FRESHWATER RESOURCE REHABILITATION AND MANAGEMENT PLAN AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED DEVELOPMENT OF BULK SERVICES ASSOCIATED WITH HAMMANSKRAAL X10, HAMMANSKRAAL, GAUTENG

Prepared for

TGM Environmental Services cc

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Prepared by:	**Scientific Terrestrial Services**
Report Author:	**C. du Preez**
Report reviewer:	**S. van Staden (Pr. Sci.Nat)**
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Scientific Terrestrial Services CC
CC Reg No 2005/122329/23
PO Box 751779
Gardenview
2047
Tel: 011 616 7893
Fax: 086 724 3132
E-mail: admin@sasenvironmental.co.za

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GLOSSARY OF TERMS

Alien vegetation/ plant species	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally.
Endangered	Organisms in danger of extinction if causal factors continue to operate.
Endemic species	Species that are only found within a pre-defined area. There can therefore be sub-continental (e.g. southern Africa), national (South Africa), provincial, regional or even within a particular mountain range.
Biodiversity	The number and variety of living organisms on earth, the millions of plants, animals and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Habitat	In relation to a specific species, a place or type of site where such species naturally occurs.
Indigenous vegetation	Vegetation occurring naturally within a defined area. In relation to a specific area, a species that occurs, or has historically occurred, naturally in a free state in nature within that specific area, but excludes a species introduced in that area as a result of human activity.
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.
Species of Conservation Concern	The term SCC in the context of this report refers to all RDL (Red Data) and IUCN (International Union for the Conservation of Nature) listed species as well as protected species of relevance to the project.
Watercourse	As defined by the National Water Act, 1998 (Act 36 of 1998): "A river or spring; A natural channel in which water flows regularly or intermittently; A wetland, lake or dam into which, or from which, water flows; and Any collection of water which the Minister may by notice in the Government Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks."

LIST OF ABBREVIATIONS

AIP	Alien and Invasive Plants
CESA	Critical Ecological Support Area
DWAF	Department of Water and Forestry
DWS	Department of Water and Sanitation
ECO	Environmental Control Officer
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
EN	Endangered
ERP	Emergency Response Plan
FRRMP	Freshwater Resource Rehabilitation and Management Plan
GA	General Authorisation
GPS	Global Positioning System
HGM	Hydrogeomorphic
KPI	Key Performance Indicator
NEMA	National Environmental Management Act
NEMBA	National Environmental Management Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Area
NWA	National Water Act
PES	Present Ecological State
RDL	Red Data Listed
SABS	South African Bureau of Standards
SAS	Scientific Aquatic Services
SCC	Species of Conservation Concern
WfW	Working for Water

DOCUMENT GUIDE

Requirements of a Freshwater Resource Rehabilitation and Management Plan (FRRMP) for a watercourse in terms of the National Environmental Management Act, 1998 (Act 107 of 1998), Environmental Impact Assessment Regulations, 2014 (as amended).

