basal cover of indigenous vegetation is achieved; 4. It is considered imperative that all works pertaining to removal of AIPs be undertaken during the drier months to limit surface water contamination; 5. After AIPs have been removed, the soil surrounding these areas must be suitably loosened on completion of AIP removal and revegetated to prevent erosion; and 6. An annual follow up should be undertaken for at least 3 years post construction.

5.2 Risk assessment discussion of anticipated ecological impacts

In summary, potential direct impacts to the impacted reach of the Riestpruit River, including increased sedimentation, changes in water quality, pattern and timing of water inflows are expected, as well as temporary habitat loss. It is therefore strongly recommended that the 15 m buffer of this system, be rehabilitated and revegetated with suitable indigenous plant species (both terrestrial and riparian plant species). Indirect impacts or edge effects from the construction and operation of the proposed repairs on the downstream reach of the Rietspruit are possible. These indirect impacts include sediment runoff into the downgradient reaches during construction, dust generation and potential AIP seed dispersal which may be transported to the receiving downgradient freshwater ecosystems via runoff or wind dispersal.

In addition, it must be noted that from a freshwater resource management perspective, two aspects of the proposed construction method are *not preferred*, specifically, the use of pipe culverts, and the sloping of embankments to a gradient of 1:2. Pipe culverts carry greater risk in terms of flow obstructions, as sediment is prone to accumulation therein. Considering the existing sediment availability within the catchment, and the modifications to the Rietspruit River caused by excess sediment, the use of pipe culverts is likely to increase the potential for further modification of the system. The sloping of embankments to a 1:2 gradient is also considered to pose an increased risk to the system, considering the demonstrated erosion potential of the soil. It is strongly recommended that the embankments be sloped to a minimum 1:3 gradient, and preferably 1:4, should space and technical considerations allow.

Should the control measures as provided in Table 8 above as well as additional “good practice” control measures applicable to a project of this nature as provided in **Appendix G** be implemented, the proposed repairs are expected to pose an overall low risk significance to the receiving freshwater environment. However, this is reliant on the strict implementation of control measures during construction.

Notwithstanding this temporary risk posed by the bridge refurbishment, the long-term benefits of replacing this infrastructure, including improvements to hydraulic connectivity and geomorphological processes, outweighs the short-term negative risk and is therefore supported by the specialist.

6. CONCLUSION

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed upgrading of an existing bridge crossing over the Rietspruit River near Olievenhoutbosch north of Midrand, Gauteng Province.

Although historically the Rietspruit River was likely to have displayed characteristics consistent with that of a channelled valley bottom wetland, the pressures exerted on the system over a period of several decades has led to a decline in the extent of wetland habitat and transformation thereof such that the system was, for the purposes of this investigation, characterised as a river with associated riparian zone. The results of the field assessment for the freshwater ecosystem are presented in Section 3.4.2 of this report, and summarised in the table below:

Table C: Summary of results of the field assessment as discussed in Section 3.4.2.

Present Ecological State (PES)	Ecoservice provision	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Category (REC) / Recommended Management Objective (RMO) / Best Attainable State (BAS)
Category: D/E (Largely to Seriously Modified)	Demand: Very High to Low Supply: Moderate to Very Low	Low/Marginal	**REC:** D; **RMO:** Improve; **BAS:** D

Following the freshwater ecosystem assessment, the Department of Water and Sanitation (DWS) Risk Assessment Matrix (2023) (RAM) was applied to determine the significance of perceived impacts of the proposed bridge upgrading activities on the receiving freshwater environment. Taking into consideration the decreased ecological integrity and lowered EIS of the Rietspruit, as well as the intention of the proponent to undertake instream construction activities during the low-flow winter period, the proposed activities are anticipated to pose an overall ‘low’ risk significance to the system. Moreover, provided that the mitigation measures outlined in this report (Section 5.1) are strictly implemented, not only can the significance of the expected short-term negative impacts be reduced, but a long-term positive outcome can be achieved through improving hydraulic connectivity and geomorphological stability.

If all mitigation measures as stipulated in Section 5.1 of this report are implemented to prevent any edge effects and cumulative impacts from occurring on the freshwater ecosystem habitat, it is the opinion of the freshwater specialist that the proposed bridge upgrade may be considered positively for authorisation by the respective authorities.

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APPENDIX A – Terms of Use and Indemnity

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 Scientific Aquatic Services (SAS) (Pty) Ltd and its staff reserve the right, at their sole discretion, to 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.

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APPENDIX B – Legislative Considerations

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 704 as published in the Government Gazette 20119 of 1999 as it relates to the National Water Act, 1998 (Act 36 of 1998)	Regarding the use of water for mining and related activities aimed at the protection of water resources. 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 National Water Act, 1998 (Act No. 36 of 1998) which contains regulations on 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:* *(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood line 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 flood line of the aquatic resource or 100m from the edge of the resource, whichever distance is the greatest.
Government Notice 4167 as published in the Government Gazette 49833 of 2023 as it relates to the National Water Act, 1998 (Act 36 of 1998)	In accordance with Regulation GN4167 of 2023, a 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 and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; b) In the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or c) A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice **replaces GN1199** and may be exercised as follows: i) Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation; ii) Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; iii) Do maintenance with their 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; iv) Conduct river and stormwater management activities as contained in a river management plan; v) Conduct rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix; and vi) Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. 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.

