FRESHWATER RESOURCE ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL AUTHORISATION PROCESS FOR THE PROPOSED DEVELOPMENT OF BULK SERVICES ASSOCIATED WITH THE PROPOSED DEVELOPMENT OF THE HAMMANSKRAAL X10 TOWNSHIP, GAUTENG

Prepared for

TGM Environmental Services cc

October 2017

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Report reference:	**STS 170062**
Date:	**October 2017**

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EXECUTIVE SUMMARY

Based on the findings of the freshwater resource assessment and the results of the risk assessment, it is the opinion of the ecologist that the proposed sewer pipeline may pose a direct risk to the unnamed tributary of the Apies River and that the proposed water pipeline may pose a direct risk to the ephemeral drainage line identified to be intersected by the proposed developments. However, due to the overall degraded state of the freshwater environment, adherence to cogent, well-conceived and ecologically sensitive site development plans, and the mitigation measures provided in this report as well as the application of general good construction practice, the significance of perceived impacts can be reduced to acceptable levels during both construction and operational phases of these pipelines. It is imperative that the proposed sewer pipeline be regularly inspected and pressure tested in order to prevent the possibility of leaking into the freshwater environment during the operational phase.

It is the opinion of the specialist therefore that the proposed bulk sewer and water pipeline development, from a freshwater resource conservation perspective, be considered favourably, with the proviso that strict adherence to mitigation measures and monitoring requirements is enforced, in order to ensure that the ecological integrity of the freshwater resources is not further compromised.

MANAGEMENT SUMMARY

Scientific Terrestrial Services (STS) was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation process for the proposed development of bulk services, namely bulk sewer and potable water pipelines, for Hammanskraal X10 within the Gauteng Province, henceforth collectively referred to as the "bulk service pipelines". The purpose of this report is to define the ecology of the area in which the proposed development is located in terms of freshwater resource characteristics, mapping of the freshwater resources, defining areas of increased Ecological Importance and Sensitivity (EIS), and to define the Present Ecological State (PES) of the freshwater resources associated with the proposed linear development, as well as to define the socio-cultural and ecological service provision of the freshwater resources and the Recommended Ecological Category (REC) for the freshwater resources. It is a further objective of this study to provide detailed information to guide the proposed project activities approximately the freshwater resources, to ensure the ongoing functioning of the ecosystem, such that local and regional conservation requirements and the provision of ecological services in the local area are supported while considering the need for sustainable economic development.

The assessment took the following approach:

- A desktop study was conducted, in which possible freshwater resources were identified for on-site investigation, and relevant national and provincial databases were consulted. The results of the desktop study are contained in Section 3 of this report;
- A field assessment took place in September 2017, in order to ground-truth the identified freshwater resources traversed by the linear development. Three freshwater resources were identified to be traversed or in close proximity to the linear development and classified according to the classification system (Ollis, *et al.,*2013); and
- The detailed results of the field assessment are contained in Sections 4 and 5 of this report and are summarised in the table below.

Table A: Summary of the results of the field assessment

Freshwater Resource	Index of Habitat Integrity (IHI)/PES	Ecological function and service provision	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Class (REC)
Apies River	D/E (Largely to Seriously modified)	Intermediate	B (High)	D (Largely modified)
Unnamed tributary of the Apies River	D (Largely modified)	Moderately low/ Intermediate	C (moderate)	D (Largely modified)
Ephemeral Drainage Line with riparian vegetation	D (Largely modified)	Moderately low	C (moderate)	D (Largely modified)

Following the assessment of the freshwater resources, the DWS risk assessment matrix of 2016 was applied in order to ascertain the significance of possible impacts, which may occur because of the proposed development. The results of this assessment are presented in Section 5 of this report, of which a summary is provided below.

Table B: Summary of the results of the DWS risk assessment applied to the freshwater resources associated with the proposed water and sewer pipelines.

No.	Phases	Activity	Aspect	Impact	Significance	Risk Rating
1	Construction Phase	Site clearing prior to commencement of construction activities.	Removal of vegetation and associated disturbances to soils.	*Exposure of soils, leading to increased runoff and erosion, and thus increased sedimentation of the freshwater resources; *Increased sedimentation of the freshwater resources, leading to smothering of biota and potentially altering surface water quality; and *Decreased ecoservice provision.	30	L
2		Ground breaking, excavation of trench within the freshwater resources	*Removal of topsoils; and *Excavation and trenching leading to stockpiling of soil within close proximity to the excavated area.	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to further altered freshwater habitat; and *Altered runoff patterns and alteration to flow patterns, leading to increased erosion and sedimentation of freshwater habitat.	56,25	M
3		Installation of (sewer and water) pipelines and associated manholes	*Mixing and casting of concrete: *Placement of bedding material within the excavated trench underneath the pipelines; *Backfilling of trench, where after it will be compacted; and *Miscellaneous activities by construction personnel.	*Erosion of the exposed trench; *Potential sedimentation of the freshwater resources; *Potential impacts on water quality and contamination of soils within the freshwater resources; *Potential of backfill material to enter the freshwater resources, increasing the sediment load within the freshwater resources; *Potential for over-compaction of soils within the freshwater resources.	40,5	L
4		Potential indiscriminate waste disposal within the freshwater resources or within the vicinity thereof.	Disposal of construction-related wastes (such as rubble, hazardous chemicals and litter)	*Altered flow regime because of solid wastes within the freshwater resources and *Altered water quality due to chemical waste disposal.	30	L

No.	Phases	Activity	Aspect	Impact	Significance	Risk Rating
5		Potential spillage from construction vehicles	Spills / chemical leaks from construction vehicles.	*Possible contamination of freshwater soils and surface water, leading to reduced ability to support biodiversity	**32**	**L**
6	**Operational Phase**	Operation and maintenance of the water pipeline	Potential failure of infrastructure, possible leaks from pipeline into the freshwater resources, causing incision and alteration of the hydroperiod of the freshwater resources	Possible incision and alteration of the hydroperiod of the freshwater resources	**32**	**L**
7			Indiscriminate movement of vehicles and vegetation trampling within the freshwater resources during maintenance activities	Possible soil compaction and disturbance, resulting in increased alteration of the vegetation community structure	**28**	**L**
8			Repair of the pipeline in the event of leaks detected	Impacts as per activity 2 and 3 above as applicable depending upon the location of the leak	**42**	**L**
9		Operation and maintenance of the sewer pipeline	Potential failure of infrastructure, resulting in blockages or leakages	*Potential contamination of freshwater soils, groundwater and surface water; and *Possible incision and alteration of the hydroperiod of the freshwater resources.	**56,25**	**M**
			Unblocking the sewer pipeline (accessed via manholes)	*Vehicular access to the sewer pipeline resulting in: - Soil compaction - Vegetation degradation - Soil and stormwater contamination from oils and hydrocarbons *Contamination of the freshwater resources with additional sewage effluent resulting in: - Increased concentration of salts, nitrate and toxic ammonia concentrations, as well as counts of Escheria coli; and - Potential eutrophication of the system, including anoxic conditions, leading to biodiversity simplification and the excess production of hydrogen sulphide gas as well as increased alien and invasive species encroachment.	**44**	**L**
10			Repair of the sewer pipeline in the event of leaks detected	Impacts as per activity 2 and 3 above as applicable depending upon the location of the leak	**60,75**	**M**
11			Operation of the sewer pipeline	Latent impacts: The installed infrastructure will be permanent, and pose an increased risk over time in terms of the concrete weakening and cracking	**40**	**L**

No.	Phases	Activity	Aspect	Impact	Significance	Risk Rating
				leading to leakages of the sewage. This may result in inputs of sewage effluent entering the freshwater system, and the following impacts: *Increased concentration of salts, nitrate and toxic ammonia concentrations, as well as counts of *Escheria coli*; and *Potential eutrophication of the system, including anoxic conditions, leading to biodiversity simplification and the excess production of hydrogen sulphide gas as well as increased alien and invasive species encroachment.		
12				Cumulative impact: Increased urban development in the area will likely place increased pressure upon the sewerage infrastructure (including the capacity of the receiving wastewater treatment works) and may result in overflows from the manholes, and potentially compromise the integrity of the pipeline itself. This may result in inputs of sewage effluent entering the aquatic system, and impacts similar to those in Activity 9.	**40**	**L**

Assuming mitigation measures are strictly enforced, based on the outcome of the Risk Assessment, impact significance is of Low and Medium levels during both construction and operational phases. Therefore, it is considered imperative that suitable mitigation measures, as provided for in this report, are strictly adhered to in order to minimise the impacts associated with the development and decrease the significance of cumulative impacts on the freshwater environment. Key mitigation measures, which are considered essential for this project, include (but are not limited to):

- If feasible, construction must be scheduled for the drier winter period in order to minimise the risk of sediment-laden runoff reaching the freshwater resources as a result of the construction activities;
- Should it be necessary to clear any areas of vegetation, these areas, including contractor laydown areas, must remain as small as possible, in order to reduce the risk of further proliferation of alien vegetation, and in order to retain a level of protection to the freshwater resources during construction (e.g. sediment trapping, slowing of stormwater runoff etc.);
- Contractor laydown areas and all non-essential activities are to remain outside of the delineated freshwater resources and the allocated setback area, and as much as feasible no natural/indigenous riparian vegetation is to be cleared;
- It is highly recommended that an alien vegetation management plan be compiled during the planning phase and implemented concurrently with the commencement of construction;
- All exposed soils must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent erosion and sedimentation of the river. During trenching, soils should not be stockpiled within close proximity to the river or

the dewatered section, but should rather be outside of the temporary zone boundaries in order to prevent sedimentation of the river, and stockpiles may not exceed 2m in height;

- Any remaining soils following the completion of construction activities are to be levelled and re-seeded with indigenous flora species to minimise the risk of further sedimentation of the freshwater resources, and to aid in the natural reclamation process;
- All manholes located within the 1:100 year floodline must be constructed in such a way as to elevate the manhole cover above the 1:100 year flood level. This can be done by extending the collar of the manhole above the ground level and then building up a mound of appropriate soil around the manhole which is then sloped as gently as possible back to natural ground level;
- It is recommended that the managing authority test the integrity of the sewer pipeline at least once every five years or more often should there be any sign or reports of leaks; and
- Should a blockage occur within the sewer pipeline, all possible steps are to be taken to prevent the pollution of the freshwater system during repair, including the placement of sheeting around the manhole used for access as well as containment barrels for any effluent withdrawn.

Based on the findings of the freshwater resource assessment and the results of the risk assessment, it is the opinion of the ecologist that the proposed development may pose a direct risk to the freshwater resources, with specific mention of the unnamed tributary of the Apies River. Adherence to cogent, well-conceived and ecologically sensitive designs and construction methods, and the mitigation measures provided in this report as well as general good construction practice, is essential if the significance of perceived impacts is to be reduced to acceptable levels.

It is the opinion of the specialist therefore, that the proposed sewer and water pipelines, from a freshwater resource perspective, be considered favourably, with the proviso that strict adherence to mitigation measures is enforced to ensure that the ecological integrity of the freshwater environment is not further compromised.

DOCUMENT GUIDE

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix G
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix G
b)	A declaration that the specialist is independent	Appendix G
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2
cA)	An indication of the quality and age of base data used for the specialist report	Section 2.1
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4.1
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 2.1
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Appendix C
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 4
g)	An identification of any areas to be avoided, including buffers	Section 4.3
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4.3
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.3
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 4, 5, and 6
k)	Any mitigation measures for inclusion in the EMPr	Section 5.1
l)	Any conditions for inclusion in the environmental authorisation	Section 5
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 5
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 6
(iA)	Regarding the acceptability of the proposed activity or activities	Section 6
(ii)	If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 6
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q)	Any other information requested by the competent authority	N/A

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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.
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Base flow:	Long-term flow in a river that continues after storm flow has passed.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans 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.
Chroma:	The relative purity of the spectral colour which decreases with increasing greyness.
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".
Ephemeral stream:	Ephemeral systems flow for less time than they are dry. Flow or flood for short periods of most years in a five-year period, in response to unpredictable high rainfall events. Support a series of pools in parts of the channel.
Episodic stream:	Highly flashy systems that flow or flood only in response to extreme rainfall events, usually high in their catchments. May not flow in a five-year period, or may flow only once in several years.
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Fluvial:	Resulting from water movement.
Gleying:	A soil process resulting from prolonged soil saturation, which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydromorphy:	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen because of soil saturation or flooding; plants typically found in wet habitats.
Intermittent flow:	Flows only for short periods.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Perennial:	Flows all year round.
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.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50cm of the surface for less than

	three months of the year
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

ABBREVIATION	DESCRIPTION
°C	Degrees Celsius.
BAR	Basic Assessment Report
BGIS	Biodiversity Geographic Information Systems
CBA	Critical Biodiversity Area
CSIR	Council of Scientific and Industrial Research
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (use to be defined in relevant sections)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMP	Environmental Management Program
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GN	General Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
IHI	Index of Habitat Integrity
m	Meter
MAP	Mean Annual Precipitation
MC	Management Classes
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act
NWCS	National Wetland Classification System
PEMC	Present Ecological Management Class
PES	Present Ecological State
REC	Recommended Ecological Category
RHP	River Health Program
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SAIAB	South African Institute of Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAS	Scientific Aquatic Services
subWMA	Sub-Water Management Area
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WRC	Water Research Commission
WULA	Water Use License Application

1 INTRODUCTION

1.1 Background

Scientific Terrestrial Services (STS) was appointed to conduct a freshwater ecological assessment as part of the environmental assessment and authorisation process for the proposed development of bulk services, namely bulk sewer and potable water pipelines, for Hammanskraal X10 within the Gauteng Province, henceforth collectively referred to as the "bulk service pipelines". In order to identify all freshwater resources that may potentially be impacted by the proposed bulk service pipelines, a 500m "zone of investigation" around the bulk service pipelines, in accordance with General Notice 509 of 2016 as it relates to the National Water Act (NWA), was used as a guide in which to assess possible sensitivities of the receiving environment. Refer to this area – i.e. the 500m zone of investigation around the bulk service pipelines, will henceforth as the "investigation area".

The proposed bulk sewer pipeline is situated approximately 900m west of the R101 (old Warmbaths Road) and 2.4km from the N1 Highway. The M21 traverses the southernmost portion of the bulk sewer pipeline, while the bulk potable water pipeline is situated approximately 1.1 km south of the M21. The Apies River is situated approximately 60m east to the most eastern end of the bulk sewer pipeline, and 2.4 km east of the bulk potable water pipeline (Figure 1 & 2).

The purpose of this report is to define the ecology of the bulk service pipelines in terms of freshwater aspects, mapping of the resources, defining areas of increased Ecological Importance and Sensitivity (EIS), and to define the Present Ecological State (PES) of the area under investigation. In addition, this report aims to define the socio-cultural and ecological service provision of the freshwater resources and the Recommended Ecological Category (REC) for each freshwater resource. It is a further objective of this study to provide detailed information to guide the proposed activities in the vicinity of the freshwater resources, to ensure that ongoing functioning of the ecosystem, such that local and regional conservation requirements and the provision of ecological services in the local area are supported.

This report, after consideration and description of the ecological integrity of the bulk service pipelines, must guide the Environmental Assessment Practitioner (EAP) and authorities, by

means of a reasoned opinion and recommendations, as to the viability of the proposed development activities, from a freshwater resource conservation perspective.