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report.	Annexure D
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae.	Annexure D
b)	A detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description.	Section 1.1
c)	Provide a map (at an appropriate scale) of the watercourse or stretch of watercourse being applied for within the stretch where maintenance activities will take place being clearly defined.	Section 2
d)	GPS coordinates must be provided for all site(s) at which maintenance activities will take place and included on the map which defines the stretch of watercourse. Coordinates must be provided in degrees, minutes and seconds. Where numerous properties/sites are involved (e.g. linear activities), you may attach a list of property descriptions and co-ordinates to this form.	Section 2
e)	Specialist assessment to be undertaken to determine -	
i)	Hydrological (incl. flood hydrological data etc.) and geomorphological assessment of watercourse functioning.	Section 2
ii)	The relevant Present Ecological Status (PES) of the stretch of watercourse in question, if not available an assessment is to be done to determine PES in accordance with the Department of Water and Sanitation (DWS) guidelines.	Section 2
iii)	What is the reason/cause for the maintenance activities based on an ecological and hydrological assessment of the watercourse within the context of the larger catchment.	Section 2
iv)	What are the drivers of system functioning within the watercourse and what is the ecological objective – based on historical condition and PES.	Section 2
v)	What is the management objective given the ecological status of the watercourse based on historical and PES data; as set out in agreement with the person(s) responsible for undertaking the maintenance activities.	Section 2
vi)	What is the impact on the watercourse/river system (resource quality characteristics: flow regime, geomorphology, water quality, habitat and biota) for a minimum of 500m both up and downstream of the proposed maintenance activities, with the mitigation measures included.	N/A
vii)	An appropriate assessment for risk for each of the proposed types of maintenance activities and linked management actions in terms of the risk matrix for General Authorisations (GA) of Section 21 (c) and (i) by the DWS (GN 509 of 2016) or where applicable.	Section 6
f)	Mapped biodiversity features such as Critical Biodiversity Area, Ecological Support Area, National Freshwater Ecosystem Priority Area (NFEPA), and the National list of Ecosystems that are threatened and in need of protection (2011) gazetted in terms of Section 52 of the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEMBA), the Western Cape Biodiversity Spatial Plan 2017, as well as relevant provincial specific plans and classifications etc. Please consult the website www.bgis.sanbi.org.za to determine mapped features.	Section 2
g)	Include a description of existing or previous protection measures or reinforcements (eg. gabions or groynes etc.) and infrastructure. Describe any evidence of erosion and/or siltation at the various sites and outlining possible causal factors and maintenance practices.	Section 2
h)	Provide historical maps and data (images/flow/water quality/land use) of the river channel (if available) in order to assess the natural to changing flow patterns of the watercourse to determine cause of maintenance and possible impact of the maintenance activities, to inform mitigation measures.	Section 2
i)	Provide a photographic record for the condition of the riparian habitat around maintenance sites, with the presence of important and/or sensitive habitat/species noted.	Section 2
j)	For sites prone to flood damage, a description regarding the history and effect of past floods and include dates of most recent events must be provided. This must inform the process to understand what actions are required along the stretch of the watercourse to reduce such impacts to the resource quality characteristics.	N/A
k)	Explain the risks associated with the no-go option for the FRRMP i.e. the risk of not undertaking the maintenance activities as stated in the FRRMP.	Section 7.1
l)	Reference must be made to any strategic plan where available, for example, a Catchment Management Strategy, with the objectives of the FRRMP shown to be in alignment with such plans.	N/A

1 INTRODUCTION

Scientific Terrestrial Services (STS) was appointed to develop a Freshwater Resource Rehabilitation and Management Plan (FRRMP) 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" (Figure 1).

The proposed bulk sewer pipeline is situated approximately 900m west of the R101 (old Warmbad 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 of the bulk sewer pipeline, and 2.4 km east of the bulk potable water pipeline.

During a site visit undertaken in September 2017, in order to assess the Present Ecological State (PES) and impacts that the construction related activities of the proposed bulk service pipelines may have on the receiving environment, with specific mention of an unnamed tributary of the Apies River and an ephemeral drainage line.

Therefore, the FRRMP acts as a freshwater resource management tool for the proposed activities associated with this project, which has been developed to address and manage all perceived and potential impacts upon the freshwater environment as a result of the installation of the proposed bulk service pipelines. Rehabilitation techniques and designs form a key part of the proposed project and will be a critical component in ensuring that present conditions are at least maintained, and that where feasible, there will be an improvement in the key characteristics of the freshwater resources:

- Drivers:
  - Hydrology;
  - Water quality; and
  - Geomorphology;
- Receptors
  - Habitat; and
  - Biota.

The key objective of this FRRMP is to ensure that impacts are managed in line with the impact mitigation hierarchy as advocated by the DEA and that ecological integrity within the receiving environment is maintained or improved upon. The management and rehabilitation assessment is a system that seeks to achieve a required end state which supports local and regional

conservation as well as the provision of downstream goods and services provision and describes how activities that have, or could have, a negative impact on the freshwater resources will be controlled and monitored and also identifies the responsible parties and relevant timeframes (where applicable) which will be tasked with implementing these measures.