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 freshwater features present or in close proximity of the proposed investigation 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 proposed investigation area.

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

The freshwater features encountered within the proposed investigation 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[4] (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.

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

[4] 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.

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) and WET-EcoServices (Kotze *et al*., 2009).

3. Index of Habitat Integrity and Riparian Vegetation Response Index

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 C3 below.

Table C5: 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

Riparian Vegetation Response Index (VEGRAI)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: 'riparian habitat' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

The Riparian Vegetation Response Assessment Index (VEGRAI) is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results[5]. Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Table C6: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately 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 modified. Modifications have reached a critical level and the lotic 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

[5] Kleynhans et al, 2007

4. Watercourse 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".[6] The assessment of the ecosystem services supplied by the identified freshwater features was conducted according to the guidelines as described by Kotze *et al.* (2020). An assessment was undertaken that examines and rates 16 different ecosystem services, selected for their specific relevance to the South African situation, as follows:

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

For each ecosystem service, indicator scores are combined automatically in an algorithm given in the spreadsheet that has been designed to reflect the relative importance and interactions of the attributes represented by the indicators to arrive at an overall supply score. In addition, the demand for the ecosystem service is assessed based on the wetland's catchment context (e.g. toxicant sources upstream), the number of beneficiaries and their level of dependency, which are also all rated on a five-point scale. Again, an algorithm automatically combines the indicator scores relevant to demand to generate a demand score.

*It is important to note that when assessing riparian zones associated with riverine habitats, the contribution of the riparian zone to streamflow regulation is omitted, owing to a lack of relevant studies (Kotze *et al*, 2020).

Table C7: Integrating scores for supply and demand to obtain and overall importance score

Integrating scores for supply & demand to obtain an overall importance score						
		Supply				
		Very Low	Low	Moderate	High	Very High
Demand		0	1	2	3	4
Very Low	0	0,0	0,0	0,5	1,5	2,5
Low	1	0,0	0,0	1,0	2,0	3,0
Moderate	2	0,0	0,5	1,5	2,5	3,5
High	3	0,0	1,0	2,0	3,0	4,0
Very High	4	0,5	1,5	2,5	3,5	4,0

A single overall importance score is generated for each ecosystem service by combining the supply and demand scores. This aggregation therefore places somewhat more emphasis on supply than demand, with the supply score acting as the starting score for a "moderate" demand scenario. The importance score is, however, adjusted by up to one class up where demand is "very high" and by up to one class down where demand is "very low". The overall importance score can then be used to derive an importance category for reporting purposes.

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

Table C8: Classes for determining the likely extent to which a benefit is being supplied.

Importance Category		Description
Very Low	0-0.79	The importance of services supplied is very low relative to that supplied by other wetlands.
Low	0.8 – 1.29	The importance of services supplied is low relative to that supplied by other wetlands.
Moderately-Low	1.3 – 1.69	The importance of services supplied is moderately-low relative to that supplied by other wetlands.
Moderate	1.7 – 2.29	The importance of services supplied is moderate relative to that supplied by other wetlands.
Moderately-High	2.3 – 2.69	The importance of services supplied is moderately-high relative to that supplied by other wetlands.
High	2.7 – 3.19	The importance of services supplied is high relative to that supplied by other wetlands.
Very High	3.2 - 4.0	The importance of services supplied is very high relative to that supplied by other wetlands.

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

The purpose 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 of the wetland system being assessed.

Table C9: 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 freshwater resource (sections above), with the objective of either maintaining, or improving the ecological integrity of the watercourse in order to ensure continued ecological functionality.

Table C10: 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 freshwater resource fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

A freshwater ecosystem may receive the same class for the REC as the PES if the freshwater resource 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 C11: Description of Recommended Ecological Category (REC) classes.

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

APPENDIX D – Risk Assessment Methodology

In order for the EAP 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 methods to be used for assessing risks/impacts is outlined in the sections below.

DWS Risk Assessment (2023) Methodology:

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[7].

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.

[7] 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.