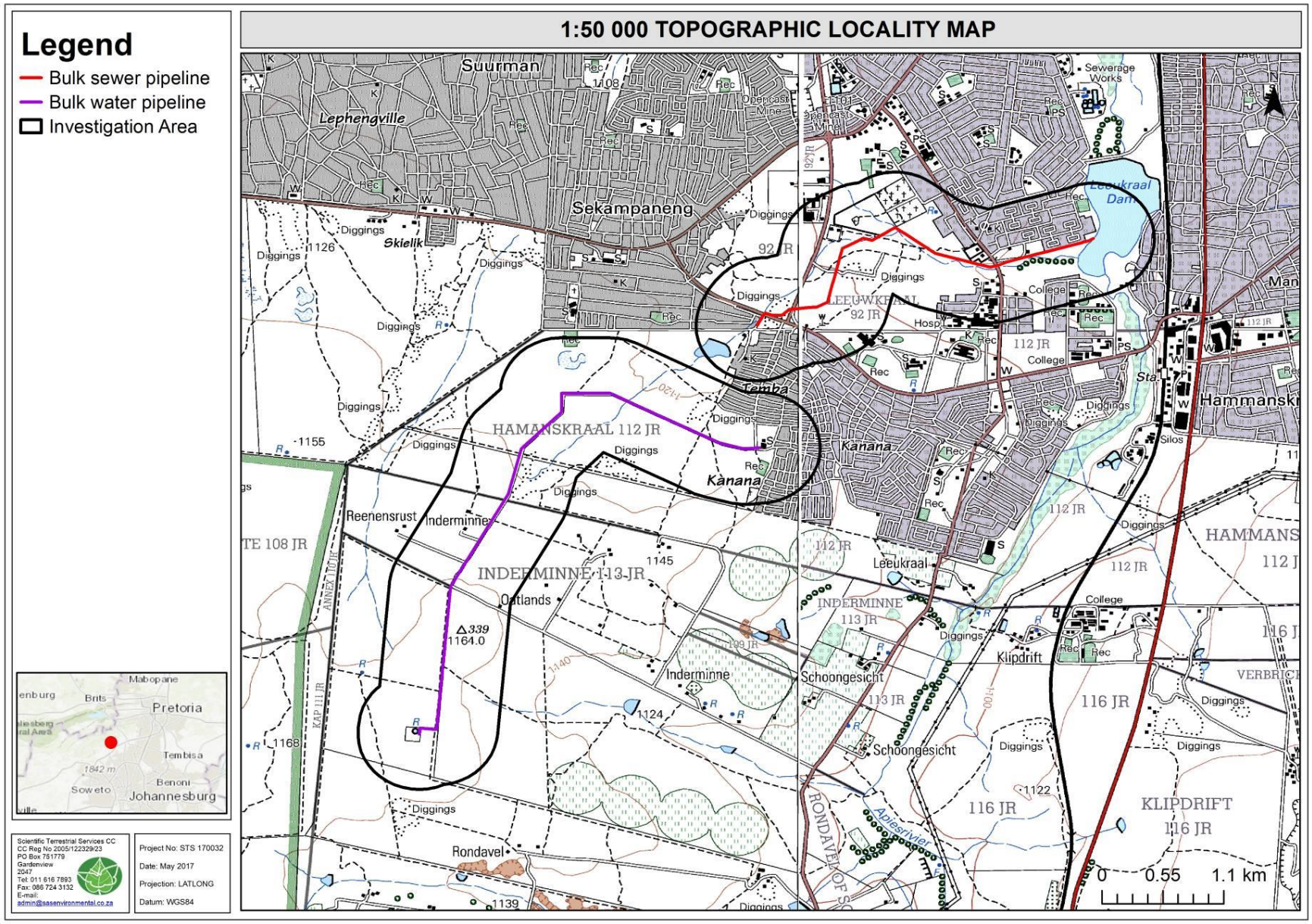


Figure 1: The bulk service pipelines depicted on a 1:50 000 topographical map in relation to the surrounding area

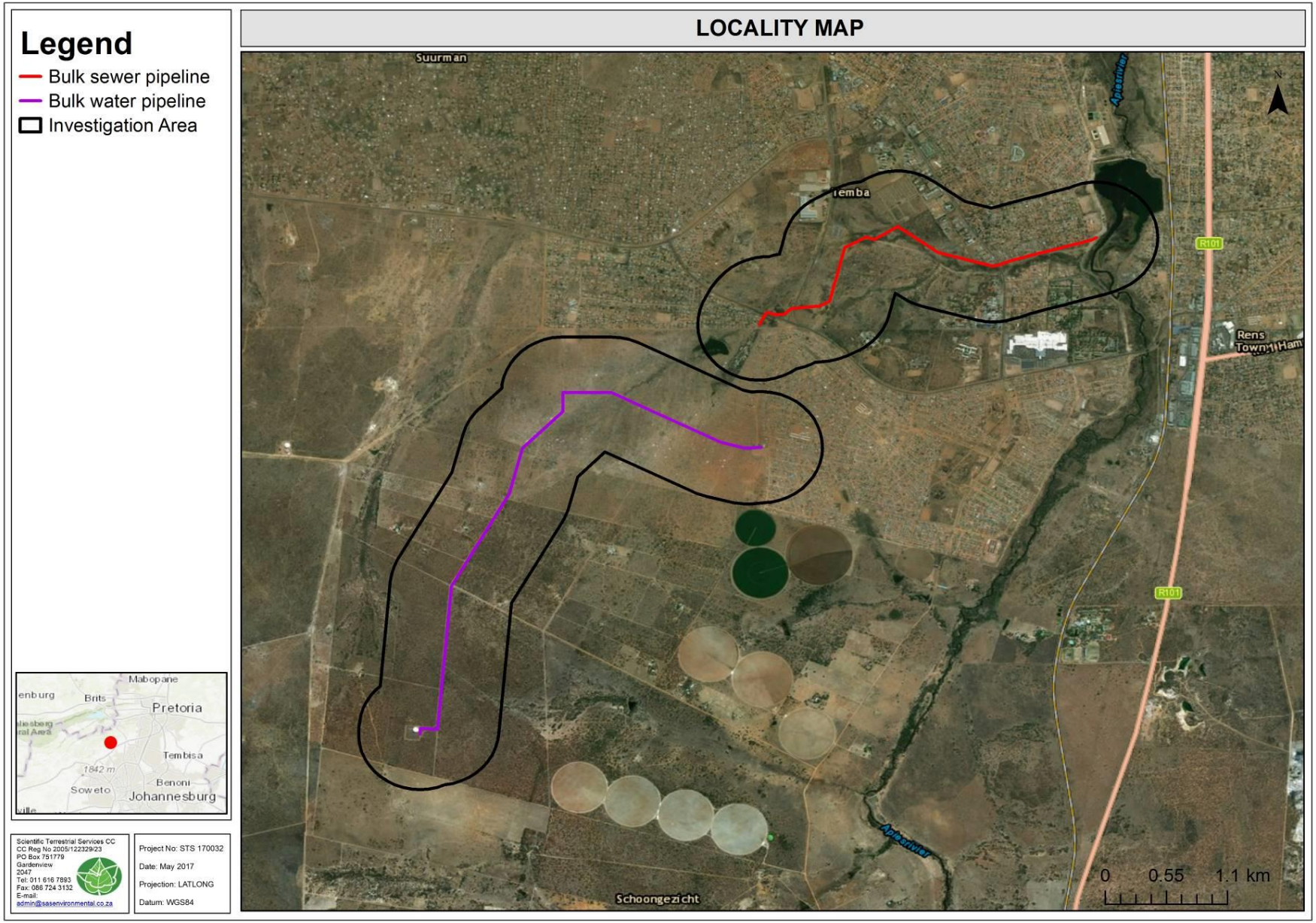


Figure 2: Satellite image depicting the location of the bulk service pipelines in relation to surrounding areas

1.2 Scope of work

Specific outcomes in terms of this report are outlined below:

- A background study of relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas [NFEPA], 2011 database; DWS RQIS PES/EIS, 2014 database and the Gauteng Conservation Plan Version 3.3 (2011); was undertaken to aid in defining the PES and EIS of the freshwater resources;
- The freshwater resources were delineated according to "DWAF[1], 2008: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". Aspects such as soil morphological characteristics, vegetation types and wetness were used to delineate the resources;
- The freshwater resource 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 EIS of the freshwater resources were determined according to the method described by Rountree & Kotze, (2013);
- The services provided by the freshwater resources associated with the bulk service pipelines were assessed according to the method of Kotze *et al.* (2009) in which services to the ecology and to the people were defined;
- Wetland Health/IHI of the freshwater resources was assessed according to the resource directed measures guideline as advocated by Macfarlane *et al.,* (2008) and DWAF (2007) respectively;
- Allocation of a suitable REC to the freshwater resources based on the results obtained from the PES, Ecoservices and EIS assessments;
- Freshwater resources were mapped according to the ecological sensitivity of each hydrogeomorphic unit in relation to the bulk service pipelines. In addition to the freshwater resource boundaries, the applicable zone of regulation was depicted where applicable;
- The DWS Risk Assessment Matrix was applied to identify potential impacts that may affect the resources as a result of the proposed development activities, and aim to quantify the significance thereof; and

[1] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known 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.

- To present management and mitigation measures which should be implemented during the various development phases to assist in minimising the impact on the receiving environment.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The determination of the freshwater resource boundaries and the assessment thereof, is confined to the bulk service pipelines. All freshwater resources identified within 500m of the bulk service pipelines were delineated in fulfilment of Regulation GN509 of the NWA on a desktop level, however these resources were not assessed individually, except where these resources formed part of the larger river system impacted upon by the proposed development;
- Some areas surrounding the freshwater resources have undergone significant anthropogenic influences (road construction, excavations, infilling) which have altered the soil profiles and vegetation composition. As a result, identification of the outer boundary of the temporary zone of some freshwater resources proved difficult in some areas. Therefore, the freshwater resource delineations as presented in this report are regarded as a best estimate of the boundaries based on the site conditions present, as observed during the site assessment;
- 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 resource boundaries will need to be surveyed and pegged according to surveying principles;
- Freshwater resources 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 resource boundaries may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results; and
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. However, it is expected that the proposed development activities have been accurately assessed and considered, based on the field observations and the consideration of existing studies and monitoring data in terms of riparian and wetland ecology.

1.4 Legislative requirements

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

- National Environmental Management Act (NEMA) (Act No. 107 of 1998);
- National Water Act (NWA) (Act No. 36 of 1998); and
- General Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the NWA (Act 36 of 1998); and
- The Gauteng Department of Agriculture and Rural Development's (GDARD) Requirements for Biodiversity Assessments, Version 3 (GDARD, 2014).

2 ASSESSMENT APPROACH

2.1 Freshwater Resource Field Verification

For the purposes of this investigation, the definition of wetland and riparian habitat as defined in the National Water Act (NWA) (1998) was used:

- A wetland is a 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; and
- Riparian habitat includes the physical structure and associated vegetation of the areas associated with a freshwater resource 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 freshwater resource delineations took place according to the method presented in the "Updated manual for the identification and delineation of wetland and riparian resources" (DWAF, 2008). The foundation of the method is based on the fact that wetlands have several distinguishing factors including the following:

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

A site visit was undertaken in September 2017, during which the presence of any freshwater resource characteristics as defined by DWAF (2008) or a wetland and riparian habitats as defined by the NWA were noted. In addition to the delineation process, a detailed assessment of the delineated resources was undertaken, whereby factors affecting the integrity of the resources were taken into consideration and aided in the determination of the functioning of the resources and the ecological and socio-cultural services provided by the freshwater resources.

A detailed explanation of the methods of assessment is provided in Appendix C of this report.

2.2 Sensitivity mapping

All freshwater resources associated with the bulk service pipelines and immediate surrounding area were delineated with the use of a Global Positioning System (GPS). Geographic Information System (GIS) was used to project these features onto aerial photographs and topographic maps. The sensitivity map presented in Section 4.3 should guide the design, layout and management of the proposed development.

2.3 Risk Assessment and Recommendations

Following the completion of the assessment, a risk assessment was conducted (please refer to Appendix D for the method of approach) and recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general management measures, which apply to the proposed development. Mitigation measures have been developed to address issues in all phases throughout the life of the operation including planning, construction and operational phases. The detailed mitigation measures are outlined in Section 5 of this report, whilst the general management measures which are considered to be best practice mitigation applicable to this project, are outlined in Appendix F.

3 RESULTS OF THE DESKTOP ANALYSIS

3.1 Conservation Characteristics of the bulk service pipelines

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 in order to allow for integration of results to take place by the reader. Where required, further discussion and interpretation is provided, and information that was considered to be of particular importance was emboldened.

It is important to note that although all data sources used provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the bulk service pipelines actual site characteristics at the scale required to inform the Environmental Assessment process. However, this information is considered to be useful as background information to the study. Thus, this data was used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance.

Table 1: Desktop data relating to the character of freshwater resources associated with the bulk service pipelines.

Aquatic ecoregion and sub-regions in which the proposed pipelines are located	
Ecoregion	Bushveld Basin
Catchment	Limpopo
Quaternary Catchment	A23F
WMA	Crocodile (West) & Marico
subWMA	Apies/Pienaars
Dominant characteristics of the Bushveld Basin Ecoregion Level 2 (8.05) (Kleynhans *et al.*, 2007)	
Dominant primary terrain morphology	Plains, low relief; Slightly undulating plains
Dominant primary vegetation types	Mixed Bushveld
Altitude (m a.m.s.l)	900 to 1500
MAP (mm)	400 to 700
Coefficient of Variation (% of MAP)	25 to 29
Rainfall concentration index	60 to >65
Mean annual temp. (°C)	16 to 20
Winter temperature (July)	2 – 22 °C
Summer temperature (Feb)	14 – 32 °C
Median annual simulated runoff (mm)	20 to 40 (limited); 40 to 100
Ecological Status of the most proximal sub-quaternary reach (DWS, 2014)	
Sub-quaternary reach	A23F – 00827 (Apies River)
Proximity to proposed pipeline	Situated immediately east of the sewer pipeline
Assessed by expert?	Yes
PES Category Median	E
Mean Ecological Importance (EI) Class	Moderate
Mean Ecological Sensitivity (ES) Class	Moderate
Stream Order	2
Default Ecological Class (based on median PES and highest EI or ES mean)	Moderate (Class C)

Detail of the proposed pipeline alternatives in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database	
FEPACODE	The proposed pipeline routes are located within a subWMA currently not considered important in terms of fish or freshwater resource conservation.
NFEPA Wetlands	According to the NFEPA database an artificial channelled valley bottom wetland is situated immediately east of the sewer pipeline, with a second artificial channelled valley bottom wetland situated ± 300m southwest of the western portion of the sewer pipeline. A natural depression wetland is situated ± 220 m north of the water pipeline (Figure 3). The two channelled valley bottom wetlands are considered to be in a heavily to critically modified ecological condition with, with < 25% natural land cover (WETCON = Z3). The depression wetland is considered to be in a natural or good ecological condition with ≥ 75% natural land cover (WETCON = AB) (Figure 4). This depression wetland is also considered to be a Freshwater Ecosystem Priority Area (FEPA) wetland (Figure 5)
Wetland Vegetation Type	The water pipeline and the western portion of the sewer pipeline falls within the Central Bushveld Group 3 (Endangered) wetland vegetation type, while the eastern portion of the sewer pipeline falls within the Central Bushveld group 2 (Vulnerable) wetland vegetation type (Figure 6).
NFEPA Rivers	The Apies River is situated ± 60m east of the most eastern end of the proposed sewer pipeline. According to the PES 1999 classification the Apies River is considered to be in a moderately modified ecological condition (Class C), however according to the NFEPA database the River is considered to be in a largely modified ecological condition (Class D) (Figure 3).
Detail of the proposed pipeline alternatives in terms of the Gauteng Conservation Plan (C-Plan V3.3, 2011) (Figure 4 & 5)	
Critical Biodiversity Area (CBA) (Figure 7)	The eastern and central portion of the sewer pipeline falls within a CBA, considered important for "Red" and "Orange" listed plant, "Red" listed mammal habitat and for primary vegetation. A CBA is an area considered important for the survival of threatened species and includes valuable ecosystems such as wetlands, untransformed vegetation and ridges (GDARD, 2014a)
Ecological Support Area (ESA) (Figure 7)	The water pipeline traverses two areas considered to be ESAs, while the western most section of the sewer pipeline is also situated within an ESA. An ESA provides connectivity and important ecological processes between CBAs and is therefore important in terms of habitat conservation.
Wetland (Figure 8)	According the Gauteng C-Plan the eastern most section of the sewer pipeline falls within a wetland buffer, with a second wetland buffer situated ± 340m southwest of the sewer pipeline. There are no wetland buffers associated with the water pipeline or its associated investigation area
River (Figure 8)	The Gauteng C-Plan indicated a non-perennial tributary of the Apies River traversing both the central portion of the sewer pipeline as well as the northern portion of the water pipeline. The Apies River is also indicated to be situated ± 60m east of the sewer pipeline, with another non-perennial tributary of the Apies River situated ± 240m east of the southern portion of the water pipeline.
Urban Area (Figure 8)	The proposed sewer pipeline and northern portion of the water pipeline falls within the Urban Area according to the Gauteng C-Plan Although the Urban Edge was rescinded as a policy document in the Gauteng Spatial Development Framework (2011), it nevertheless remains a useful indicator of where the concentration [of development] should occur.

DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; m.a.m.s.l = Meters Above Mean Sea Level; MAP = Mean Annual Precipitation; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State WMA = Water Management Area

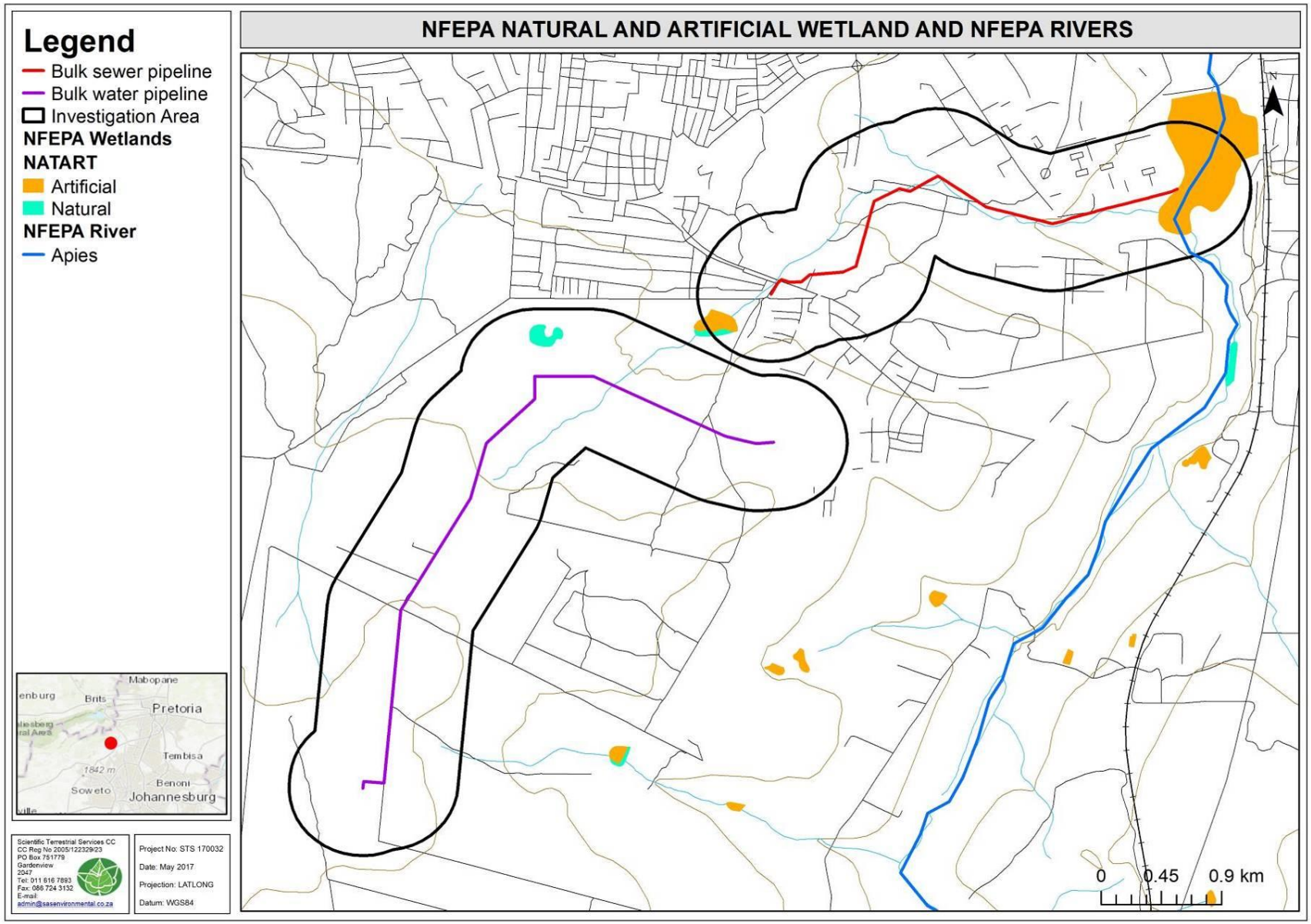


Figure 3: The NFEPA database indicating natural and artificial wetlands as well as the Apies River located within 500m of the bulk service pipelines (NFEPA, 2011).