1.1 Context of the Freshwater Resource Rehabilitation and Management Plan

The FRRMP fits into the overall planning process of the development activities, with specific mention of the construction phase of the freshwater resource crossings and should be implemented by the proponent as soon as it has been approved by the relevant authorities and as soon as construction of the proposed development has reached a stage where management actions are required and when rehabilitation activities become viable.

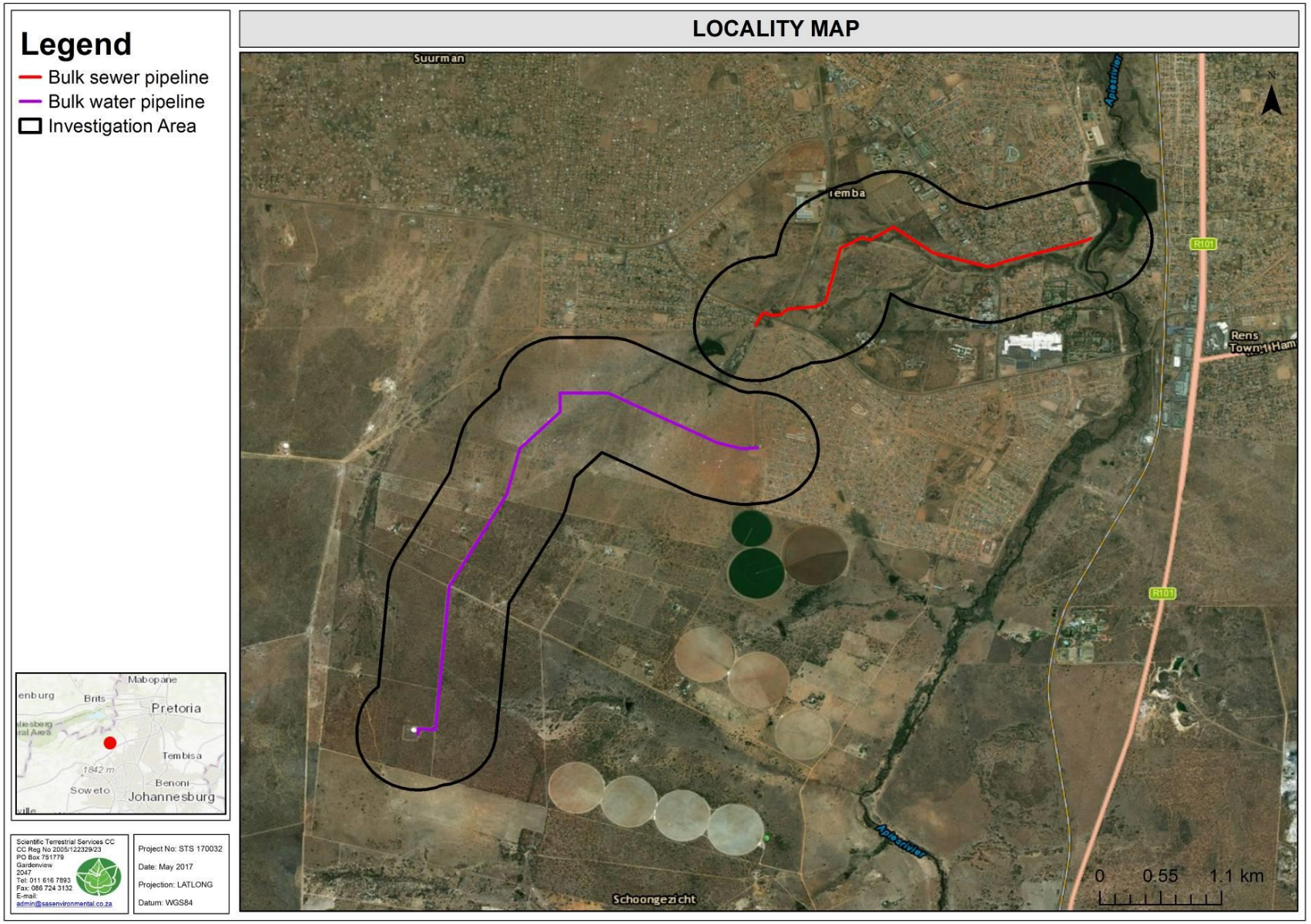


Figure 1: A digital satellite image depicting the location of the bulk service pipelines in relation to surrounding areas