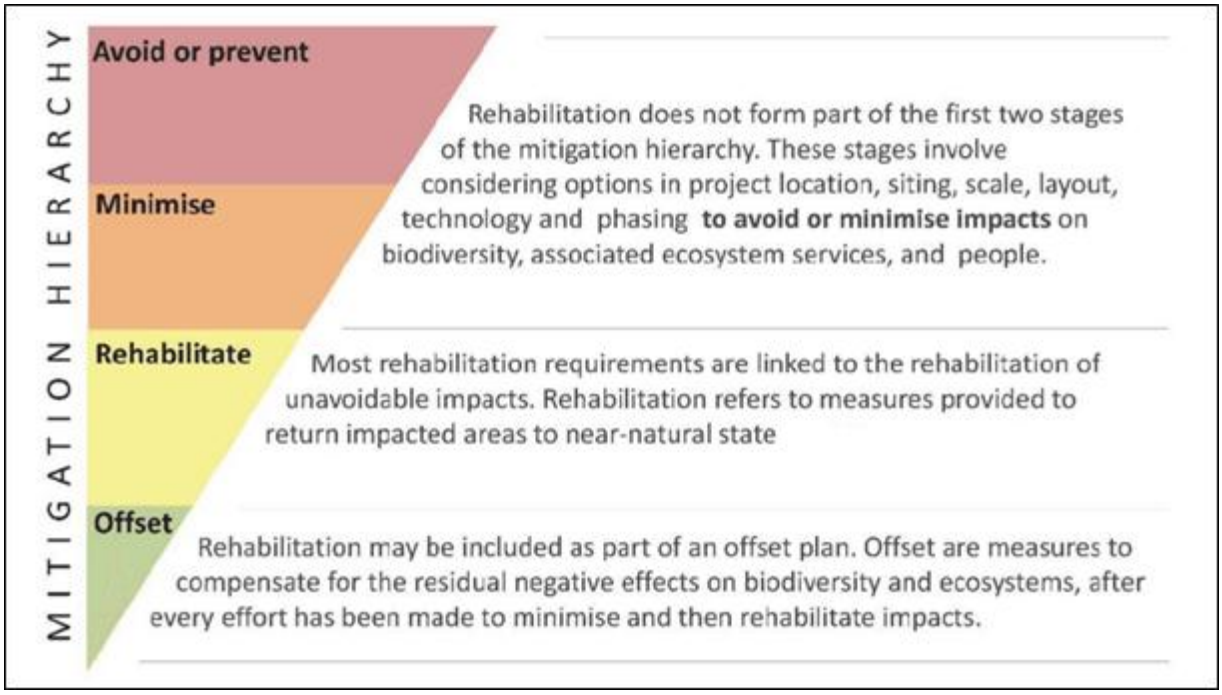
RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 29	**(L) Low Risk OR (+) Positive (+ +) Highly positive**	Acceptable as is or or with proposed mitigation measures. Impact to watercourses and resource quality small and easily mitigated, or positive.
30 – 60	**(M) Moderate Risk**	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
61 – 100	**(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.

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

In applying the DWS Risk Assessment Matrix (Section 8.3), the mitigation hierarchy as advocated by the DEA *et al* (2013) was consulted and implemented. In line with the mitigation hierarchy, the following actions were undertaken:

- **Avoid:** Impacts to the valley bottom freshwater ecosystems were largely avoided by the optimisation of the PV footprint areas to avoid the obvious extent of the wetlands based on desktop methods. Note that with the field-verification of the extent of the CVB wetland (CVB L1), it was noted that marginal portions of the wetland is encroached by the proposed PV footprint areas, and the layout in this area must preferably be adjusted to avoid the delineated extent of the valley bottom freshwater ecosystems, along with their 21m or 15m ecological buffers;
- **Minimise:** In instances where the freshwater ecosystems could not be avoided, such as where PV areas overlap with the HSS wetlands, suitable mitigation measures have been provided to best minimise the potential impacts to the affected freshwater ecosystems.
- **Rehabilitate:** Suitable rehabilitation measures and stormwater management systems have been defined to ensure that all disturbed areas within the freshwater ecosystems outside the final physical footprint areas of the infrastructure are suitably rehabilitated. A stormwater management plan, to be developed for the site, will ensure safeguarding of the freshwater ecosystems against possible erosion and sedimentation.
- **Offset:** It is not anticipated that a wetland offset is required as suitable actions have been taken to best avoid, minimise (where avoidance is not possible) and rehabilitate the freshwater ecosystems associated with the proposed PV. This is however subject to the decision of the respective authorities.


MITIGATION HIERARCHY
Avoid or prevent
Minimise
Rehabilitate
Offset
Rehabilitation does not form part of the first two stages of the mitigation hierarchy. These stages involve considering options in project location, siting, scale, layout, technology and phasing to avoid or minimise impacts on biodiversity, associated ecosystem services, and people.
Most rehabilitation requirements are linked to the rehabilitation of unavoidable impacts. Rehabilitation refers to measures provided to return impacted areas to near-natural state
Rehabilitation may be included as part of an offset plan. Offset are measures to compensate for the residual negative effects on biodiversity and ecosystems, after every effort has been made to minimise and then rehabilitate impacts.

APPENDIX E – Results of Freshwater Field Investigation

PRESENT ECOLOGICAL STATE (PES) AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table E1: Presentation of the results of the riparian IHI assessments applied to the Rietspruit River reach associated with the proposed project.

	MRU
RIPARIAN IHI	
Base Flows	-2,0
Zero Flows	2,0
Moderate Floods	-2,0
Large Floods	-2,0
HYDROLOGY RATING	**2,0**
Substrate Exposure (marginal)	3,0
Substrate Exposure (non-marginal)	3,0
Invasive Alien Vegetation (marginal)	5,0
Invasive Alien Vegetation (non-marginal)	5,0
Erosion (marginal)	4,0
Erosion (non-marginal)	4,0
Physico-Chemical (marginal)	0,0
Physico-Chemical (non-marginal)	0,0
Marginal	5,0
Non-marginal	5,0
BANK STRUCTURE RATING	**5,0**
Longitudinal Connectivity	1,0
Lateral Connectivity	1,0
CONNECTIVITY RATING	**1,0**
RIPARIAN IHI %	**37,8**
RIPARIAN IHI EC	**D/E**
RIPARIAN CONFIDENCE	**2,0**

Table E2: Presentation of the results of the VEGRAI assessments applied to the Rietspruit River reach associated with the proposed project.