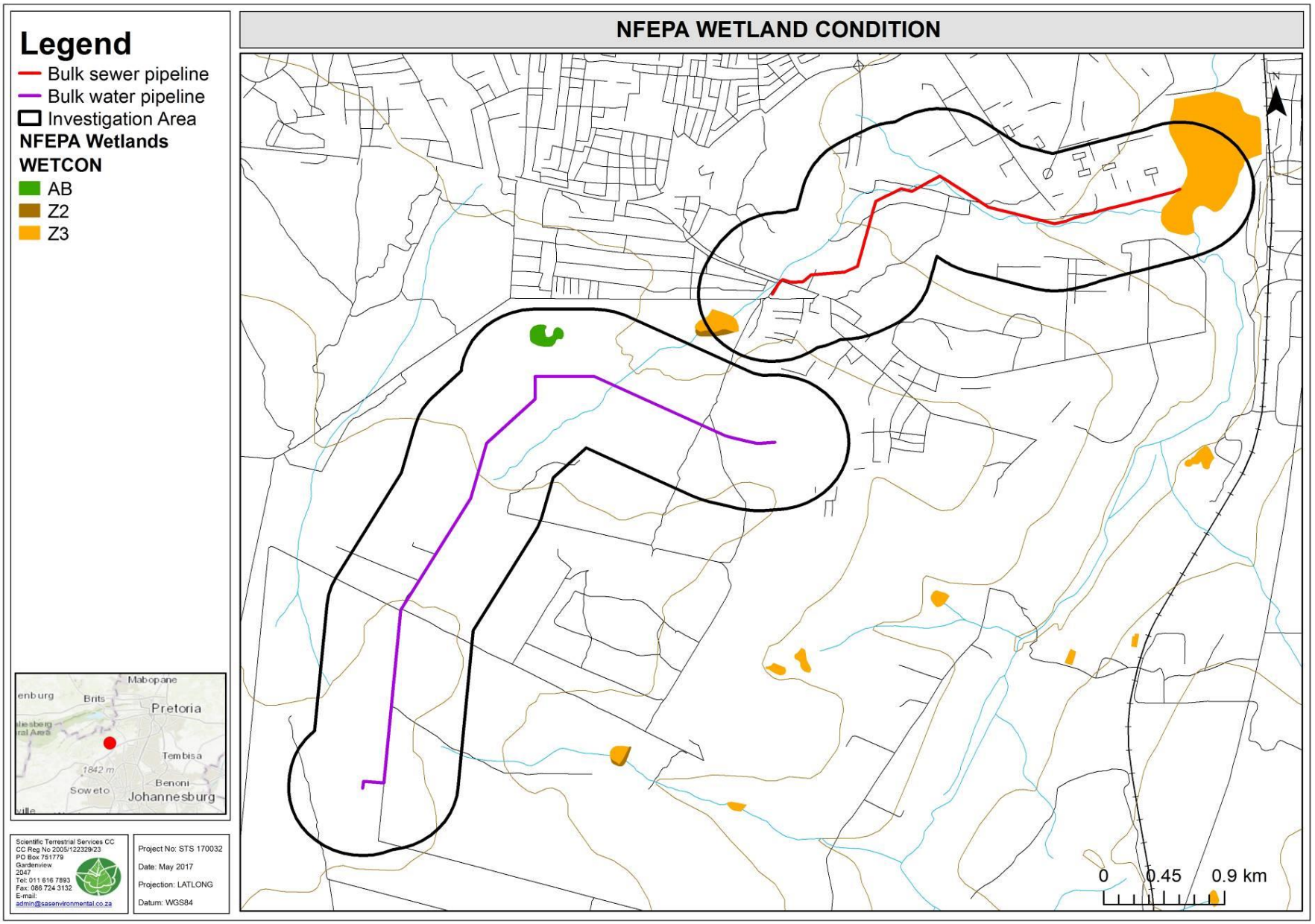


Figure 4: Conditions of the wetlands associated with the bulk services pipelines and investigation areas (NFEPA, 2011)

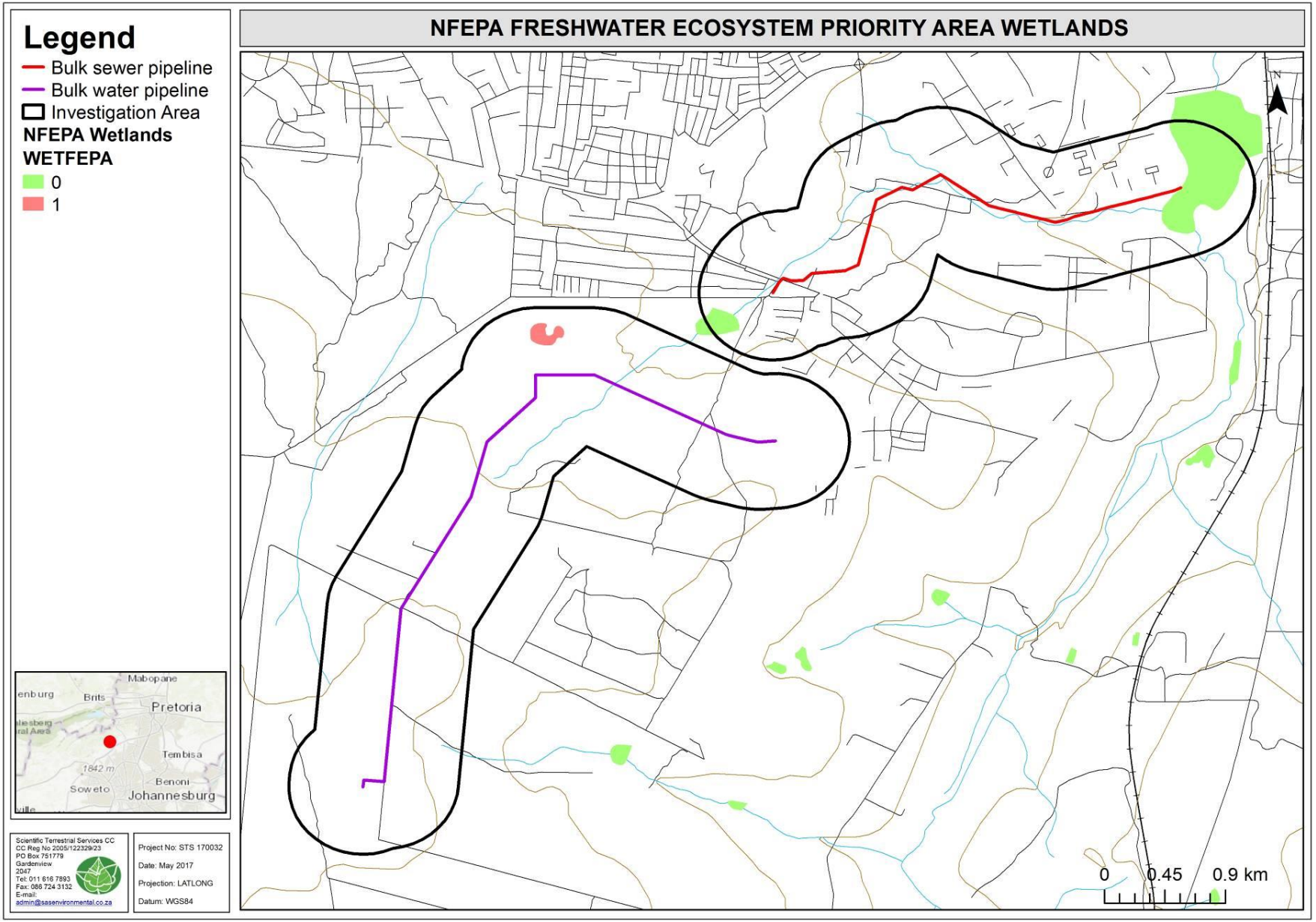


Figure 5: FEPA wetland situated within the investigation area of the bulk potable water pipeline (NFEPA, 2011)

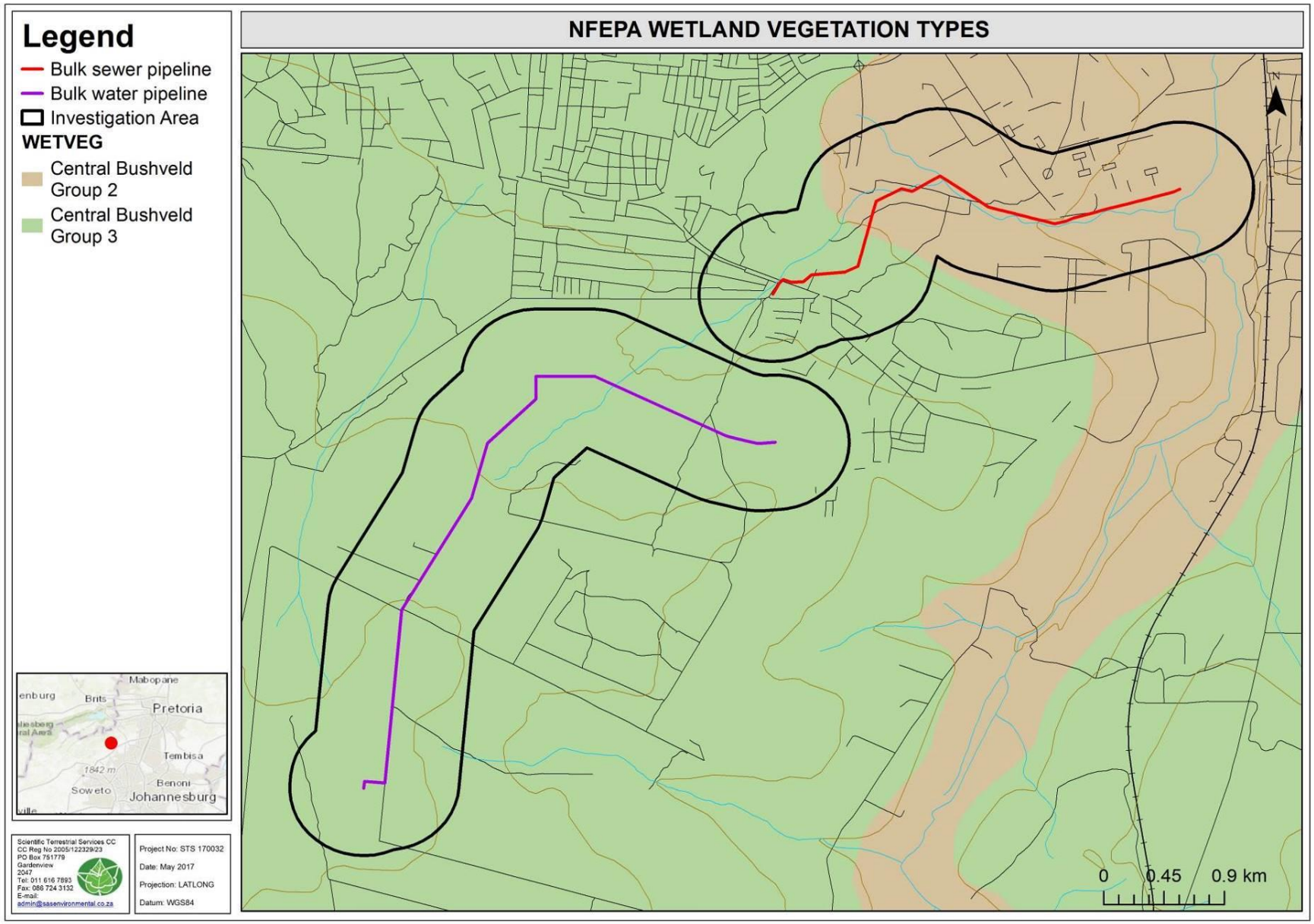


Figure 6: Wetland Vegetation associated with the bulk service pipelines (NFEPA, 2011)

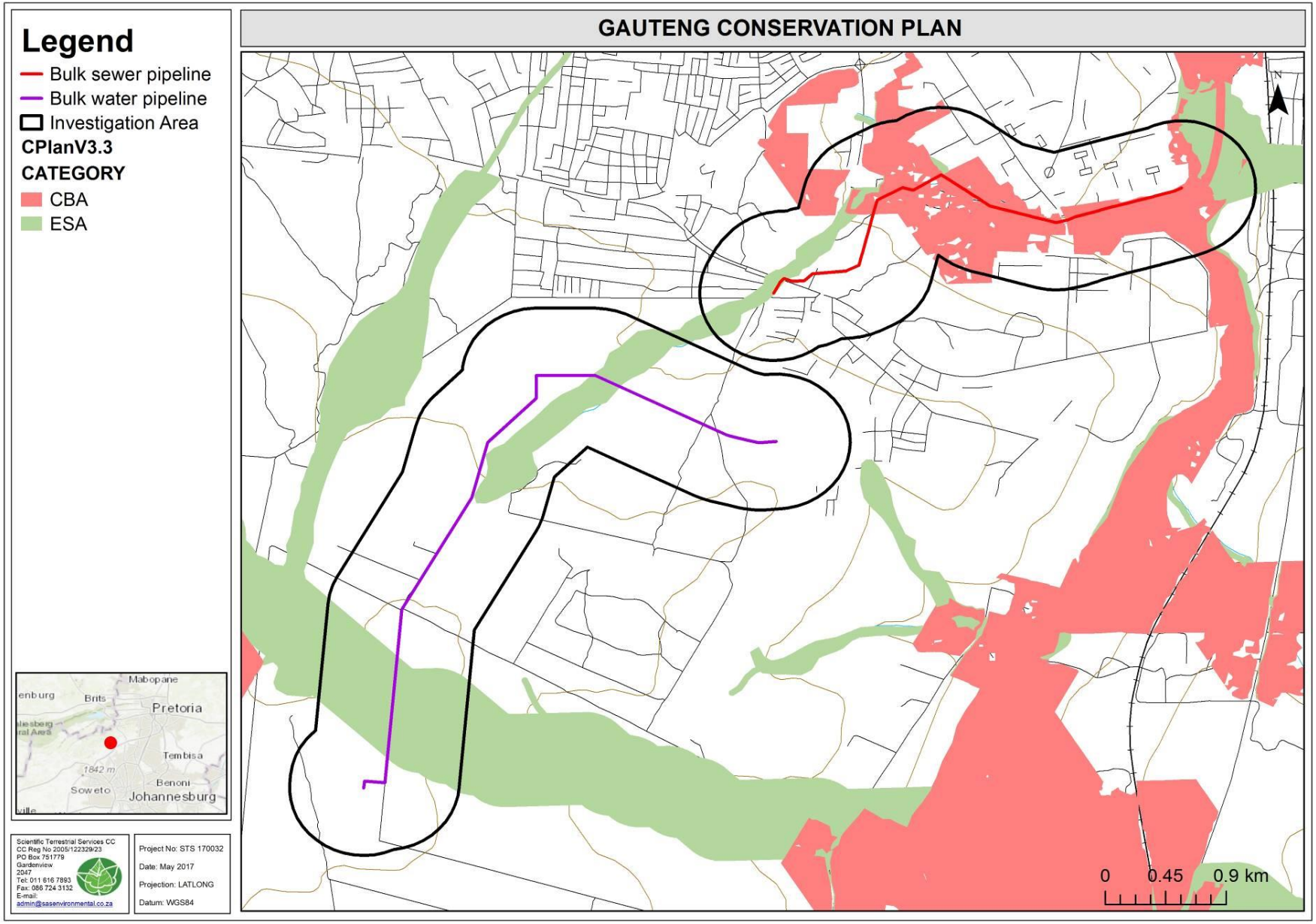


Figure 7: CBA and ESAs associated with the bulk service pipelines according to the Gauteng C-Plan V3.3 (2011)