2 RECEIVING ENVIRONMENT

The following information on the ecological characteristics of the freshwater resources associated with the proposed bulk service pipelines are taken from a report titled: "Freshwater Resource Ecological Assessment as part of the Environmental Authorisation process for the proposed development of bulk services associated with Hammanskraal X10, Hammanskraal, Gauteng" (SAS, 2017), which also provides further information if required.

The National Freshwater Ecosystem Priority Areas (NFEPA 2011) database and the Gauteng Department of Agriculture and Rural Development's (GDARD) Conservation Plan version 3.3 (2011) indicated the following applicable important background information:

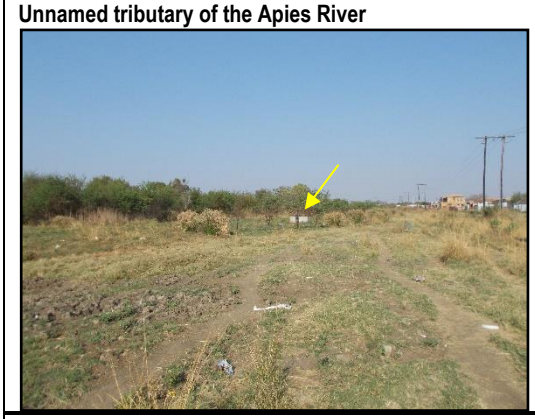
Table 1: Conservation characteristics associated with the locality of the proposed bulk service pipelines

GDARD C-Plan v3.3 (2011)	➢ 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; ➢ 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; ➢ 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; ➢ 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; and ➢ 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.
NFEPA database (2011)	➢ 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; and ➢ The Apies River is situated ± 60m east of the 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).
Wetland Vegetation (NFEPA, 2011)	➢ 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.

Following the completion of a site visit in September 2017, it was observed that an unnamed tributary of the Apies River would be directly traversed by the proposed sewer pipeline, and that an ephemeral drainage line would be traversed by the proposed water pipeline (Figure

2). Within the study of STS (2017) the above mentioned freshwater resources was assessed, of which a summary is provided in the table below. Kindly refer to the Freshwater Ecological Assessment (STS, 2017) for a detailed analysis.

Table 2: Summary of results of the field assessment as discussed in the Freshwater Ecological Report by STS (2017).