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	23,7	14,8	3,3	1,0	100,0
NON MARGINAL	23,0	8,6	0,0	2,0	60,0
	2,0				160,0
LEVEL 3 VEGRAI (%)				23,4	
VEGRAI EC				**E**	
AVERAGE CONFIDENCE				1,7	

Table E3: Presentation of the results of the WET Ecoservices assessment applied to the Rietspruit River reach associated with the proposed project.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1,0	0,3	0,0	Very Low
	Stream flow regulation	-	-	#VALUE!	#VALUE!
	Sediment trapping	1,5	4,0	2,0	Moderate
	Erosion control	1,4	2,7	1,2	Low
	Phosphate assimilation	1,6	3,0	1,6	Moderately Low
	Nitrate assimilation	1,4	3,0	1,4	Moderately Low
	Toxicant assimilation	1,5	3,0	1,5	Moderately Low
	Carbon storage	1,3	2,7	1,2	Low
	Biodiversity maintenance	2,0	2,0	1,5	Moderately Low
PROVISIONING SERVICES	Water for human use	2,0	0,0	0,5	Very Low
	Harvestable resources	2,0	1,3	1,2	Low
	Food for livestock	1,0	1,3	0,2	Very Low
	Cultivated foods	1,5	0,0	0,0	Very Low
CULTURAL SERVICES	Tourism and Recreation	0,9	0,0	0,0	Very Low
	Education and Research	0,8	0,0	0,0	Very Low
	Cultural and Spiritual	1,0	0,0	0,0	Very Low

Table E4: Presentation of the results of the Ecological Importance and Sensitivity of the Rietspruit River reach associated with the proposed project.

Freshwater Ecosystems			Rietspruit	
Ecological Importance and Sensitivity			Score (0-4)	*Confidence (1-5)*
Biodiversity support			A (average)	(average)
			0,67	4,00
Presence of Red Data species			0	4
Populations of unique species			0	4
Migration/breeding/feeding sites			2	4
Landscape scale			B (average)	(average)
			1,00	4,40
Protection status of the wetland			0	5
Protection status of the vegetation type			2	5
Regional context of the ecological integrity			0	4
Size and rarity of the wetland type/s present			1	4
Diversity of habitat types			2	4
Sensitivity of the wetland			C (average)	(average)
			1,00	3,33
Sensitivity to changes in floods			1	4
Sensitivity to changes in low flows/dry season			1	3
Sensitivity to changes in water quality			1	3
ECOLOGICAL IMPORTANCE & SENSITIVITY			B (1.00) Low/Marginal	
Hydro-Functional Importance			Score (0-4)	*Confidence (1-5)*
Regulating & supporting benefits	Flood attenuation		2	4
	Streamflow regulation		3	4
	Water Quality Enhancement	*Sediment trapping*	1	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	2	4
	Carbon storage		3	4
HYDRO-FUNCTIONAL IMPORTANCE			2	4
Direct Human Benefits			Score (0-4)	*Confidence (1-5)*
Subsistence benefits	*Water for human use*		0	4
	Harvestable resources		3	4
	Cultivated foods		0	4
Cultural benefits	*Cultural heritage*		0	3
	Tourism and recreation		0	4
	Education and research		0	3
DIRECT HUMAN BENEFITS			0.50	4

APPENDIX F – Diatom Analysis

1. BACKGROUND

Diatoms are unicellular algae at the base of the aquatic food web and thus provide meaningful and valuable information for means of biomonitoring as they are highly representative of water quality. As diatoms are primary producers, localised within an area and due to their short life span (2 – 3 weeks) they are important indicators of short-term impacts and are thus the first indicators of change within their environment. Diatoms have a rapid response to environmental change and their ecology is well understood allowing the interpretation of specific physico-chemical conditions within the aquatic environment. Specific environmental changes (nutrient loading, salinisation, pH change and organic enrichment) can be determined based on the presence and absence of key indicator diatom taxa.

2. METHODOLOGY

Diatom slides were prepared through pipetting three drops of the diatom samples onto microscope plates and covering with a microscope cover slide. Diatom taxa were identified to the lowest possible level of identification and diatom valves counted (400 counts) for ecological conclusions to be drawn. Dominant species ecology was inferred from Taylor *et al*. (2007) and Omnidia software (Lecointe *et al.,* 1993) were used to calculate diatom index scores with score interpretation presented in Tables 1 to 4. The following indices were calculated for the present report:

- Specific Pollution sensitivity Index (SPI) (CEMAGREF, 1982) (Tables 1 & 2): This index is the most comprehensive as it includes >1400 species to calculate its final score and provides a measure of organic pollution.
- Generic Diatom Index (GDI) (Coste and Ayphassorho, 1991) (Table 2): Final score is based on genus level and is a measure of organic pollution.
- Trophic Diatom Index (TDI) (Kelly and Whitton, 1995) (Table 3): The index's final score is quantified based on the degree of organic and inorganic pollution.
- Percentage Pollution Tolerant Valves (%PTV) (Kelly and Whitton, 1995) (Table 4): Indicates the diatoms in the sampled community that are tolerant to pollution, thus indicating the degree of eutrophication vs organic pollution. The %PTV score indicates whether nutrients or organic pollution contributed to the TDI final score.