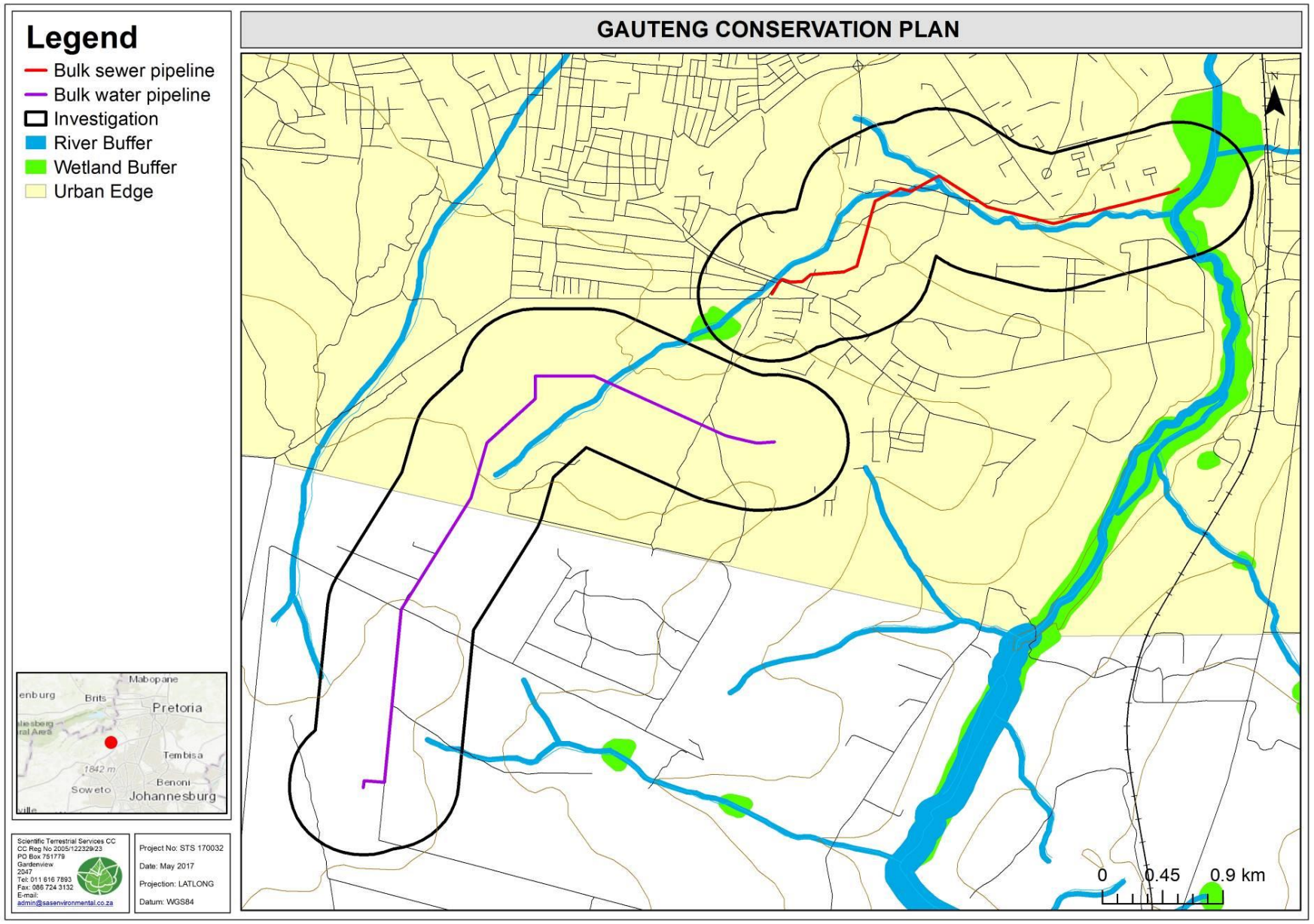


Figure 8: Wetland and River buffers associated with the bulk service pipelines according to the Gauteng C-Plan V3.3 (2011)

3.2 Ecological Status of Sub-Quaternary Catchments [Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS Database]

The PES/EIS database, as developed by the DWS RQS department, was utilised to obtain additional background information on the project area. The PES/EIS database has been made available to consultants since mid-August 2014. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, EWR sites and Hydro WMS sites.

Key information on background conditions associated with the proposed bulk service pipeline development, as contained in this database and pertaining to the Present Ecological State (PES), ecological importance and ecological sensitivity for the sub-quaternary catchment reach (SQR) A23F – 00827 (Apies River) is tabulated in Table 2 and indicated in Figure 9.

The Ecological Importance (EI) data for SQR A23F – 00827 (Apies River) indicates that the following fish species are expected to occur at this site:

Barbus trimaculatus Peters, 1852
Barbus paludinosus Peters, 1852
Barbus unitaeniatus Gunther, 1866
Clarias gariepinus Burchell, 1822
Labeobarbus marequensis Smith, 1841
Labeo cylindricus Peters, 1852
Labeo molybdinus Du Plessis, 1963
Oreochromis mossambicus Peters, 1852
Pseudocrenilabrus philander Weber, 1897
Tilapia sparrmani, Smith, 1840

The Ecological Importance (EI) data for SQR A23F – 00827 (Apies River) indicate that the following macro-invertebrate species are expected to occur at this site:

Ancylidae
Baetidae 1 sp.
Belostomatidae
Ceratopogonidae
Chironomidae
Coenagrionidae
Corixidae
Culicidae
Caenidae
Dytiscidae
Gerridae
Gomphidae
Gyrinidae
Hirudinea
Hydropsychidae 1sp.
Libellulidae
Muscidae
Notonectidae
Oligochaeta
Potamonautidae
Pleidae
Physidae
Simuliidae
Tipulidae
Veliidae/Mesoveliidae

Table 2: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR A23F – 00827 (Apies River) based on the DWS RQS PES/EIS database

Synopsis SQR A23F – 00827 (Apies River)					
PES[1] category median	**Mean EI[2] class**	**Mean ES[3] class**	**Length**	**Stream order**	**Default EC[4]**
E (Seriously Modified)	Moderate	Moderate	71.69	2	C
PES details					
Instream habitat continuity MOD		Large	**Riparian/wetland zone MOD**		Large
RIP/wetland zone continuity MOD		Moderate	**Potential flow MOD activities**		Serious
Potential instream habitat MOD activities		Serious	**Potential physico-chemical MOD activities**		Serious
EI details					
Fish spp/SQ		10	**Fish average confidence**		5.00
Fish representivity per secondary class		Moderate	**Fish rarity per secondary class**		Moderate
Invertebrate taxa/SQ		25	**Invertebrate average confidence**		4.60
Invertebrate representivity per secondary class		Moderate	**Invertebrate rarity per secondary class**		Moderate
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		High	**Habitat diversity class**		Low
Habitat size (length) class		Very High	**Instream migration link class**		Moderate
Riparian-wetland zone migration link		High	**Riparian-wetland zone habitat integrity class**		Moderate
Instream habitat integrity class		Low	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**		Moderate
Riparian-wetland natural vegetation rating based on expert rating					Low
ES details					
Fish physical-chemical sensitivity description		High	**Fish no-flow sensitivity**		High
Invertebrates physical-chemical sensitivity description		Moderate	**Invertebrates velocity sensitivity**		Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					High
Stream size sensitivity to modified flow/water level changes description					Low
Riparian-wetland vegetation intolerance to water level changes description					Low

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;
[2] EI = Ecological Importance;
[3] ES = Ecological Sensitivity
[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

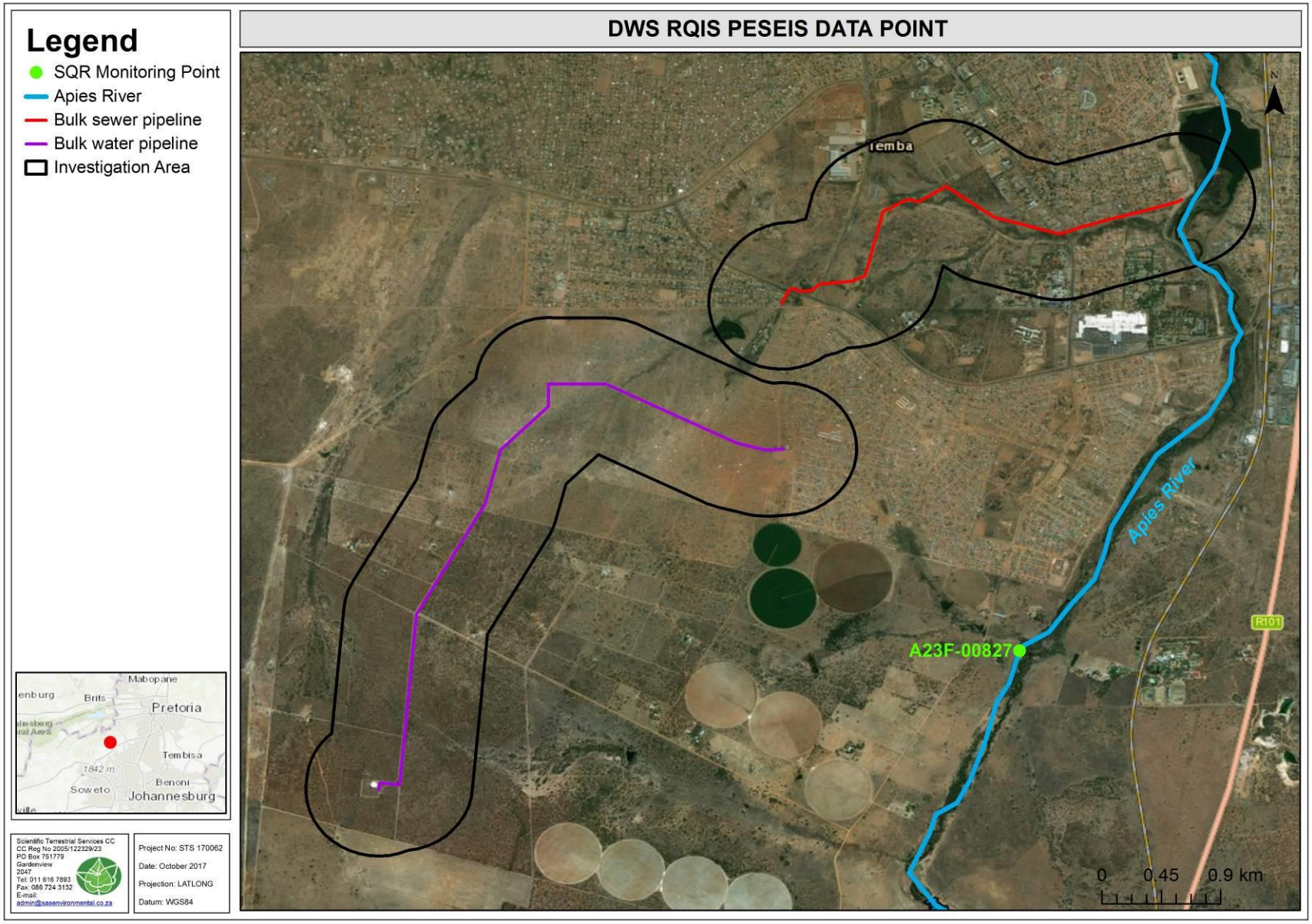


Figure 9: The applicable sub-quaternary catchment reach associated with the Apies River.

4 RESULTS: FRESHWATER ASSESSMENT

4.1 Freshwater Resource System Characterisation

Three interrelated freshwater systems were identified during the field assessment, which was grouped according to the level of development of their riparian zones, where the larger systems (perennial river and tributary) had a well-developed riparian zone and the smaller system (ephemeral drainage line) a weakly developed riparian zone.

The Apies River is located approximately 60m east of the most eastern end of the proposed sewer pipeline. An unnamed tributary of the Apies River (located on the western side of the Apies River) is proposed to be traversed by the sewer pipeline. An ephemeral drainage line was identified to be traversed by the proposed water pipeline. These freshwater resources in relation to the proposed bulk pipelines are depicted in Figure 11.

Historical images (Figure 10) indicate that an artificial dam (located south west of the tributary) and the unnamed tributary was historically connected, however, recent developments (road and housing infrastructure) has fragmented the connectivity of these two segments of the watercourse.

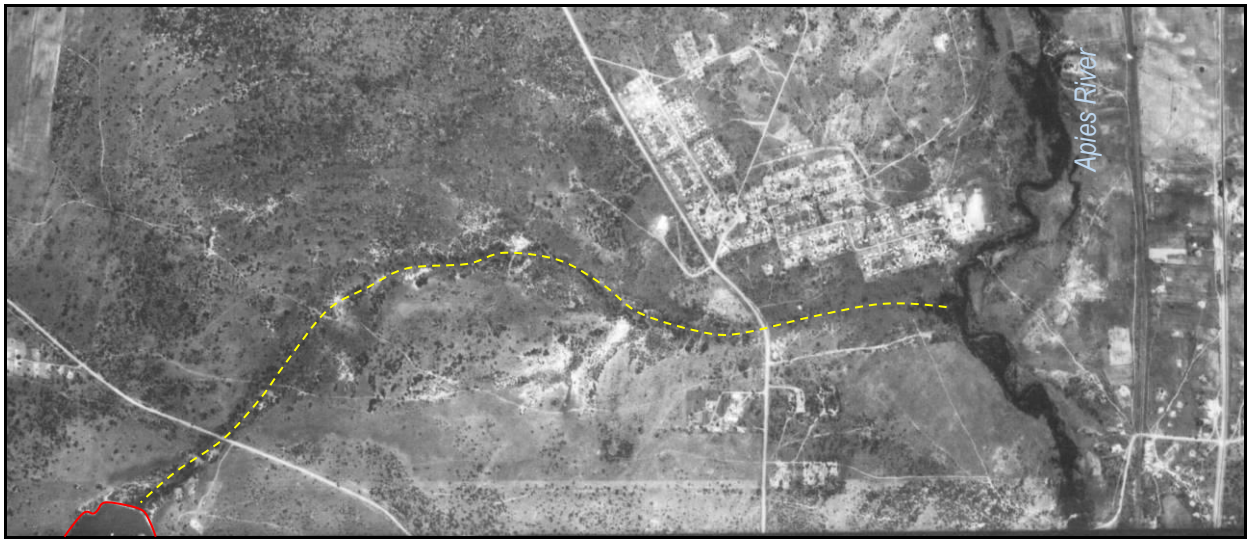


Figure 10: Historical imagery circa 1965, indicating the extent of the unnamed tributary of the Apies River (yellow dashed line), connected to the artificial dam in the left-hand corner (red outline).

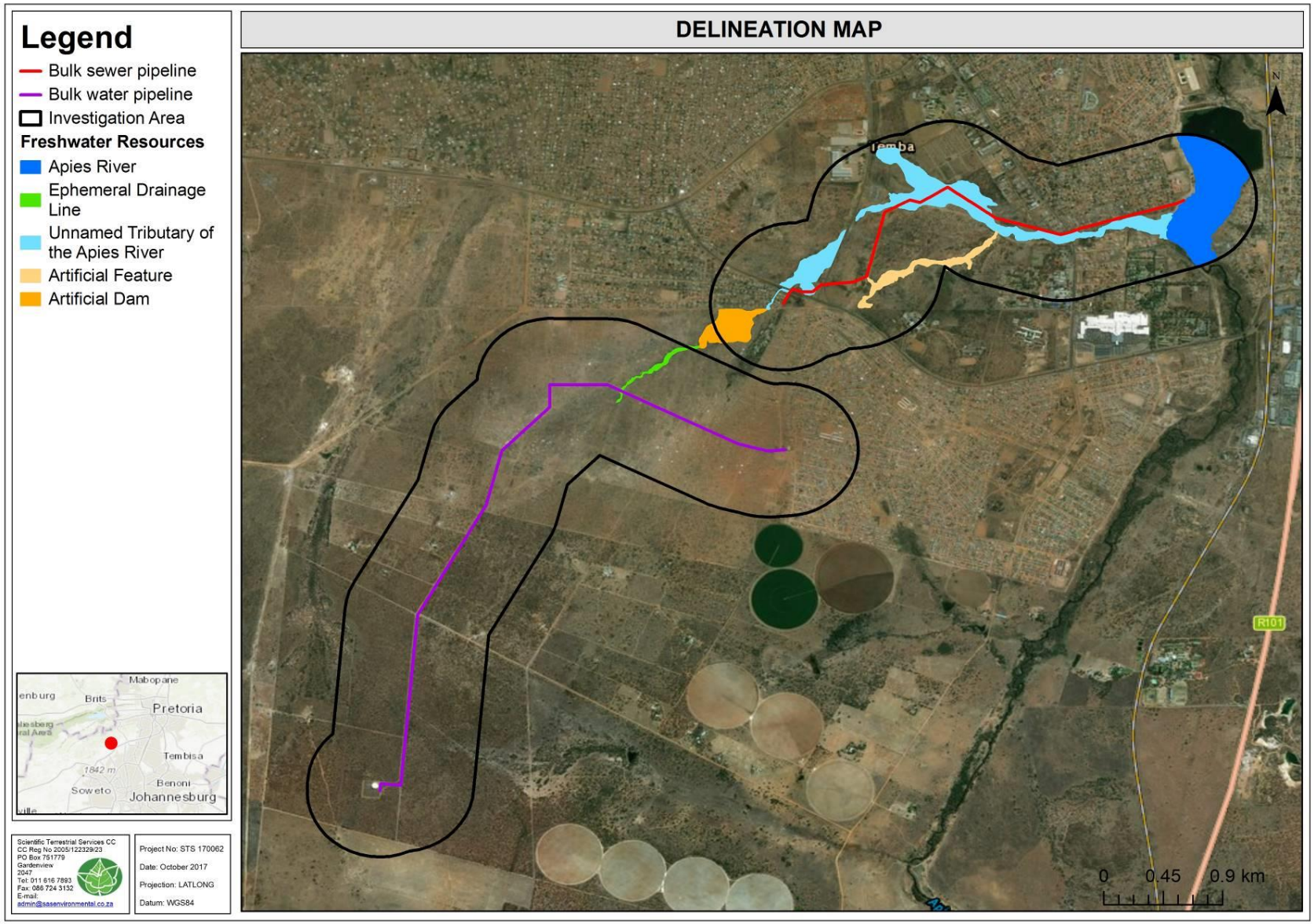


Figure 11: The location of the identified freshwater resources within the investigation area, in relation to the proposed bulk pipelines and surrounding areas.