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

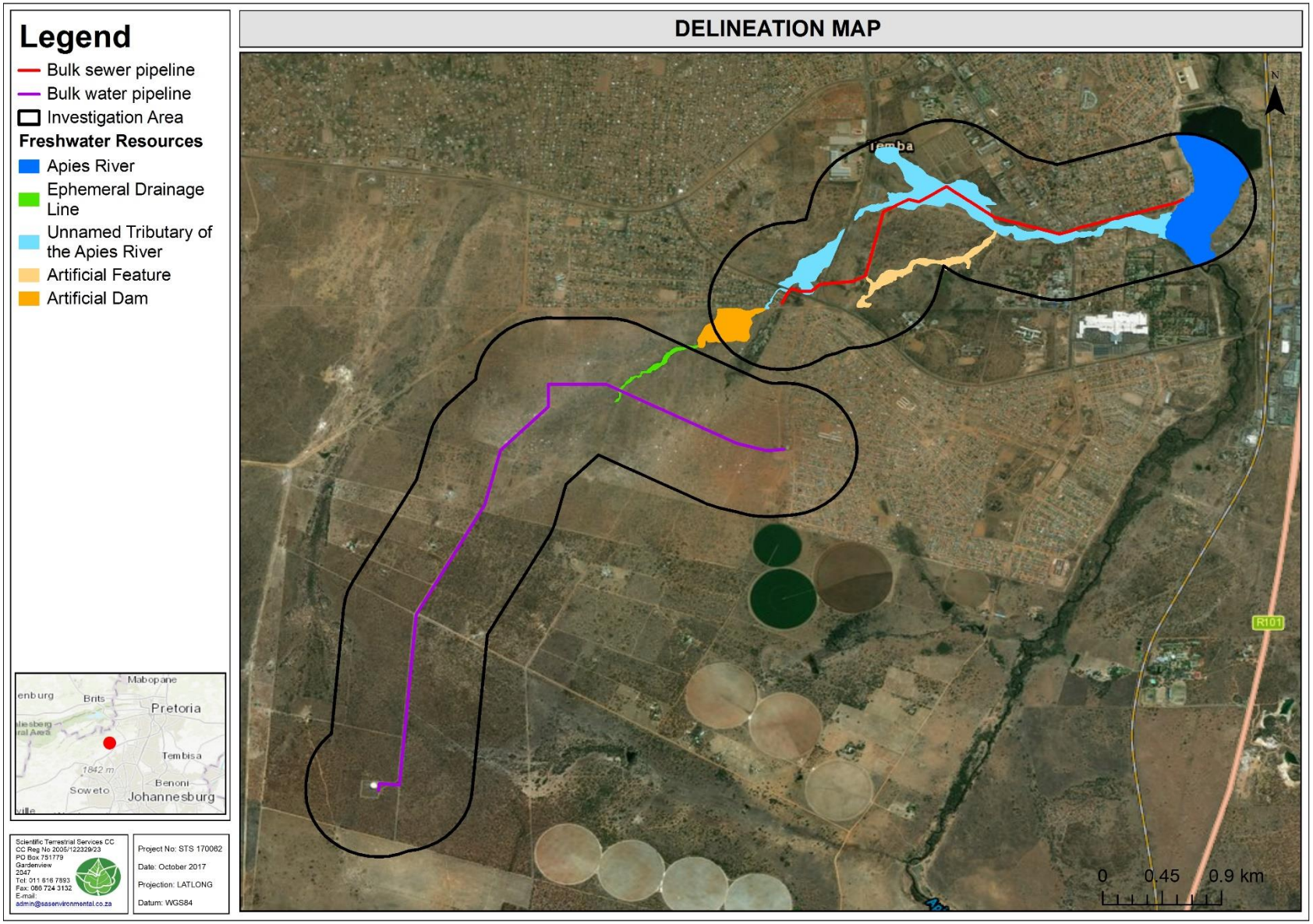


Figure 2: The location of the identified freshwater resources within the investigation area, in relation to the proposed bulk service pipelines and surrounding areas, assessed by STS (2017).

Overall, the freshwater environment could be considered severely degraded. Along the greater part of the unnamed tributary, disposal of building rubble, domestic litter and excavation/infilling was visible (Figure 3). Additional runoff into these resources from roads has also influenced the water quality of the overall freshwater system.

Figure 3: Photographs depicting a variety of anthropogenic activities which have impacted on the overall condition of the freshwater resources associated with the proposed bulk service 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.

Although the construction of the proposed bulk service pipelines is considered to be of a relatively short duration which will take place at selected localities over within the freshwater resources, since it is proposed that the pipelines would be installed by trenching through the unnamed tributary of the Apies River (sewer pipeline) and the ephemeral drainage line (water pipeline), even with strict implementation of cogent, well-developed, activity-specific mitigation measures being implemented, the risk of installing the pipelines would pose a 'Medium' risk to the freshwater resources. The strict implementation of the stipulated mitigation measures as recommended in the Freshwater Assessment report (STS, 2017), could potentially enable the reduction of the perceived impacts.