Values for the SPI and GDI were transformed to a score out of 20 where a score of 0 indicates eutrophication and very heavy pollution and a score of 20 indicates no pollution and oligotrophic conditions (Tables 1 & 2). The TDI score is worked off a maximum of 100, where a score of <20% infers that the site is oligotrophic and free from pollution and a score >60% infers that the site is eutrophic with pollution present (Table 3). The %PTV is worked off a maximum score of 100%, where a score of <20% infers that the site is free from organic pollution and a score >60% infers that the site is heavily contaminated with organic pollution (Table 4). For the diatom frustule abnormality assessment, if the percentage of deformed frustules is greater than 2% of the population it is considered that there is significant impact from either pesticides or metals and further assessment is recommended, especially where mining is a related concern.

Further to the calculated index scores, the diatom results are also discussed based on functional groups (diatom species grouped together based on ecological and morpho-physiological features). Diatoms are grouped and discussed based on life-forms (benthic, colonial, mobile, mucous tubules, pedunculate, pioneer and planktonic), ecological guilds (high profile, low profile, motile), and size classes (Size 1 to Size 5) (Passy, 2007; Rimet & Bouchez, 2011; Viktória *et al.,* 2017). Diatoms have adapted to these different groups as a strategy to survive and resist a large set of environmental stressors. Knowledge on these functional groups and diatom ecology allows us to make precise conclusions on environmental health and stressors based on the adaptability of the diatoms.

Table F1: Interpretation of Ecological Categories from the SPI index scores.

Index Score (up to 20)	Ecosystem quality	Ecological Category
18 – 20	High quality	A
17 – 18		A/B
15 – 17	Good quality	B
14 – 15		B/C
12 – 14	Moderate quality	C
10 – 12		C/D
8 – 10	Poor quality	D
6 – 8		D/E
5 – 6	Bad quality	E
4 – 5		E/F
< 4		F

Table F2: Interpretation of both the SPI and GDI scores to determine the Ecosystem Quality and Trophic level of the sampled site.

Index Score (up to 20)	Trophic Level
>17	Oligotrophic (No Pollution)
15 - 17	Oligo-mesotrophic
12 - 15	Mesotrophic
9 - 12	Meso-eutrophic
< 9	Eutrophic

Table F3: Interpretation of the TDI score to determine the Trophic level of the sampled site.

Index Score	Trophic Level
0 – 20	Oligotrophic (No Pollution)
21 – 40	Oligo-mesotrophic
41 – 60	Mesotrophic
61 – 80	Meso-eutrophic
>80	Eutrophic

Table F4: Interpretation of the %PTV score to determine the Ecological Status of the site.

Index Score (up to 20)	Ecological Status
< 20	Site free from organic pollution
21 – 40	Some evidence of organic pollution
41 – 60	Organic pollution likely to contribute to eutrophication
>60	Heavily contaminated with organic pollution

Table F5: Interpretation of the different diatom ecological groups, guilds and size classes.

Category	Name	Key Features	Ecological Role	Typical Habitat	Examples
Functional Group	**Benthic**	Live on/in substrate (sediments, rocks)	Nutrient cycling, biofilm formation	Stream beds, lake bottoms	*Navicula*, *Cymbella*
	Colonial	Form chains or colonies (often planktonic)	Buoyancy, resistance to grazing	Pelagic or littoral zones	*Asterionella*, *Fragilaria*
	Mobile	Glide using raphe	Access to resources, avoid stress	Benthic habitats, biofilms	*Nitzschia*, *Navicula*
	Mucous Tubules	Secrete tubes for protection	Shelter, nutrient filtering	Benthic, periphytic	*Berkeleya*, *Encyonema*
	Pedunculate	Stalked diatoms; elevate above substrate	Avoid burial; better light access	Vegetated, stable benthic zones	*Gomphonema*, *Rhoicosphenia*
	Pioneer	Fast colonizers of new substrates	Early succession species	Recently disturbed surfaces	*Achnanthidium*, *Nitzschia*
	Planktonic	Free-floating in water column	Primary production in open water	Lakes, oceans	*Cyclotella*, *Thalassiosira*
Guild	**High Profile**	Tall, erect, or chain-forming forms	Good light access, sensitive to disturbance	Stable, low-disturbance zones	*Fragilaria*, *Gomphonema*