Noted during the site visit, was an extensive artificial feature, extending from a leaking water tower (located just north of Harry Gwala Road) into a north-easterly direction, which drains into the unnamed tributary of the Apies River (Figure 12). However, this feature was not assessed since it is apparent from historical photographs (note the absence thereof in Figure 10) as well as observations made during the site assessment that it was formed due to altered topography and is assumed to be hydrologically driven by the leaking water tower and that this feature would not persist under "normal circumstances" as per the definition of a wetland in the NWA.

Figure 12: The leaking water tower has created saturated soils downstream in which facultative/obligate wetland vegetation established. However, if this driver is removed, it is expected that these vegetation species would no longer persist under the normal circumstances.

A small area of artificial ponding was identified on the southern side of the Harry Gwala Road (Figure 13), at the most southern end of the proposed sewer pipeline. Here, stormwater from the surrounding roads and impermeable surface is being discharged. Some indigenous wetland vegetation was evident in this area (such as *Typha capensis*); however, this area is mainly dominated by alien vegetation species (such as *Cirsium vilgare*). Even though the unnamed tributary flows underneath this road, it is diverted in between houses to ultimately be connected to the artificial dam located to the south-west of this artificial ponding area. Therefore, this feature was not assessed since it is apparent from historical and current digital satellite imagery as well as observations made during the site assessment that it was formed due to altered topography as a result of the construction of the Harry Gwala Road and infilling activities, and that this feature would not persist under "normal circumstances" as per the definition of a wetland in the NWA.

Figure 13: The area just south of Harry Gwala Road, where the most southern end of the proposed sewer pipeline is located. This area is highly disturbed due to the disposal of household and building rubble, in the inflow of stormwater from the surrounding roads.

Overall, the freshwater environment could be considered severely degraded. Along the greater part of the unnamed tributary, disposal of building rubble, household litter and excavation/infilling was visible (Figure 14). Additional runoff into these resources from roads has also influenced the water quality of the overall freshwater system.

Figure 14: Photographs depicting a variety of anthropogenic activities which have impacted on the overall condition of the freshwater resources associated with the proposed bulk pipelines. Such activities include the disposal of building rubble (top left) and household litter (bottom left), the excavation of tranches in order to drain upgradient areas (i.e. road surfaces) and the construction of infrastructures within close proximity to the freshwater resources.

The freshwater resources were classified (according to the Classification System outlined in Appendix C of this report) as Inland Systems, located within the Bushveld Basin Aquatic Ecoregion. The applicable WetVeg group is the *Endangered* Central Bushveld Group 3 wetland vegetation type and the *Vulnerable* Central Bushveld Group 2 wetland vegetation type. Table 3 below presents the classification from level 3 to 4 of the Wetland Classification System.

Table 3: Characterisation of the freshwater resources associated with the bulk pipelines.

Watercourse	Level 3: Landscape unit	Level 4: HGM Type
Apies River & unnamed tributary of the Apies River (Watercourses with distinct Riparian Zones)	**Valley floor:** The typically gently sloping, lowest surface of a valley.	**River:** A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water
Ephemeral drainage line (Watercourse without Distinct Riparian Zone)	**Valley floor:** The typically gently sloping, lowest surface of a valley.	**Ephemeral drainage line:** A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water

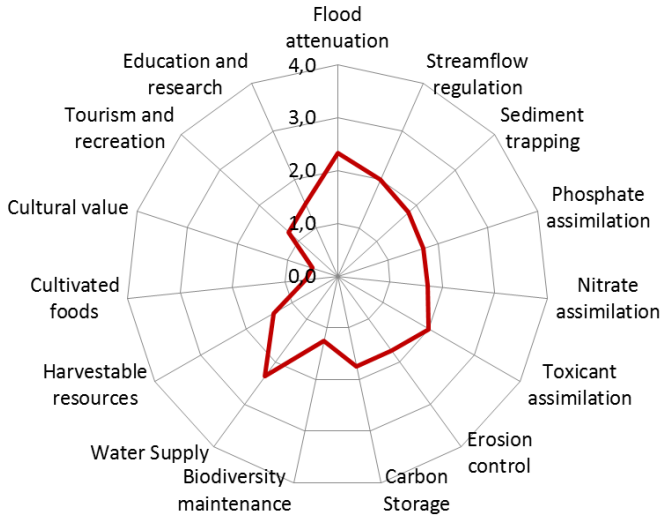
4.2 Field Verification Results

Following the site visit, various assessments were undertaken in order to determine the following:

- PES, incorporating aspects such as hydrology, vegetation and geomorphology;
- Service provision of the freshwater resources, which incorporates biodiversity maintenance, flood attenuation, streamflow regulation and assimilation, to name a few;
- The EIS is guided by the results obtained from the assessment of PES and service provision of the freshwater resources;
- An appropriate REC to guide the management of the resource with the intent of enhancing the ecological integrity of the resources where feasible; and
- Assessment of impacts of the construction and operation of the proposed bulk pipelines on the freshwater system.

Table 4: Summary of the assessment of the Apies River located approximately 60m from the most eastern end of the bulk sewer pipeline.

Ecological & socio-cultural service provision graph:



PES and general habitat integrity discussion

IHI Riparian PES Category: D/E (Largely to Seriously modified)
VEGRAI Category: D

Alterations to the riparian habitat have occurred, primarily due to historical disturbances relating to the transformation of the surrounding area to urbanised areas. The Apies River has its origins near Pierre van Ryneveld in Pretoria (approximately 48km south of the bulk sewer pipeline) and flows in a northwesterly direction through central Pretoria. The river is canalised for most of its length through central Pretoria and the water quality impacted on due to the stormwater received as runoff from impermeable surfaces. Clearing of the non-marginal zone (of this portion of the river), and therefore removing the protective buffer strip (a vegetated area ordinarily situated embankment of the river, designed to filter out insoluble pollutants in runoff) has increased the probability of impacts on this portion of the river and to the overall river system. These disturbances have also increased the proliferation of alien vegetation in this area. Flow-impeding structures (such as road crossings, bridges and dams) are present upstream of this site as well as downstream (i.e. the Leeukraal Dam). These instream structures have impacted on the overall ecological condition of the river as well as decreased the functionality thereof. Debris and disposed household rubble were noticed along the non-marginal zone of the river portion assessed.

Photograph notes

Left: The boundary of the Apies River below the Leeukraal dam. This portion of the river is dominated with *Typha capensis* (permanent zone) and invasive alien species in the marginal zone. The yellow arrow (at an existing manhole) indicates where the proposed sewer pipeline would be routed from. Right: The portion of the Apies River where the unnamed tributary drains into the Apies River. Within this area existing manholes, trampling and household litter was evident.

Watercourse drivers:

a) Hydrology

Since this river flows the city of Pretoria, the river receives stormwater from the urbanised catchment and essentially functions as a stormwater channel. The increase in water volume of the river has resulted in an incised river channel. Several energy dissipating structures (attenuation ponds, upstream dams such as the Bon Accord Dam) has been constructed to decrease the velocity of flow into the lower reaches of this river. However, in between these large dams, runoff from the residential/industrial areas enters the system again.

b) Water quality

The water quality of this system is considered to be moderately to highly impacted, most likely from the stormwater water entering the river but also from seepage of small scale septic systems along the upstream portion of the river. This water is not considered potable (EC: 63.9 mS/m) and it is expected that no sensitive aquatic invertebrate species would survive in this portion of the river entering the Leeukraal Dam.

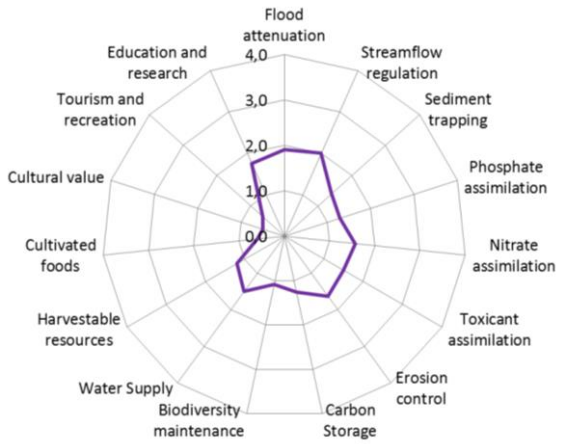
c) Topography: Geomorphology and sediment balance

Due to the increased velocity of stormwater inputs in the upper reaches of this river, originating from increased impermeable surfaces and the overall loss of vegetation in the catchment, modifiers to the geomorphology of the river can mainly be attributed to stream bank and stream bed incision and erosion. Increased sediment into the system are also anticipated due to reduced vegetation cover and impermeable surfaces. Sediment deposits from the upstream river settles at the inlet of the Leeukraal Dam which has created additional substrate for vegetation to

<table>
<tr><td></td><td></td><td colspan="2">establish within the dam, increasing the surface roughness of this resource.</td></tr>
<tr><td>Ecoservice provision</td><td>Intermediate:
Despite this river having a reduced ecological integrity, functioning remains at a moderately low to intermediate level, particularly in terms of eco-services such as flood attenuation and streamflow regulation. Also, the provision of this river of water supply for direct human use is considered of intermediate importance, since water extracted on a small scale for household usage and downstream forms part of a Waste Water Treatment Works (WWTW). Since this portion of the river is located in a peri-urban area, it is not considered of great importance in terms of harvestable resources.</td><td colspan="2">d) Habitat and biota

Invasive species such as Cirsium vilgare and Asclepia fruiticosa species were found to be located within the non-marginal zone of the river, whilst the permanent zone is dominated by reed species such as Typha capensis and Phragmites australis. Despite these modifications so the vegetation, the river is still considered to provide habitat for some faunal species, as it is connected to other natural areas in the upper and lower reaches of the river. For more detail pertaining to the surrounding vegetation habitat, please refer to the Terrestrial Ecological Habitat Integrity Report for a more detailed discussion (STS, 2017).</td></tr>
<tr><td rowspan="2">EIS discussion</td><td rowspan="2">EIS Category: B (High)
The EIS of this river falls within Category B, which are freshwater resources considered to be ecologically important and sensitive, and the biodiversity thereof may be sensitive to flow and habitat modifications. This river is also considered to be an CBA (Gauteng Conservation Plan, 2014), as it is considered important for the survival of threatened species and includes valuable ecosystems such as wetlands, untransformed vegetation and ridges.
It is the opinion of the freshwater ecologist that this EIS class is not representative of the ecological sensitivity of the resource at its current stage, and the an EIS Category C (Moderate) is a more accurate representation. Nevertheless, it is important to conserve the remaining habitat and the connectivity this river provides to other natural areas, and to promote the re-establishing of indigenous species.</td><td>REC Category</td><td>Category: D (Largely modified)
Due to the degraded ecological state of the river, no further degradation should not be permitted. Mitigation measures should be implemented during all phases of the proposed pipeline development to minimise the risk of further negative impacts on the river, and wherever possible, to improve the conditions of the portion of the river associated with the development.</td></tr>
<tr><td colspan="2">Possible significant impacts, Business case, Conclusion and Mitigation Requirements:
The most eastern end of the proposed sewer pipeline would be routed approximately 60m upstream of the Apies River. Even though no direct impacts are expected to occur on this section of the river related to the construction phase of the proposed sewer pipeline, edge effects from such activities may occur. Also, the failure of the sewer pipeline during the operational phase of the pipeline, could pose a direct risk to the downstream system – in this case, the Apies River. Therefore, adherence to cogent, well-conceived and ecologically sensitive site designs and construction methods, and the mitigation measures as provided in this report as well as general good construction practice, is essential if the significance of potential impacts on this river is to be reduced.</td></tr>
</table>

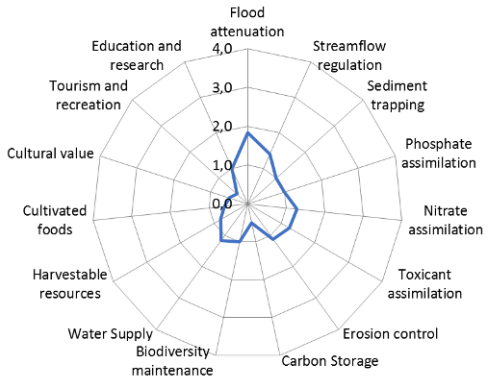
Table 5: Summary of the assessment of the unnamed tributary of the Apies River to be traversed by the bulk sewer pipeline.

<table>
<tr><td colspan="2">Ecological & socio-cultural service provision graph:
 
</td><td colspan="2">   
Photographs depicting various portions of the tributary with heaps of disposed household rubble and litter within the non-marginal zone of the tributary. Manholes (yellow arrow) and other infrastructure is also located within the non-marginal zone of the tributary. Note the large woody component within the marginal zone of the tributary.</td></tr>
<tr><td>PES and general habitat integrity discussion</td><td>IHI Riparian PES Category: D (Largely to Seriously modified)
VEGRAI Category: D
Alterations to the riparian zone of this tributary is mainly due to ongoing disposal of household and building rubble within the non-marginal zone of the tributary. Additionally, this clearing of the non-marginal zone, and therefore removal the protective buffer strip has increased the probability of impacts occurring on this tributary. These disturbances have also increased the proliferation of alien vegetation in this area, with specific mention of the non-marginal zone. Excavated trenches to drain runoff from informal roads is present along the entire length of the tributary.</td><td colspan="2">Watercourse drivers:
a) Hydrology
As with the Apies River, this tributary receives stormwater runoff originating from the adjacent residential developments, roads and from a leaking water tower. This has increased the overall volume of water entering the tributary, leading to the erosion and sedimentation of the tributary stream channel. Due to this permanent inflow of water, the hydrological regime in terms of the frequency of inundation and seasonal fluctuation has changed.

b) Water quality
The quality of the water in this tributary is considered to be impacted based on measurement of basic water quality parameters (pH: 7.48, TDS: 7.15mg/l; EC: 81 mS/m) with a tolerable salt concentration, however salts are considered significantly elevated from natural conditions. This lowered quality of water can be attributed to the inflow of mainly stormwater from surrounding residential/industrial developments and roads, as well as runoff contaminated by the disposal of waste surrounding the tributary. Even though existing pipelines and manholes are located within the non-marginal zone of this tributary, these manholes seem to be intact with no visible impact (especially with regards to a sewerage leak) on the tributary.</td></tr>
<tr><td>Ecoservice provision</td><td>Moderately Low/Intermediate:
The tributary is considered of moderate importance for streamflow regulation and flood attenuation. Due to the disturbed nature of the surrounding riparian habitat mainly due to the disposal of household/building rubble, this tributary is not considered to support a variety of faunal and floral species. This tributary has the potential to be used as a recreational area, however since the tributary in its entirety is considered degraded, the direct cultural benefits this tributary currently provide it considered limited.</td><td colspan="2">c) Topography: Geomorphology and sediment balance
The gentle slope from the south-west to the lower north-eastern portion of the sewer pipeline, allows for water to drain through the tributary into the Apies River. Water from upstream areas does get attenuated by the dam (located within the south-western portion of the sewer pipeline investigation area) as well as by the Harry Gwala Road. Additional inputs into the tributary through stormwater and the increased velocity thereof (due to a lowered surface roughness through vegetation removal), has incised the channel, increased erosion and ultimately increased the sediment load of the tributary.</td></tr>
</table>

EIS discussion	**EIS Category: C (Moderate)** The importance of the tributary in terms of providing a migratory corridor for faunal species and habitat for some riparian flora contributed to the EIS class. This EIS class is considered to be representative of the sensitivity of the tributary, since it is not considered that the tributary would be sensitive to flow and further habitat modifications.	**d) Habitat and biota** This tributary boasts a large woody component within the marginal zone of the tributary. These are mostly indigenous tree species (i.e. *Acacia karoo*). However, the non-marginal zone in considered to be highly disturbed with a variety of alien invasive species present along the entire extent of the tributary, especially where disruptions (such as excavated trenches, infrastructure) have occurred. For more detail pertaining to the surrounding vegetation habitat, please refer to the Terrestrial Ecological Habitat Integrity Report for a more detailed discussion (STS, 2017).
REC Category	**Category: D (Largely modified)** Due to the degraded ecological state of the tributary, no further degradation should not be permitted. Mitigation measures should be implemented during all phases of the proposed development and all potential impacts suitably managed to ensure that present levels of ecological services and functioning of these features are not further degraded. Furthermore, suitable erosion control and surface water runoff management must be implemented in order to reduce the impacts on this tributary.	**Possible significant impacts, Business case, Conclusion and Mitigation Requirements:** The proposed sewer pipeline will directly traverse this tributary, and therefore, the perceived impact significance of the construction of the proposed sewer pipeline is deemed to be of Medium risk significance. Also, the possibility of the sewer line bursting/leaking during the operational phases, poses a moderate risk to the freshwater resource and its downstream system Therefore, adherence to cogent, well-conceived and ecologically sensitive site development plans, and the mitigation measures as provided in this report as well as general good construction practice, is essential if the significance of perceived impacts is to be reduced to acceptable levels and to limit degradation to the remaining freshwater environment.