3 OBJECTIVES OF MAINTENANCE AND REHABILITATION ACTIVITIES/TERMS OF REFERENCE

All essential mitigation measures and recommendations as listed in this section of the report should be adhered to as to ensure the ecology within the proposed construction areas as well as surrounding zone of influence is protected or adequately rehabilitated in order to minimise the deviations from the PES. Particular attention needs to be paid to the location and extent of the affected sections of the freshwater resources in order to ensure development related activities do not encroach unnecessarily into upstream/downstream areas and that ongoing functionality in these areas is maintained in order to ensure that habitat areas downgradient of the proposed development activities are not adversely affected.

3.1 Principles of the FRRMP

To assist in achieving the objectives of the FRRMP, a set of principles was applied, which contributed to the formulating of action plans and specific management measures. The principles of the FRRMP are:

- Avoiding impacts by not performing environmentally detrimental actions;
- Minimising impacts by limiting aspects of an action which could lead to environmental damage;
- Rectifying impacts through rehabilitation, restoration, etc. of the affected environment;
- Minimising impacts by optimising processes, structural elements and other design features;
- Provide ongoing monitoring and management of environmental impacts of a development and documenting of any digressions /good performances; and
- The FRRMP, once approved for implementation by the relevant authorities, is a legally binding document that all parties involved in the project must be informed about the importance of the FRRMP.

3.2 Key Objectives of the FRRMP

The FRRMP aims to address impacts associated with the construction and operation of the proposed development as well as anticipated impacts that the development is likely to have on the affected freshwater resources. Therefore, certain objectives were developed which guided the development of the FRRMP. The objectives of the FRRMP are to:

- Meet the requirements of relevant local and regional authorities;

- Ensure that the operational phase of the proposed bulk service pipelines continues within the principles of Integrated Environmental Management;
- Identify a range of mitigation measures which could reduce and mitigate the potential impacts on the receiving environment to minimal or acceptable levels;
- Ensure that the development does not negatively impact on the social environment and that clear communication channels are present through which concerns can be raised and addressed;
- Prevent the further degradation of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the affected sections of the freshwater resources;
- Ensure that the affected portions of the freshwater resources is rehabilitated appropriately in order to meet the Recommended Ecological Class (REC) of the resource and prevent further degradation of the freshwater environment;
- Support the Resource Quality Objectives for the greater catchment;
- Identify measures that could optimise beneficial impacts in order to improve the ecological value of the affected freshwater resources, such as:
    - Assisting in the promotion of sustainable management and ongoing functioning of the unnamed tributary of the Apies River and the ephemeral drainage line;
    - Encouraging hydrological connectivity and preventing habitat fragmentation;
    - Maximise the service provision and hydrology of the unnamed tributary of the Apies River and the ephemeral drainage line;
    - Removal of alien and invasive plant species from the system and replacing these species with indigenous vegetation;
    - Detail specific actions deemed necessary to assist in mitigating the potential environmental impact on the unnamed tributary of the Apies River and the ephemeral drainage line;
    - Controlling alien vegetation in a phased manner as to not encourage erosion and further proliferation along the affected portion of the unnamed tributary of the Apies River and the ephemeral drainage line; and
    - Prevent contamination of the unnamed tributary of the Apies River and the ephemeral drainage line and no litter may be tolerated within the resources itself.
- Ensure that appropriate solid waste disposal facilities are provided and adequate signage is provided for all solid, liquid and hazardous waste types;
- Ensure as far as is practicable that the measures contained in the report are implemented; and
- Propose mechanisms for monitoring compliance with the MMP and reporting thereon.

3.3 Environmental Education, Training and Awareness

3.3.1 Training of Construction Workers

Construction workers must receive basic training in environmental awareness, including minimisation of disturbance to the freshwater environment, as well as fauna and flora with a no poaching policy, management of waste and prevention of water pollution.

3.3.2 Contractor Performance

The Contractor must ensure that the conditions of the FRRMP are adhered to. Should the Contractor require clarity on any aspect of the FRRMP the Contractor must contact the ECO for advice.