	Low Profile	Small, adnate, or prostrate	Tolerate disturbance and low light	High-shear or nutrient-poor areas	*Achnanthidium*, *Cocconeis*
	Motile	Glide over substrate	Avoid stress; access nutrients	Fine sediments, biofilms	*Navicula*, *Nitzschia*
Size Class	**Size 1**	Very small (<15 µm)	Tolerant to stress; high surface area	Oligotrophic or disturbed systems	*Achnanthidium minutissimum*
	Size 2	Small (15–30 µm)	Efficient resource use	Common in most environments	*Fragilaria*, *Eunotia*
	Size 3	Medium (30–60 µm)	Balanced traits	Mid-succession or stable zones	*Navicula*, *Cymbella*
	Size 4	Large (60–100 µm)	Competitive in stable, rich habitats	Low flow or high productivity sites	*Gomphonema*, *Surirella*
	Size 5	Very large (>100 µm)	Sensitive; low colonization rate	Undisturbed, nutrient-rich zones	*Gyrosigma*, *Didymosphenia*

3. ASSUMPTIONS AND LIMITATIONS

To ensure that our turnaround time meets expectations diatom analysis and identification is done on "live" diatom samples. There are no limitations through the use of "live" samples with accurate analysis and identification of samples and as such results for the report are considered accurate. There is no substantial impact on the validity of the final conclusions drawn in this report.

4. RESULTS

Table F6: Ecological and Biological traits summary of diatom samples.

Parameter	S1
Dominant Taxa	*Nitzschia* sp., *Fragilaria biceps*, *Nitzschia linearis*, *Nitzschia palea*, *Gomphonema affine*, *Cymbella aspera*, *Aulacoseira granulata*
Functional Groups	Mix of benthic motile, attached/stalked, and planktonic centric taxa.
Ecological Guilds	High-profile guild dominant with motile taxa present and some planktonic taxa.
Size Classes	Wide range of size classes including small motile and larger attached taxa.
SPI	9.1 – Poor quality (Category D)
%PTV	28.3 – Some evidence of organic contamination.
Diversity	3.56 – High
Evenness	0.91 – High

Discussion:

Site **S1** has a high species diversity with an even species distribution, indicating a well-distributed and diverse diatom community. The site is considered to be in a Poor ecological condition (Category D) that is considered synonymous with a largely modified ecosystem. The site is considered to have moderate to high (meso-eutrophic) nutrient content, elevated electrolyte conditions, and extremely contaminated conditions, as per the calculated SPI score (9.1) and dominant diatom community. The dominant diatom taxa at the site included *Nitzschia* sp., *Fragilaria biceps*, *Nitzschia linearis*, *Nitzschia palea*, *Gomphonema affine*, *Cymbella aspera*, and *Aulacoseira granulata*, as such consisting of a mix of motile, high-profile, and planktonic taxa. The presence of *Fragilaria* sp., *Gomphonema* sp., and *Cymbella* sp. indicates periods of some substrate stability at times, with motile taxa indicating nutrient enrichment and overall physical disturbances (erosion, sedimentation, trampling, etc.) at the site. The presence of *Aulacoseira granulata* indicates some hydrological variability. The diatom functional groups is an indication of sedimentation and hydrological variability influencing the community structure for site S1. The diatom size classes ranged from small motile forms to medium and larger benthic taxa, which is consistent with nutrient and electrolyte enriched conditions. The calculated %PTV score (28.3%) indicates that there is some evidence of organic contamination at the site.

5. REFERENCES

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2. Coste M. and Ayphassorho H. 1991. Etude de la qualité des eaux du bassin Artois Picardie à l'aide des communautés de diatomées benthiques (Application des indices diatomiques). Rapport Cemagref Bordeaux – Agence de l'Eau Artois Picardie. 227 pp. [in French]
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5. Passy, S.I. 2007. Diatom ecological guilds display distinct and predictable behaviour along nutrient and disturbance gradients in running waters. *Aquatic Botany*, 86(2):171–178.
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8. Viktória, B., Török, P., Kókai, Z., Lukács, Á., Enikő, T., Tóthmérész, B. and Bácsi, I. 2017. Ecological background of diatom functional groups: Comparability of classification systems. *Ecological Indicators*, 82:183–188

APPENDIX G – Site Sensitivity Verification Report (SSVR)

FRESHWATER ECOSYSTEM SITE SENSITIVITY VERIFICATION REPORT FOR THE PROPOSED CONSTRUCTION OF A BRIDGE CROSSING OVER THE RIETSPRUIT RIVER, IN OLIVIENHOUTBOSCH, GAUTENG PROVINCE.

Introduction

According to the "Protocols for the Assessment and Minimum Criteria for Reporting on identified Environmental Themes ("the Protocols") published in Government Gazette No. 43110 on 20 March 2020 and Government Gazette No. 43855 on 30 October 2020, the Environmental Assessment Practitioner (EAP) must verify the current use of the site in question and its environmental sensitivity as identified by the Screening Tool to determine the need for specialist inputs in relation to the themes included in the Protocols. The Protocols are allowed for in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) ("NEMA"). The Protocols must be complied with for every new application for Environmental Authorisation that is submitted after 9 May 2020.

This document serves as the Freshwater Ecosystem Site Sensitivity Verification Report for the proposed Kosmosdal Extension 92 culvert bridge construction, Gauteng Province.

Study Area

The proposed culvert bridge is to be constructed over the Rietspruit, along Rietspruit Road, west of the Rooihuiskraal/Rietspruit road intersection (Figure G1).