Table 6: Summary of the assessment of the ephemeral drainage line (with riparian vegetation) to be traversed by the proposed water pipeline.

<table>
<tr>
<td colspan="2">Ecological & socio-cultural service provision graph:
 
</td>
<td colspan="2"> 
Left and centre: Photographs depicting the northern extent of the ephemeral drainage line, indicating the removal of vegetation surrounding the drainage line, but vegetation still remains within the active channel. Right: The drainage line portion opposite of the road that crosses this drainage line (southern portion), indicate that the typical vegetation of the drainage line in the northern portion does no longer persist in the southern portion, indicating total fragmentation of the drainage line at this point.</td>
</tr>
<tr>
<td rowspan="2">PES discussion</td>
<td rowspan="2">PES Category: D (Largely modified)
This ephemeral drainage line was found to have undergone some intensive impacts, which include the construction of informal houses along the embankment of the drainage line, fragmentation of the vegetation component of the drainage line, and disrupting the hydrological connectivity from the upstream to the downstream portions through the construction of informal roads and soil compaction. Where roads traverse the drainage line, it has resulted in localised incidences of increased sediment inputs, which has overall altered the ecological integrity of the drainage line.</td>
<td colspan="2">Watercourse drivers:
a) Hydrology
The hydrological regime of this ephemeral drainage line is mostly driven by the runoff of overland flow into the drainage line. Due to the surrounding informal developments, the quantity of natural overland flow into this drainage line has decreased, however, due to increased compacted areas it is most likely that stormwater runoff into this drainage line is of a higher quantity than the natural inflow of water would be.</td>
</tr>
<tr>
<td colspan="2">b) Water quality
The ephemeral drainage line was dry at the time of the assessment. However, the soil did show signs of moisture. The water quality of this drainage line is expected to be impacted upon by the release of household water into the drainage line, and due to the runoff entering the drainage line.</td>
</tr>
<tr>
<td rowspan="2">Ecoservice provision</td>
<td rowspan="2">Moderately Low.
Due to the ephemeral nature of this drainage line, its capacity to provide certain ecological services is considered reduced. This drainage line is considered to be connected to other natural features but does, however, drain into an artificial dam, which is connected to the unnamed tributary of the Apies River. Despite this connectivity it is not considered important for streamflow regulation. It is also not considered important for water supply, harvestable resources or cultivated foods, mainly due to the drainage lines ephemeral nature. It is considered of moderate importance for flood attenuation since it does dissipate flow, and due to the presence of reed species within the active channel, is considered to have a high surface roughness.</td>
<td colspan="2">c) Topography: Geomorphology and sediment balance
The gentle slope of the site has allowed surface water to move down the slope (in the path of least resistance) where the flow became concentrated and eroded a channel. Historically this drainage line would not have received high runoff rates and the channel would have been shallow and concave in cross-section, however, currently, due to the increase in runoff off higher volumes and velocity, this drainage line has become more incised. Due to the removal of all surrounding vegetation to this drainage line (vegetation clearing for the construction of an informal residential area), sediment loaded runoff enters this drainage line and erosion is exacerbated.</td>
</tr>
<tr>
<td colspan="2">d) Habitat and biota
Only reed species (Typha capensis) were identified within the active channel of the ephemeral drainage line, with very little other vegetation (wetland or terrestrial species) present within the surrounding area. Invasive alien species such as Asclepia fruiticosa and Tagetus minuta. This drainage line is not considered large enough to support significant populations of larger animals but could potentially provide habitat for avifaunal species. For more detail pertaining to the surrounding vegetation habitat, please refer to the Terrestrial Ecological Habitat Integrity Report for a more detailed discussion (STS, 2017).</td>
</tr>
</table>

<table>
<tr><td rowspan="2">EIS discussion</td><td rowspan="2">EIS Category: C (Moderate)
Even though the extent of this drainage line is small when compared to that of the larger drainage system, it does still play a role in the hydrological regime of the large river system. This drainage line is considered of moderate ecological importance due to the wetland vegetation group it is associated with is considered to be Endangered (Central Bushveld Group 3). Also, this drainage line is considered to be an ESA by the (Gauteng Conservation Plan, 2014) as it still provides connectivity and important ecological processes to the unnamed tributary (with is considered to be a CBA) and is therefore important in terms of habitat conservation. However, due to the condition of the drainage line, it is the opinion of the ecologist that this drainage line has already been altered and not highly susceptible to impacts of limited severity.</td><td>REC Category</td><td>Category: D (Largely modified)
The ephemeral drainage line has been impacted upon, and not considered to be highly ecologically sensitive or important; however, efforts should be made to increase current levels of ecological functioning and prevent further degradation of this drainage line.</td></tr>
<tr><td colspan="2">Business case, Conclusion and Mitigation Requirements:
The proposed pipeline will directly traverse a section of this ephemeral drainage line, and therefore, the perceived impact significance of the construction of the proposed pipeline is deemed to be of Medium risk levels. Since the proposed pipeline would only be used for potable water, in the event of a leak of the pipeline during the operational phase, the severity thereof would not be as significant as if it would have been for contaminated water or conveyance of sewage, however some impact from the chlorine rich water is possible. Adherence to cogent, well-conceived and ecologically sensitive site development plans, and the mitigation measures as provided in this report as well as general good construction practice, is essential if the significance of perceived impacts is to be reduced to acceptable levels and to limit further degradation to the freshwater environment.</td></tr>
</table>

4.3 Delineation and Sensitivity Mapping

Due to the significant anthropogenic influences on the freshwater resources, mainly due to the surrounding urbanisation and disposal of rubble on the boundary of these freshwater resources, in some instances, the freshwater resources were partially delineated in the field, and the delineations subsequently refined with the use of aerial photographs, digital satellite imagery and topographical maps. The delineations as presented in this report are thus regarded as a best estimate of the freshwater resources boundaries based on the site conditions present at the time of assessment.

During the assessment, the following indicators were used to delineate the boundaries of the riparian zones of the freshwater features:

- The vegetation indicator could not be extensively utilised, as only the permanent zone of the freshwater resources contained vegetation indicative of wet or moist conditions. However, in some areas of less disturbance vegetation indicative of wet or moist conditions was present and was used as an indicator of the freshwater resources boundaries;
- Terrain units were utilised in some sections to ascertain the freshwater resource boundary, but due to historical earthworks and infilling, extensive urbanisation and catchment hardening, could not be relied upon throughout; and
- Due to the degree of disturbances along the length of the proposed bulk pipelines, historical and current digital satellite imagery was also utilised to aid in the delineation of certain areas.

4.3.1 *Legislative Requirements, national and provincial guidelines pertaining to the application of buffer zones*

According to Macfarlane *et al.* (2015), the definition of a buffer zone is variable, depending on the purpose of the buffer zone, however in summary, it is considered to be “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 to be important to provide protection of basic ecosystem processes (in this case, the protection of aquatic and wetland ecological services), reduce impacts on water resources arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015). It should be noted however that buffer zones are not considered to be effective mitigation against impacts such as hydrological changes arising from stream

flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

Legislative requirements were first taken into consideration when determining a suitable buffer zone for the freshwater resources. The definition and motivation for a regulated zone of activity as well as buffer zone for the protection of the freshwater resource can be summarised as follows:

- **Activity 14** of Listing Notice 3 (GN 324) of the NEMA (1998) as amended in April 2017 states that:

  The development of:

  (x) buildings exceeding 10 square meters in size;

  (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 metres of a watercourse, measured from the edge of a watercourse;
- Activity 19 of Listing Notice 3 (GN 324) of the NEMA (1998) as amended in April 2017 states that:

  The infilling or deposition of any material of more than 5 cubic meters into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic meters from

  i.) a watercourse

  ii.) the seashore; or

  iii.) the littoral active zone, an estuary or a distance of 100 meters inland of the high-water mark of the sea or an estuary, whichever distance is the greater.

In terms of possible constraints to the development, as per legislative requirements, **Activity 14** of Listing Notice 3 (GN 324) of the NEMA (1998) as amended in April 2017, of the NEMA (Act 107 of 1998) must be considered in defining the relevant regulated zone associated with any watercourse. Thus, the 32 m Zone of Regulation as prescribed by NEMA is applicable to this proposed development. If activities are planned within the riparian zone or 32m zone of regulation, from an enviro-legal viewpoint, the project will face some challenges and the relevant environmental authorisation process will need to be followed.

According to the GDARD Minimum Requirements for Biodiversity Assessments (2014), a specific buffer zone is recommended for freshwater resources, depending on the location of the freshwater resources in relation to Urban Areas. According to the Gauteng C-Plan (2011), the proposed bulk sewer pipeline and the northern portion of the proposed bulk water pipeline is located inside of the Urban Edge (see Figure 8), thus in terms of the GDARD guidelines, a 32m buffer or setback is applicable to the freshwater resources;

In accordance with GN509 of 2016 as it relates to the NWA, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 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.

The delineated freshwater resources and their zones of regulation in terms of GDARD, NEMA and the NWA are conceptually depicted in Figure 15 below.

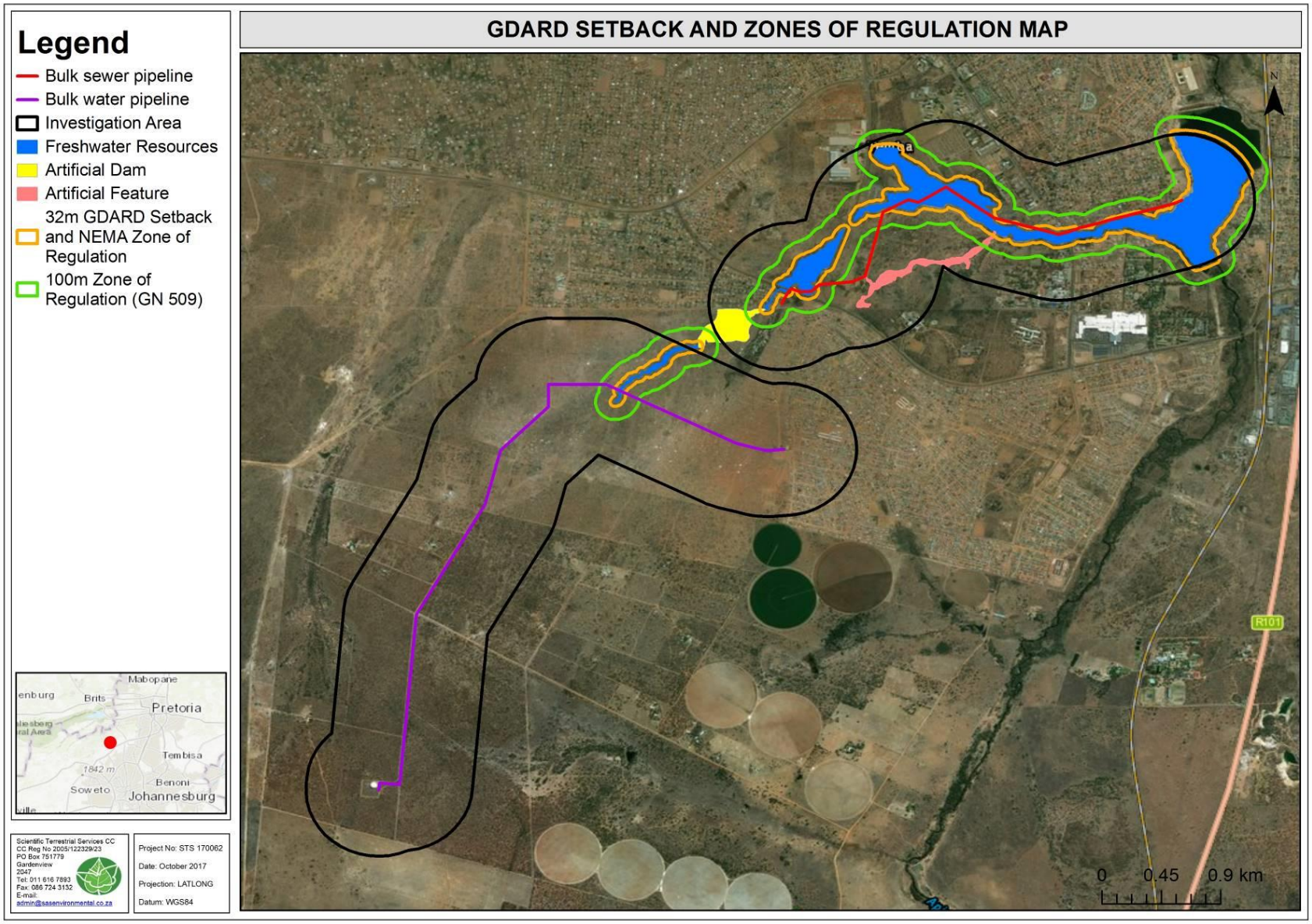


Figure 15: Presentation of the freshwater resources and their associated zones of regulation in relation to the proposed bulk sewer and water pipelines and surrounds.

5 RISK ASSESSMENT

This section presents the significance of potential impacts on the freshwater ecology of the identified freshwater resources associated with the proposed bulk pipelines. In addition, it also indicates the required mitigatory measures needed to minimise the perceived impacts of the proposed development and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented.

The risk assessment was based on the initial proposed layout as provided by the proponent. Both the bulk sewer and water pipelines would be installed by means of open trenching. Due to the similarity of the perceived impacts (especially in terms of the construction phase), as well as the largely similar sensitivities of the freshwater resources associated with the linear development, the risk assessment was undertaken collectively for the freshwater resources.

5.1 Risk Analyses

5.1.1 Consideration of impacts and application of mitigation measures

Following the assessment of the freshwater resources, the DWS approved Risk Assessment Matrix (2016) was applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of the freshwater resources associated with the bulk pipelines. These results are summarised in Tables 7 presented at the end of Section 5.1.2 of this report.

Following the risk assessment, mitigation measures were compiled to serve as guidance throughout the construction and operational phases. The points below summarise the considerations undertaken during this process:

- 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* would be followed, i.e. the impacts would first be avoided, minimised if avoidance is not feasible, rehabilitated as necessary and offset if required;
- The activities are all highly site specific, not of a significant extent relative to the area of the freshwater resources assessed, and therefore have a limited spatial extent;

- While the operation of the bulk pipelines will be a permanent activity, the construction thereof is envisioned to take no more than a few months. However, the frequency of the construction impacts may be daily during this time;
- Most impacts are considered to be easily detectable, with the exception of contamination of surface and groundwater which will require some effort;
- The considered mitigation measures are easily practicable; and
- It is highly recommended that the proponent make provision for small-scale rehabilitation of the areas of the freshwater resources, which may be directly impacted upon by construction activities. The area must preferably be rehabilitated to conditions as close as possible to the "natural" state, not the pre-construction state since the state of the freshwater resources is deemed to be significantly altered from a reference condition. This is especially applicable to the revegetation of the affected areas. This will ensure that the current levels of ecological service provision of the freshwater resources are maintained and where feasible, improved.

5.1.2 Impact Discussion and Essential Mitigation Measures

There are four key ecological impacts on the freshwater resources that are anticipated to occur, specifically:

- Loss of riparian habitat and ecological structure;
- Changes to the sociocultural and service provision;
- Impacts on the hydrology and sediment balance of the riparian system; and
- Impacts on water quality.

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

Although the construction of the proposed bulk pipelines is considered to be of a relatively short duration which will take place at selected localities within the unnamed tributary of the Apies River and the ephemeral drainage line, since it is proposed that the pipelines would be installed by trenching, even with strict implementation of cogent, well-developed, activity-specific mitigation measures (see Appendix F) being implemented the risk of installing the pipelines would pose a 'Medium' risk to the freshwater resources (with specific mention of

the unnamed tributary of the Apies River). The strict implementation of the stipulated mitigation measures as recommended in this report, with specific mention of preventing the sedimentation of the freshwater resources, will enable the reduction of the perceived impacts; however, impacts to the freshwater system are inevitable.

Since the proposed pipeline traversing the ephemeral drainage line would only be used for potable water, in the event of a leak of the pipeline during the operational phase, the severity thereof would not be as significant as if it would have been for contaminated water or sewage effluent, however some impact from the chlorine rich water is possible. The additional water input into freshwater resources could influence its hydrological regime, and possible concentrated flow within the freshwater resources. However, the activities related to the repair of such a leak, would be the same as those during the construction phase, however, based on the crossing point of this pipeline at the most southern end of the ephemeral drainage line and taking into consideration the degraded nature of this resource, the significance of such repair/maintenance activities would be considered of 'Low' risk significance.

During the operation of the proposed sewer pipeline within the unnamed tributary of the Apies River, potential failure of the sewer line poses a Medium risk to the freshwater system. Any such leaks or spills from the sewer pipeline would significantly impact on the hydrological regime and water quality of the freshwater resource area within the immediate vicinity of the spill, as well as the downstream freshwater system (the Apies River) of such an event. Thus, the implementation of mitigation measures, in particular regular pro-active monitoring and maintenance of the infrastructure is considered critical.