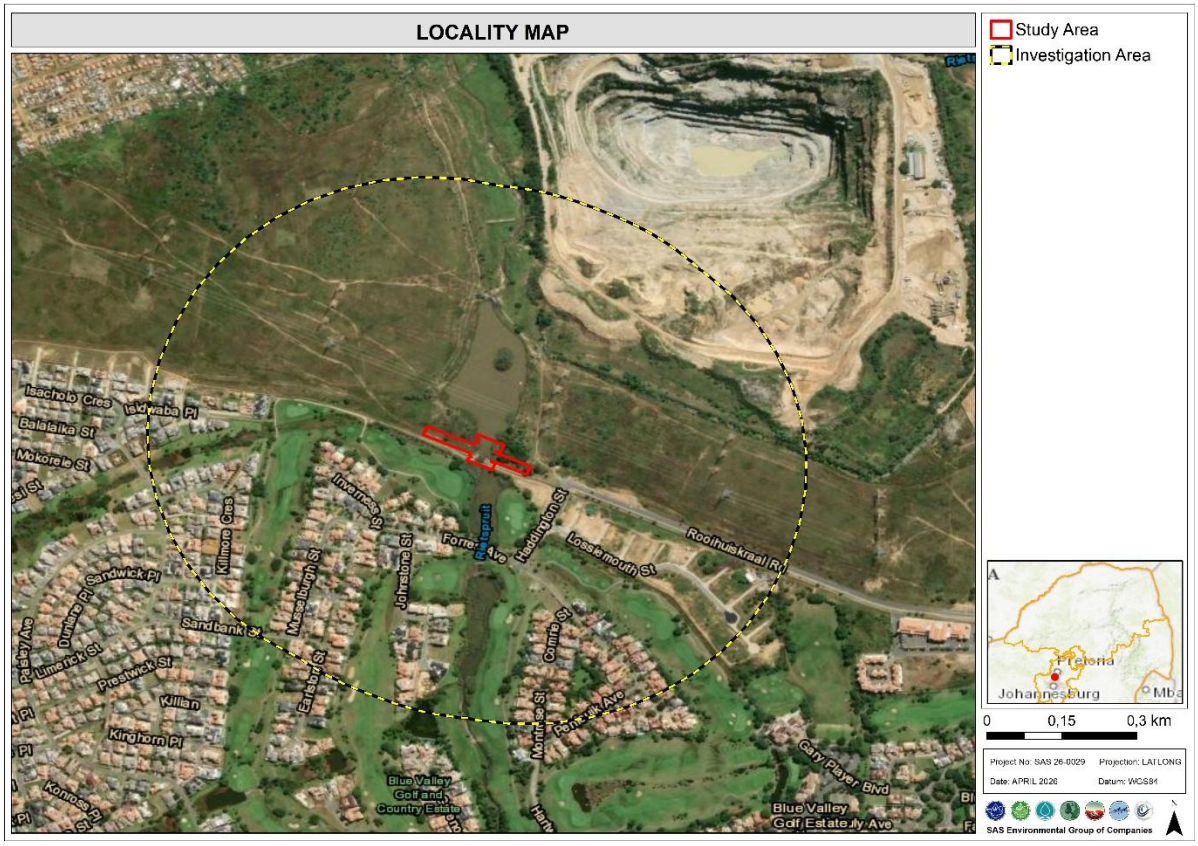

Figure G1: Digital satellite image depicting the location of the proposed culvert bridge (study area).

This Freshwater Ecosystem site sensitivity verification report relates to a Screening Tool Report (STR) completed for the site in April 2026.

Site Verification Methodology

A site visit was conducted in March 2026 by the specialist to inform the specialist reports required for the proposed project.

Aquatic Biodiversity Site Verification

The table below provides information regarding the outcome of the Screening Tool in terms of the aquatic biodiversity theme sensitivity associated with the proposed project as well as a brief summary of the outcome of the freshwater ecosystem specialist report in response.

Table G1: Aquatic Biodiversity Theme Sensitivity analysis for the proposed project.

Environmental Theme	Applicable Protocol	Response
Aquatic Biodiversity **Screening Tool Sensitivity Rating:** The study area overlaps with freshwater features per the NBA (2018) Database, which are indicated as features of the very high aquatic sensitivity (See Figure 3, Section 3.1 in main report). The remainder of the study area is indicated as being of low aquatic biodiversity sensitivity. The trigger feature for the very high sensitivity is the presence of channelled valley bottom and seep wetlands. **Actual Sensitivity Rating**: The designation of very high sensitivity to freshwater features by the DFFE Screening Tool is confirmed through the findings of the freshwater assessment, in the context of the inherently sensitive freshwater ecosystem (i.e. the Rietspruit). The designation of low freshwater sensitivity for the remainder of the study area, where no freshwater ecosystems have been delineated, is also confirmed.	3(b) Protocol for the assessment and reporting of environmental impacts on aquatic biodiversity (GG 43110 of 20/03/2020).	A Freshwater Ecosystem Assessment was conducted by Scientific Aquatic Services (SAS, 2026). During the assessment and associated field verification it was determined that the majority of the study area is of high aquatic biodiversity (freshwater) sensitivity due to the presence of a natural watercourse, namely the Rietspruit River. A detailed study was required to support both the authorisation process required in terms of NEMA as well as the NWA. The study and associated comprehensive report from a site visit in March 2026 provide a detailed description of the freshwater ecosystem associated with the proposed project, considered the potential impacts applicable to the freshwater ecosystem and provided suitable mitigation measures to best minimise the potential impact on the freshwater ecosystem.