Based on the findings of the freshwater ecological assessment, several recommended mitigation measures are made to minimise the impact on the freshwater ecology:

- If feasible, construction must be scheduled for the drier winter period in order to minimise the risk of sediment-laden runoff reaching the freshwater resources as a result of the construction activities;
- Should it be necessary to clear any areas of vegetation, these areas, including contractor laydown areas, must remain as small as possible, in order to reduce the risk of further proliferation of alien vegetation, and in order to retain a level of protection to the freshwater resources during construction (e.g. sediment trapping, slowing of stormwater runoff etc.);

- Contractor laydown areas and all non-essential activities are to remain outside of the delineated freshwater resources and the allocated setback area, and as much as feasible no natural/indigenous riparian vegetation is to be cleared;
- It is highly recommended that an alien vegetation management plan be compiled during the planning phase and implemented concurrently with the commencement of construction;
- All exposed soils must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent erosion and sedimentation of the river. During trenching, soils should not be stockpiled within close proximity to the river or the dewatered section, but should rather be outside of the temporary zone boundaries in order to prevent sedimentation of the river, and stockpiles may not exceed 2m in height;
- Any remaining soils following the completion of construction activities are to be levelled and re-seeded with indigenous flora species to minimise the risk of further sedimentation of the freshwater resources, and to aid in the natural reclamation process;
- All manholes located within the 1:100 year floodline must be constructed in such a way as to elevate the manhole cover above the 1:100 year flood level. This can be done by extending the collar of the manhole above the ground level and then building up a mound of appropriate soil around the manhole which is then sloped as gently as possible back to natural ground level;
- It is recommended that the managing authority test the integrity of the sewer pipeline at least once every five years or more often should there be any sign or reports of leaks; and
- Should a blockage occur within the sewer pipeline, all possible steps are to be taken to prevent the pollution of the freshwater system during repair, including the placement of sheeting around the manhole used for access as well as containment barrels for any effluent withdrawn.

Additional “good practice” mitigation measures applicable to a project of this nature are provided in Appendix F of this report.

Table 7: Summary of the results of the DWS risk assessment applied to the freshwater resources associated with the proposed water and sewer pipelines.

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
1	Construction Phase	Site clearing prior to commencement of construction activities.	Removal of vegetation and associated disturbances to soils.	*Exposure of soils, leading to increased runoff and erosion, and thus increased sedimentation of the freshwater resources; *Increased sedimentation of the freshwater resources, leading to smothering of biota and potentially altering surface water quality; and *Decreased ecoservice provision.	1,75	3,75	8	**30**	**L**	**90**	*Contractor laydown areas and stockpiles to be established outside of the delineated freshwater resources and the applicable setback zone in consultation with the appropriate authority; *All development footprint areas to remain as small as possible and vegetation clearing to be limited to what is absolutely essential; *Retain as much indigenous vegetation as possible; *Vehicles to be serviced at the contractor laydown area and all re-fuelling is to take place outside of the freshwater resources and its applicable setback zone; *It should be feasible to utilise existing roads to gain access to the construction site, and crossing the freshwater resources in areas where no existing crossing is apparent should be unnecessary, but if it is essential crossings should be made at right angles; *Sanitation services must be provided for construction personnel, whereby at least one portable toilet will be provided per ten personnel and will be emptied regularly; *Construction personnel must be informed that no firewood is to be harvested, all litter must be stored immediately and only in closed dustbins, including cigarette ends, and no litter is to remain behind on site following completion of construction activities; and *The freshwater resources, and the applicable setback area should be clearly demarcated with danger tape by an ECO and marked as a 'no-go' area where no construction activities are planned;

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
2		Groundbreaking, excavation of trench within the freshwater resources	*Removal of topsoils; and *Excavation and trenching leading to stockpiling of soil within close proximity to the excavated area.	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to further altered freshwater habitat; and *Altered runoff patterns and alteration to flow patterns, leading to increased erosion and sedimentation of freshwater habitat.	3,25	6,25	9	**56,25**	**M**	**90**	With regards to open trenching within the freshwater resources: *During trenching, the topsoil as well as the vegetation should be removed up to a depth of 150mm and be stockpiled outside of the GDARD setback area (32m). The vegetation must be kept moist, until it can be used to rehabilitate the exposed areas as part of the backfilling operation; *Excavated materials (from the trenches) should not be contaminated and it should be ensured that the minimum surface area is taken up, however the stockpiles may not exceed 2m in height. Mixture of the lower and upper layers of the excavated soil should be kept to a minimum, so as for later usage as backfill material; and *All exposed soils must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent erosion and sedimentation of the freshwater resources in close proximity to these stockpiles; and *After the trench has been excavated, a bedding layer (such as clean gravel) should be placed and should be spread evenly and compacted uniformly to a firm, but not hard, support. With regards to the installation of manholes: *For the installation of the manholes within the freshwater resources, a plastic liner should be placed on the bottom of the excavated trench before concrete is poured as a base. The manholes should be sealed with an approved epoxy. No contamination of surface and ground water may be allowed; and *All manholes located within the 1:100 year floodline must be
3		Installation of (sewer and water) pipelines and associated manholes	*Mixing and casting of concrete: *Placement of bedding material within the excavated trench underneath the pipelines; *Backfilling of trench, where after it will be compacted; and *Miscellaneous activities by construction personnel.	*Erosion of the exposed trench; *Potential sedimentation of the freshwater resources; *Potential impacts on water quality and contamination of soils within the freshwater resources; *Potential of backfill material to enter the freshwater resources, increasing the sediment load within the freshwater resources; *Potential for over-compaction of soils within the freshwater resources.	2,5	4,5	9	**40,5**	**L**	**90**	
4		Potential indiscriminate waste disposal within the freshwater resources or within the vicinity thereof.	Disposal of construction-related wastes (such as rubble, hazardous chemicals and litter)	*Altered flow regime as a result of solid wastes within the freshwater resources; and *Altered water quality due to chemical waste disposal.	1,75	3,75	8	**30**	**L**	**90**	

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
5		Potential spillage from construction vehicles	Spills / chemical leaks from construction vehicles.	*Possible contamination of freshwater soils and surface water, leading to reduced ability to support biodiversity	2	4	8	**32**	**L**	**90**	constructed in such a way as to elevate the manhole cover above the 1:100 year flood level. This can be done by extending the collar of the manhole above the ground level (protude a minimum of 100mm) and then building up a mound of appropriate soil around the manhole which is then sloped as gently as possible back to natural ground level With regards to concrete mixing on site: *No mixed concrete may be deposited outside of the designated construction footprint; *A batter / dagga board mixing trays and impermeable sumps should be provided, onto which any mixed concrete can be deposited whilst it awaits placing; and *Concrete spilled outside of the demarcated area must be promptly removed and taken to a suitably licensed waste disposal site. Backfilling of the trenches: *After installation of the pipelines and manholes, the open trenches should be closed immediately, in sections so as to ensure that no open trenches are left open for extensive periods; *Trenches should be backfilled with the stockpiled excavated materials in layers, up to 150mm below the natural ground level, after which the topsoil is replaced (to the stream bed level) and re-worked and the removed vegetation is reinstated as part of the rehabilitation of the site; *If and *Soil must be recompacted to a depth of 450 mm, and all construction material must be removed from site upon the completion of construction.

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
6	Operational Phase	Operation and maintenance of the water pipeline	Potential failure of infrastructure, possible leaks from pipeline into the freshwater resources, causing incision and alteration of the hydroperiod of the freshwater resources	Possible incision and alteration of the hydroperiod of the freshwater resources	2	4	8	**32**	**L**	**80**	*It should be ensured that additional freshwater areas are not inundated as a result of leaks or bursting of the pipeline, and that an emergency plan should be compiled to ensure a quick response and attendance to the matter in case of a leakage or bursting of the pipeline; *Only existing roadways should be utilised during maintenance and monitoring activities to avoid indiscriminate movement of vehicles; and *Should repair of the pipeline be required to address a leak, mitigations as per activity 2 and 3 above as applicable depending upon the location of the leak.
7			Indiscriminate movement of vehicles and vegetation trampling within the freshwater resources during maintenance activities	Possible soil compaction and disturbance, resulting in increased alteration of the vegetation community structure	1,5	3,5	8	**28**	**L**	**80**	
8			Repair of the pipeline in the event of leaks detected	Impacts as per activity 2 and 3 above as applicable depending upon the location of the leak	3,25	5,25	8	**42**	**L**	**80**	
9		Operation and maintenance of the sewer pipeline	Potential failure of infrastructure, resulting in blockages or leakages	*Potential contamination of freshwater soils, groundwater and surface water; and *Possible incision and alteration of the hydroperiod of the freshwater resources.	3,25	6,25	9	**56,25**	**M**	**80**	*The sewer line and manholes must be pressure tested for integrity upon the completion of construction; *It is recommended that the managing authority test the integrity of the sewer line at least once every five years or more often should there be any sign or reports of a leak; *Should a blockage occur all possible steps are to be taken

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
			Unblocking the sewer pipeline (accessed via manholes)	*Vehicular access to the sewer pipeline resulting in: - Soil compaction - Vegetation degradation - Soil and stormwater contamination from oils and hydrocarbons *Contamination of the freshwater resources with additional sewage effluent resulting in: - Increased concentration of salts, nitrate and toxic ammonia concentrations, as well as counts of *Escheria coli*; and - Potential eutrophication of the system, including anoxic conditions, leading to biodiversity simplification and the excess production of hydrogen sulphide gas as well as increased alien and invasive species encroachment.	3,5	5,5	8	**44**	**L**	**80**	to prevent the pollution of the freshwater resources during repair, including the placement of sheeting around the manhole used for access as well as containment barrels for any effluent withdrawn; and *Should repair of the sewer line be required to address a leak, mitigations as per activity 2 and 3 above as applicable depending upon the location of the leak.
10			Repair of the sewer pipeline in the event of leaks detected	Impacts as per activity 2 and 3 above as applicable depending upon the location of the leak	3,75	6,75	9	**60,75**	**M**	**80**	

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
11			Operation of the sewer pipeline	Latent impacts: The installed infrastructure will be permanent, and pose an increased risk over time in terms of the concrete weakening and cracking leading to leakages of the sewage. This may result in inputs of sewage effluent entering the freshwater system, and the following impacts: *Increased concentration of salts, nitrate and toxic ammonia concentrations, as well as counts of *Escheria coli*; and *Potential eutrophication of the system, including anoxic conditions, leading to biodiversity simplification and the excess production of hydrogen sulphide gas as well as increased alien and invasive species encroachment.	3	5	8	**40**	**L**	**80**	
12				Cumulative impact: Increased urban development in the area will likely place increased pressure upon the sewerage infrastructure (including the capacity of the receiving wastewater treatment works) and may result in overflows from the manholes, and potentially compromise the integrity of the pipeline itself.	3	5	8	**40**	**L**	**80**	

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
				This may result in inputs of sewage effluent entering the aquatic system, and impacts similar to those in Activity 9.							

6 CONCLUSION

An unnamed tributary of the Apies River was will be traversed by the proposed sewer pipeline, whilst an ephemeral drainage line will be traversed by the proposed water pipeline. The Apies river was also seen to be located downgradient and in close proximity (approximately 60m from) to the proposed sewer pipeline. Following the assessment of these freshwater resources, the ecological condition thereof could be summarised as below:

Table 8: Summary of the results of the assessments applied to the watercourses traversed by the proposed linear development.

Freshwater Resource	Index of Habitat Integrity (IHI)/PES	Ecological function and service provision	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Class (REC)
Apies River	D/E (Largely to Seriously modified)	Intermediate	B (High)	D (Largely modified)
Unnamed tributary of the Apies River	D (Largely modified)	Moderately low/ Intermediate	C (moderate)	D (Largely modified)
Ephemeral Drainage Line	D (Largely modified)	Moderately low	C (moderate)	D (Largely modified)

For the most part, the freshwater environment through which the proposed pipelines will be routed through, are considered impacted upon. Historical agricultural activities, vegetation clearing and catchment hardening, road infrastructure and runoff originating from impermeable surfaces are the most frequent factors impacting on the freshwater environment.

Following the assessment of the freshwater resources, the DWS risk assessment matrix of 2016 was applied in order to ascertain the significance of possible impacts, which may occur as a result of the proposed development. The results of this assessment are presented in Section 5 of this report, and show that, assuming mitigation measures are strictly enforced; impact significance is of Low and Medium levels during both construction and operational phases. Therefore, it is considered imperative that suitable mitigation measures, as provided for in Section 5 and Appendix F of this report, are strictly adhered to minimise the impacts associated with the development and decrease the significance of cumulative impacts on the freshwater environment.

Based on the findings of the freshwater resource assessment and the results of the risk assessment, it is the opinion of the ecologist that the proposed development may pose a direct risk to the freshwater resources, with specific mention of the unnamed tributary of the Apies River. Adherence to cogent, well-conceived and ecologically sensitive designs and construction methods, and the mitigation measures provided in this report as well as general

good construction practice, is essential if the significance of perceived impacts is to be reduced to acceptable levels.

It is the opinion of the specialist therefore that the proposed sewer and water pipelines, from a freshwater resource perspective, be considered favourably, with the proviso that strict adherence to mitigation measures is enforced to ensure that the ecological integrity of the freshwater environment is not further compromised.

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APPENDIX A – Indemnity and Terms of Use

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 STS CC and its staff reserve the right 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 Requirements

National Environmental Management Act (NEMA) (Act No. 107 of 1998)	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 Water Act (NWA) (Act No. 36 of 1998)	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).
General Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the NWA (Act 36 of 1998)	In accordance with Regulation GN509 of 2016, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 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. 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.
GDARD Requirements for Biodiversity Assessments Version 3 (GDARD, 2014).	The biodiversity assessment must comply with the minimum requirements as stipulated by GDARD Version 3 of 2014 and must contain the following information: ➢ The wetland delineation procedure must identify the outer edge of the temporary zone of the wetland, which marks the boundary between the wetland and adjacent terrestrial areas; ➢ The delineation must be undertaken according to the DWAF guidelines; ➢ The wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive in a sensitivity map. Rules for buffer zone widths are as follows: • 30m for wetlands occurring inside urban areas; • 50m for wetlands occurring outside urban areas; and • 50m for priority pans.

APPENDIX C – Freshwater System 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 resources and drainage line features present in close proximity of the proposed development 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 the proposed development.

1.2 *Department of Water and Sanitation (DWS) Resource Quality Information Services Present Ecological State / Ecological Importance and Sensitivity (PES/EIS) Database (2014)*

The PES/EIS database as developed by the DWS RQIS department was utilised to obtain background information on the project area. The PES/EIS database has been made available to consultants since mid-August 2014. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, EWR sites and Hydro WMS sites. The results obtained serve to summarise this information as a background to the conditions of the watercourse traversed by the proposed linear development.

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

The freshwater resources encountered in close proximity to the proposed development 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[2] (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 are 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) groups 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.
- 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.

[2] 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.

- 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
- Seep: a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2009).

3. Index of Habitat Integrity (IHI)

To assess the PES of the channelled valley bottom wetlands identified, the IHI for South African floodplain and channelled valley bottom wetland types (Department of Water Affairs and Forestry Resource Quality Services, 2007) was used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (table below), and provide a score of the PES of the habitat integrity of the wetland or riparian system being examined.

Table C3: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

Ecological Category	PES (% Score)	Description
A	90-100%	Unmodified, natural.
B	80-90%	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. 20-40% Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E	20-40%	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	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.

4. Riparian Vegetation Response Assessment 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[3]. 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).

5. *Wetland Function Assessment*

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[4] The assessment of the ecosystem services supplied by the identified freshwater resources was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

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

Table C4: Classes for determining the likely extent to which a benefit is being supplied.

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

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

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

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWA (now the DWS) used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, *et, al,*

[3] Kleynhans et al, 2007

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

2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

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

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C7) of the wetland system being assessed.

Table C5: 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

7. Recommended Ecological Category (REC)

"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." [5]

The REC (Table C8) was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above). Followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A freshwater resource may receive the same class for the PES as the REC 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 freshwater resource.

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

Table C6: Description of REC classes.

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

8. Freshwater Resource Delineation

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

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

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA, 2005 & 2008).

Riparian and wetland zones can be divided into three zones (DWAF, 2005 & 2008). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

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 method to be used for assessing risks/impacts is outlined in the sections below.

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

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation;
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[6]. The interaction of an aspect with the environment may result in an impact;
- **Environmental risks/impacts** are the consequences of these aspects 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;
- **Frequency of activity** refers to how often the proposed activity will take place;
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor;
- **Severity** 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 extent** 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 severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. 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 (No. 108 of 1997) 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.

[6] The definition has been aligned with that used in the ISO 14001 Standard.
[7] Some risks/impacts that have low significance will however still require mitigation

"RISK ASSESSMENT KEY" (Based on DWS 2015 publication: Section 21 c and i water use Risk Assessment Protocol)

Table D1: Severity (How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.	

Table D2: Spatial Scale (How big is the area that the aspect is impacting on)

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

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

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
PES and EIS (sensitivity) must be considered.	

Table D4: Frequency of the activity (How often do you do the specific activity)

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Table D5: The frequency of the incident or impact (How often does the activity impact on the resource quality)

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table D6: Legal issues (How is the activity governed by legislation)

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

Table D7: Detection (How quickly or easily can the impacts/risks of the activity be observed on the resource quality, people and resource)

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table D8: Rating Classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

A low risk class must be obtained for all activities to be considered for a GA

Table D9: Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence X Likelihood

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for construction phase and operational phase; and
  - Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status were assessed.

Control Measure Development

The following points presents the key concepts considered in the development of mitigation measures for the proposed construction:

- Mitigation and performance improvement measures and actions that address the risks and impacts[8] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
  - Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the freshwater ecology of the resources in traversed by or in close proximity of the proposed infrastructure.