Figure G2: Representative photographs of the Rietspruit River reach associated with the study area.

APPENDIX H – Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

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

Amanda Mileson	Postgraduate Diploma Nature Conservation (UNISA)
Paul Da Cruz	BA (Hons) (Geography and Environmental Studies) (University of the Witwatersrand)
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:	SAS Environmental (Pty) Ltd		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	1401	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc Environmental Management (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	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)		

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

I, Amanda Mileson, 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, Paul Da Cruz, 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** 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 AMANDA MILESON

PERSONAL DETAILS

Position in Company	Senior Ecologist: Wetland Ecology
Joined SAS Environmental Group of Companies	2013

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the South African Wetland Society (SAWS)

Member of the International Society of Wetland Scientists

Member of the Gauteng, Western Cape and Northern Cape Wetland Forums

EDUCATION

Qualifications

N. Dip Nature Conservation (UNISA)	2017
Advanced Diploma Nature Conservation (UNISA)	2020
Postgraduate Diploma Nature Conservation (UNISA)	2023

Short Courses

Wetland Management: Introduction and Delineation (University of the Free State)	2018
Tools for Wetland Assessment (Rhodes University)	2017
Wetland Rehabilitation (University of the Free State)	2015

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Free State, North West, Limpopo, Northern Cape, Eastern Cape, Western Cape
Africa – Zimbabwe, Zambia

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Ecosystem Delineation
- Freshwater Ecosystem Verification Assessment
- Freshwater Ecosystem (wetland / riparian) Delineation and Assessment
- Freshwater Ecosystem EcoService and Status Determination
- Freshwater Ecosystem Rehabilitation Assessment / Planning
- Freshwater Ecosystem Maintenance and Management Plans
- Freshwater Ecosystem Plant Species Plans
- Freshwater Ecosystem Offset Plans

Biodiversity Assessments

- Biodiversity Ecological Assessments
- Biodiversity Offset Plans

SAS ENVIRONMENTAL GROUP OF COMPANIES

SPECIALIST CONSULTANT INFORMATION - CURRICULUM VITAE OF

STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Director, Group CEO, Water Resource Discipline Lead, Ecologist, Aquatic Ecologist
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SEGC	2003 (year of establishment)
Other Business	Trustee of several Trusts focusing on property and stock investment on behalf of beneficiaries

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

DEVELOPMENT SECTOR EXPERIENCE

1. Mining: Coal, chrome, Platinum Group Metals (PGMs), mineral sands, gold, phosphate, river sand, clay, fluorspar
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

CORE FIELDS OF EXPERTISE

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 and faunal Assessments
- Biodiversity Offset planning
- 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

**SAS ENVIRONMENTAL GROUP OF COMPANIES –
SPECIALIST CONSULTANT INFORMATION**

CURRICULUM VITAE OF PAUL DA CRUZ

PERSONAL DETAILS

Position in Company	Senior Ecologist
Joined SAS Environmental Group of Companies	2022

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Certificated Scientist at South African Council for Natural Scientific Professions (SACNASP)
Registered Environmental Assessment Practitioner (EAP) with the Environmental Assessment Practitioners Association of South Africa (EAPASA)
Member of the South African Wetland Society (SAWS)

EDUCATION

Qualifications

BA (Hons) (Geography and Environmental Studies) (University of the Witwatersrand)	1998
BA (Geography) (University of the Witwatersrand)	1997

Short Courses

Taxonomy of Wetland Plants (Water Research Commission)	2017
Advanced Grass Identification (Frits van Outshoorn)	2010
Grass Identification (Frits van Outshoorn),	2009
Soil Form Classification and Wetland Delineation; (TerraSoil Science)	2008

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana
International – United Kingdom (England and Scotland); USA

DEVELOPMENT SECTORS OF EXPERIENCE

1. Renewable energy (Wind and solar)
2. Linear developments (energy transmission, telecommunication, pipelines, roads, border infrastructure)
3. Nature Conservation and Ecotourism Development
4. Commercial development
5. Residential development
6. Environmental and Development Planning and Strategic Assessment
7. Industrial/chemical; Non-renewable power Generation

KEY SPECIALIST DISCIPLINES

Legislative Requirements, Processes and Assessments

- EIA / BA Applications
- Environmental Authorisation Amendments
- EMPr Compilation
- Environmental Compliance Monitoring (Environmental Auditing)
- Environmental Screening Assessments and Listing Notice 3 Trigger Identification / Mapping
- Strategic Environmental Assessments and Environmental Management Frameworks
- EIA / Specialist Study Peer Review

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 Assessments in support of Environmental Screening Assessments, Precinct Planning & SEA
- Wetland Construction (Compliance) Monitoring

Biodiversity Assessments

- Avifaunal Assessments
- Strategic Biodiversity Assessment

Visual Impact Assessment

- Visual Impact Assessments

GIS / Spatial Analysis

- GIS Spatial Analysis and Listing Notice 3 mapping.