[8] Mitigation measures should address both positive and negative impacts

APPENDIX E – Results of Field Investigation

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

Table E1: Presentation of the results of the IHI assessment applied to the Apies River

RIPARIAN IHI	
Base Flows	-2,0
Zero Flows	2,0
Moderate Floods	2,5
Large Floods	2,0
HYDROLOGY RATING	**2,1**
Substrate Exposure (marginal)	2,0
Substrate Exposure (non-marginal)	2,0
Invasive Alien Vegetation (marginal)	3,0
Invasive Alien Vegetation (non-marginal)	3,0
Erosion (marginal)	1,5
Erosion (non-marginal)	1,5
Physico-Chemical (marginal)	2,0
Physico-Chemical (non-marginal)	3,0
Marginal	3,0
Non-marginal	3,0
BANK STRUCTURE RATING	**3,0**
Longitudinal Connectivity	4,0
Lateral Connectivity	4,0
CONNECTIVITY RATING	**4,0**
RIPARIAN IHI %	**41,6**
RIPARIAN IHI EC	**D/E**
RIPARIAN CONFIDENCE	**3,0**

Table E2: Presentation of the results of the IHI assessment applied to the unnamed tributary of the Apies River

RIPARIAN IHI	
Base Flows	-2,0
Zero Flows	2,0
Moderate Floods	2,5
Large Floods	2,0
HYDROLOGY RATING	**2,1**
Substrate Exposure (marginal)	2,0
Substrate Exposure (non-marginal)	2,0
Invasive Alien Vegetation (marginal)	3,0
Invasive Alien Vegetation (non-marginal)	3,0
Erosion (marginal)	1,5
Erosion (non-marginal)	1,5
Physico-Chemical (marginal)	2,5
Physico-Chemical (non-marginal)	3,0
Marginal	3,0
Non-marginal	3,0
BANK STRUCTURE RATING	**3,0**
Longitudinal Connectivity	3,0
Lateral Connectivity	3,0
CONNECTIVITY RATING	**3,0**
RIPARIAN IHI %	**46,0**
RIPARIAN IHI EC	**D**
RIPARIAN CONFIDENCE	**3,0**

Table E3: Presentation of the results of the IHI assessment applied to the ephemeral drainage line with riparian vegetation

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	**Weighting**	**Score**	***Confidence Rating***	**PES Category**
DRIVING PROCESSES:		**100**	**2,5**		
Hydrology	1	100	2,6	*3,2*	**D**
Geomorphology	2	80	2,7	*3,8*	**D**
Water Quality	3	30	1,7	*2,0*	**C**
WETLAND LANDUSE ACTIVITIES:		**80**	**2,9**	***4,0***	
Vegetation Alteration Score	1	100	2,9	*4,0*	**D/E**
OVERALL SCORE:			**2,7**		
	PES %		**45,8**	***Confidence Rating***	
	PES Category:		**D**	***1,8***	

Table E4: Presentation of the results of the ecosystem services provided by the watercourses.

Ecosystem service	Apies River	Unnamed Tributary	Ephemeral Drainage Line
Flood attenuation	2,3	1,9	1,8
Streamflow regulation	2,0	2,0	1,4
Sediment trapping	1,8	1,4	1,0
Phosphate assimilation	1,7	1,3	1,0
Nitrate assimilation	1,7	1,6	1,3
Toxicant assimilation	2,0	1,5	1,3
Erosion control	1,8	1,6	1,1
Carbon Storage	1,8	1,3	0,5
Biodiversity maintenance	1,3	1,1	1,0
Water Supply	2,3	1,5	1,2
Harvestable resources	1,4	1,2	0,8
Cultivated foods	0,6	0,6	0,6
Cultural value	0,5	0,5	0,5
Tourism and recreation	1,3	0,6	0,4
Education and research	1,5	1,8	1,0
SUM	**23,9**	**19,8**	**14,8**
Average score	**1,6**	**1,3**	**1,0**

Table E5: Presentation of the EIS assessment applied to the freshwater resources.

FRESHWATER FEATURE:			Apies River	Unnamed Tributary	Ephemeral drainage line
Ecological Importance and Sensitivity			Score (0-4)	Score (0-4)	Score (0-4)
Biodiversity support			**A (average)**		
			1,33	0,33	0,33
Presence of Red Data species			1	0	0
Populations of unique species			1	0	0
Migration/breeding/feeding sites			2	1	1
Landscape scale			**B (average)**		
			2,00	1,60	1,40
Protection status of the wetland			2	2	1
Protection status of the vegetation type			1	1	3
Regional context of the ecological integrity			2	2	1
Size and rarity of the wetland type/s present			3	2	1
Diversity of habitat types			2	1	1
Sensitivity of the wetland			**C (average)**		
			1,67	1,33	1,00
Sensitivity to changes in floods			2	2	1
Sensitivity to changes in low flows/dry season			1	1	1
Sensitivity to changes in water quality			2	1	1
ECOLOGICAL IMPORTANCE & SENSITIVITY (max of A,B or C)			**B**	**B**	**B**
Hydro-Functional Importance			**Score (0-4)**		
Regulating & supporting benefits	**Flood attenuation**		2	2	1
	Streamflow regulation		2	2	1
	Water Quality Enhancement	***Sediment trapping***	2	1	1
		Phosphate assimilation	2	1	1
		Nitrate assimilation	2	1	1
		Toxicant assimilation	2	1	1
		Erosion control	2	1	1
	Carbon storage		2	1	0,5
HYDRO-FUNCTIONAL IMPORTANCE (average score)			2	1	1
Direct Human Benefits			**Score (0-4)**		
Subsistence benefits	***Water for human use***		2	1	1
	Harvestable resources		1	1	1
	Cultivated foods		0,5	0,5	0,5
Cultural benefits	***Cultural heritage***		0,5	0,5	0,5
	Tourism and recreation		1	0,5	0,5
	Education and research		1	1	1
DIRECT HUMAN BENEFITS (average score)			1,00	0,75	0,75

Table E6: Presentation of the VEGRAI assessment applied to the Apies River

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	58,3	29,2	1,8	1,0	100,0
NON MARGINAL	55,0	27,5	0,0	1,0	100,0
2,0					200,0
LEVEL 3 VEGRAI (%)				56,7	
VEGRAI EC				**D**	
AVERAGE CONFIDENCE				0,9	

Table E7: Presentation of the VEGRAI assessment applied to the unnamed tributary of the Apies River

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	48,3	24,2	1,8	1,0	100,0
NON MARGINAL	56,7	28,3	0,0	1,0	100,0
2,0					200,0
LEVEL 3 VEGRAI (%)				52,5	
VEGRAI EC				**D**	
AVERAGE CONFIDENCE				0,9	

APPENDIX F – Risk Analysis and Mitigation Measures

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

Development footprint

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

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Vegetation

- Proliferation of alien and invasive species is expected within any disturbed areas. The vegetation component within the freshwater environment is already transformed to an extent as a result of alien plant invasion; therefore, these species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;
- Removal of the alien and weed species encountered within the freshwater resources must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction, operational, and maintenance phases; and
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas should be kept as small as possible when removing alien plant species; and
  - No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species.

Soils

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

Rehabilitation

- Construction rubble must be collected and disposed of at a suitable landfill site; and
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed development should be removed. Alien vegetation control should take place for a minimum period of two growing seasons after rehabilitation is completed.

APPENDIX G – Specialists Details

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

Stephen van Staden	MSc (Environmental Management) (University of Johannesburg)
Christel du Preez	MSc (Environmental Sciences) (North West University)

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

Company of Specialist:	Scientific Terrestrial Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	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 Natural 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		

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

SCIENTIFIC TERRESTRIAL SERVICES (STS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist, Aquatic Ecologist
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO)
Member of the Gauteng Wetland Forum

EDUCATION

Qualifications
Qualifications

MSc (Environmental Management) (University of Johannesburg)	2002
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2000
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	1999
Tools for wetland Assessment short course Rhodes University	2016

COUNTRIES OF WORK EXPERIENCE

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

SELECTED PROJECT EXAMPLES

Impoundment studies

- Lalini Dam specialist aquatic ecological assessment with focus on aquatic macro-invertebrate and fish community analysis and fish migration.
- Ntabalenga Dam specialist aquatic ecological assessment with focus on macro-invertebrate fish community analysis and fish migration.
- Donkerhoek Dam specialist aquatic ecological assessment and consideration of fish migration requirements;
- Groot Phisantekraal dam specialist aquatic ecological assessment and Ecological Water Requirements for the Diep River;
- Musami Dam (Zimbabwe) assessment with focus on the FRAI and MIRAI aquatic community assessment indices and the development of the Ecological Water Requirements;
- Mhlabatsane dam Ecological Water specialist aquatic ecological assessment and consideration of fishway needs and macro-invertebrate community sensitivity.

Development compliance studies

- Project co-leader for the development of the EMP for the use of the Wanderers stadium for the Ubuntu village for the World Summit on Sustainable Development (WSSD).
- Environmental Control Officer for Eskom for the construction of an 86Km 400KV power line in the Rustenburg Region.
- Numerous Environmental Impact Assessment (EIA) and EIA exemption applications for township developments and as part

of the Development Facilitation Act requirements.

- EIA for the extension of mining rights for a Platinum mine in the Rustenburg area by Lonmin Platinum. EIA Exemption application for a proposed biodiesel refinery in Chamdor.
- Compilation of an EIA as part of the Bankable Feasibility Study process for proposed mining of a gold deposit in the Lofa province, Liberia.
- EIA for the development of a Chrome Recovery Plant at the Two Rivers Platinum Mine in the Limpopo province, South Africa.
- Compilation of an EIA as part of the Bankable Feasibility Study process for the Mooihoek Chrome Mine in the Limpopo province, South Africa.
- Mine Closure Plan for the Vlakfontein Nickel Mine in the North West Province.

Specialist studies and project management

- Development of the Water Resource and biodiversity chapters of the 2015 Limpopo Province Biodiversity outlook.
- Development of a zero discharge strategy and associated risk, gap and cost benefit analyses for the Lonmin Platinum group.
- Development of a computerised water balance monitoring and management tool for the management of Lonmin Platinum process and purchased water.
- The compilation of the annual water monitoring and management program for the Lonmin Platinum group of mines.
- Analyses of ground water for potable use on a small diamond mine in the North West Province.
- Project management and overview of various soil and land capability studies for residential, industrial and mining developments.
- The design of a stream diversion of a tributary of the Olifants River for a proposed opencast coal mine.
- Waste rock dump design for a gold mine in the North West province.
- Numerous wetland delineation and function studies in the North West, Gauteng and Mpumalanga KwaZulu Natal provinces, South Africa.
- Hartebeespoort Dam Littoral and Shoreline PES and rehabilitation plan.
- Development of rehabilitation principles and guidelines for the Crocodile West Marico Catchment, DWAF North West.

Aquatic and water quality monitoring and compliance reporting

- Development of the Resource quality Objective framework for Water Use licensing in the Crocodile West Marico Water management Area.
- Development of the Resource Quality Objectives for the Local Authorities in the Upper Crocodile West Marico Water management Area.
- Development of the 2010 State of the Rivers Report for the City of Johannesburg.
- Management of the water quality reporting programs for several mining projects in the Gold, Chrome and Platinum mining industries.
- Initiation and management of a physical, chemical and biological monitoring program, President Steyn Gold Mine Welkom.
- Aquatic biomonitoring programs for several Xstrata Alloys Mines and Smelters.
- Aquatic biomonitoring programs for several Anglo Platinum Mines.
- Aquatic biomonitoring programs for African Rainbow Minerals Mines.
- Aquatic biomonitoring programs for several Assore Operations.
- Aquatic biomonitoring programs for Petra Diamonds.
- Aquatic biomonitoring programs for several Coal mining operations.
- Aquatic biomonitoring programs for several Gold mining operations.
- Aquatic biomonitoring programs for several mining operations for various minerals including iron ore, and small platinum and chrome mining operations.
- Aquatic biomonitoring program for the Valpre bottled water plant (Coca Cola South Africa).
- Aquatic biomonitoring program for industrial clients in the paper production and energy generation industries.
- Aquatic biomonitoring programs for the City of Tshwane for all their Waste Water Treatment Works.
- Baseline aquatic ecological assessments for numerous mining developments.
- Baseline aquatic ecological assessments for numerous residential commercial and industrial developments.
- Baseline aquatic ecological assessments in southern, central and West Africa for gold mining projects, Phosphate mining diamond mining and copper mining.

Wetland delineation and wetland function assessment

- Wetland biodiversity studies for three copper mines on the copper belt in the Democratic Republic of the Congo.
- Wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Terrestrial and wetland biodiversity studies for developments in the mining industry.
- Terrestrial and wetland biodiversity studies for developments in the residential commercial and industrial sectors.
- Development of wetland riparian resource protection measures for the Hartbeespoort Dam as part of the Harties Metsi A Me integrated biological remediation program.

- Priority wetland mammal species studies for numerous residential, commercial, industrial and mining developments throughout South Africa.

Terrestrial ecological studies and biodiversity studies

- Development of a biodiversity offset plan for Xstrata Alloys Rustenburg Operations.
- Biodiversity Action plans for numerous mining operations of Anglo Platinum throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Assmang Chrome throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Xstrata Alloys and Mining throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plan for the Nkomati Nickel and Chrome Mine Joint Venture.
- Terrestrial and wetland biodiversity studies for three copper mines on the copperbelt in the Democratic Republic of the Congo.
- Terrestrial and wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Numerous terrestrial ecological assessments for proposed platinum and coal mining projects.
- Numerous terrestrial ecological assessments for proposed residential and commercial property developments throughout most of South Africa.
- Specialist Giant bullfrog (*Pyxicephalus adspersus*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist Marsh sylph (*Metisella meninx*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Project management of several Red Data Listed (RDL) bird studies with special mention of African grass owl (*Tyto capensis*).
- Project management of several studies for RDL Scorpions, spiders and beetles for proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist assessments of terrestrial ecosystems for the potential occurrence of RDL spiders and owls.
- Project management and site specific assessment on numerous terrestrial ecological surveys including numerous studies in the Johannesburg-Pretoria area, Witbank area, and the Vredefort dome complex.
- Biodiversity assessments of estuarine areas in the Kwa-Zulu Natal and Eastern Cape provinces.
- Impact assessment of a spill event on a commercial maize farm including soil impact assessments.

Fisheries management studies

- Tamryn Manor (Pty.) Ltd. still water fishery initiation, enhancement and management.
- Verlorenkloof Estate fishery management strategising, fishery enhancement, financial planning and stocking strategy.
- Mooifontein fishery management strategising, fishery enhancement and stocking programs.
- Wickams retreat management strategising.
- Gregg Brackenridge management strategising and stream recalibration design and stocking strategy.
- Eljira Farm baseline fishery study compared against DWAF 1996 aquaculture and aquatic ecosystem guidelines.

SCIENTIFIC TERRESTRIAL SERVICES (STS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTEL DU PREEZ

PERSONAL DETAILS

Position in Company	Junior Wetland Ecologist
Date of Birth	22 March 1990
Nationality	South African
Languages	English, Afrikaans
Joined SAS	January 2016

EDUCATION

Qualifications

MSc Environmental Sciences (North West University)	2016
BSc (Hons) Environmental Sciences (North West University)	2012
BSc Environmental and Biological Sciences (North West University)	2011

COUNTRIES OF WORK EXPERIENCE

South Africa – KwaZulu Natal, Northern Cape, Gauteng, Mpumalanga, Free State, Eastern Cape

SELECTED PROJECT EXAMPLES

Wetland Assessments

- Baseline freshwater assessment as part of the environmental assessment and authorisation process for the proposed National Route 3 (N3) Van Reenen Village Caltex Interchange, KwaZulu Natal.
- Basic assessment for the proposed construction of supporting electrical infrastructure for the Victoria West Wind Farm, Victoria West, Northern Cape Province.
- Freshwater Ecological Assessment in Support of the WULA Associated with the Rehabilitation of the Wetland Resources in Ecopark, Centurion, Gauteng.
- Wetland Ecological Assessment for the Proposed Mixed Land Use Development (Kosmosdal Extension 92) on the remainder of Portion 2 of the farm Olievenhoutbosch 389 Jr, City of Tshwane Metropolitan Municipality, Gauteng Province.
- Freshwater Ecological Assessment for the Mokate Pig Production and Chicken Broiler Facility on the farm Rietvalei Portion 1 and 6 near Delmas, Mpumalanga.
- Wetland Ecological Assessment as part of the Environmental Assessment and Authorisation Process for the Proposed Relocation of a Dragline from the Kromdraai Section to Navigation Section of the Anglo American Landau Colliery in Mpumalanga.
- Freshwater Assessment as part of the Environmental Assessment and Authorisation Process for a proposed 132kv powerline and associated infrastructure for the proposed Kalkaar Solar Thermal Power Plant near Kimberley, Free State and Northern Cape Provinces.
- Freshwater Ecological Assessment of the Freshwater Prospect Stream in the AEL Operational Area, Modderfontein, Gauteng.
- Specialist Freshwater Scoping and Environmental Impact Assessment for the Proposed Development of the Platberg and Teekloof Wind Energy Facility and Supporting Electrical Infrastructure near Victoria West, Northern Cape Province.
- Wetland Ecological Assessment as part of the Environmental Assessment and Authorisation Process for the Proposed Development of Wilgedraai, Vaaldam Settlement 1777, Free State Province.
- Freshwater Resource Delineation and Assessment as part of the consolidation of four Environmental Management Plans at the Graspan Colliery, in Middelburg, Mpumalanga Province.
- Freshwater Assessment as part of the Water Use Authorisation for the proposed Copperton Wind Energy Facility, Northern Cape.
- Freshwater Resource and Water Quality Ecological Assessment for the Lakefield Manor Residential project, Boksburg, Gauteng Province.