The ECO must regularly audit the operation and establish whether the measures in the FRRMP are applied, where after the ECO reports to the lead project manager. The lead project manager must ensure that the FRRMP is implemented and that suitable penalties are in place for non-conformance to the FRRMP by contractors. The ECO should be the designated authority to issue a stop work order if severe non-compliance is taking place by the contractor.

4 ROLES & RESPONSIBILITIES

4.1 Proponent

- The Proponent is responsible for the appointment of a suitably qualified Environmental Practitioner as an independent Environmental Control Officer (ECO) for the construction phase of the project;
- The contractor is responsible for ensuring that sufficient funds are available to ensure that the development of the structure takes place in such a way as to ensure that the impact on the receiving environment is minimised and that all measures contained in the FRRMP can be implemented and that the recommendations made by the ECO are implemented;
- A management body must be appointed to ensure compliance with the FRRMP during the project phases (including the construction and operational phases); and
- The Proponent will be responsible for ensuring all relevant contractors receive a copy of the rehabilitation plan and understand its contents.

4.2 Environmental Control Officer (ECO)

The ECO is the person responsible for the monitoring of the implementation of the FRRMP for the duration of the project phases and for reporting on the degree of compliance. The ECO should ideally be appointed at the start of the construction phase and is mandated to do the following:

- Ensure that all contractors/ subcontractors/ employees are fully aware of their environmental responsibilities. This should take the form of an initial environmental awareness-training program in which requirements of the rehabilitation plan will be explained;
- Monitor site activities on a regular basis to ensure that there is minimal environmental impact due to construction and maintenance activities;
- Ensure that a 'hotline' exists for reporting incidents and resolving any problems rapidly;
- Ensure that there is a mechanism available for Interested and Affected Parties to raise concerns and a mechanism to ensure that all such concerns are addressed;
- The ECO has the authority to stop works if in his/her opinion there is/may be a serious threat to or impact on the environment caused directly by the construction operations;
- Review or amend the FRRMP as necessary, and inform the relevant parties of the changes; and
- Conduct a final environmental audit and a review of management and rehabilitation measures.

4.3 Contractors

The Contractor must ensure that the conditions of the FRRMP are adhered to. Should the Contractor require clarity on any aspect of the FRRMP the Contractor must contact the Environmental Control Officer (ECO) for advice.

The ECO must regularly audit the operation and establish whether the measures in the FRRMP are applied, where after the ECO reports to the lead project manager. The lead project manager must ensure that the FRRMP is implemented and that suitable penalties are in place for non-conformance to the FRRMP by contractors. The ECO should be the designated authority to issue a stop work order if severe non-compliance is taking place by the contractor.

Points below serves as a summary of responsibilities of the Contractor:

- The contractor/s in this case refers to any contractor/s on site, including the building contractor/s and sub-contractors;

- Such contractor/s will take full responsibility for each of his/her employees and any penalties imposed;
- It is the responsibility of the contractor/s to ensure that they adhere to the FRRMP; and
- Contractor workers must receive basic training in environmental awareness, including minimisation of disturbance to the freshwater resources of increased ecological sensitivity, as well as fauna and flora with a no poaching policy, management of waste and prevention of water pollution.

5 SURFACE WATER REHABILITATION AND MANAGEMENT PLAN

The Contractor's responsibility is set out in the Construction Method Statement as provided by Nyeleti Consulting Engineers. The Contractor must provide a detailed method statement including the following, but not limited only to:

- Biophysical description of the site;
- Duration and timing of the freshwater environment crossing construction;
- Itemised list of equipment that will be used for construction;
- Measure to maintain flow (if surface water is present) in the system throughout the construction phase;
- Description of the design and methods for installing the bulk service pipelines through open trenching;
- Measures to be used to control sediment and turbidity, spillage of any hazardous chemicals (solid or liquid). Monitoring as to provide rapid feedback on effectiveness of controls.

Documentation must be prepared by the Contractor that specifies details pertaining to site planning, waste management, pollution control, storm water run-off, erosion control and rehabilitation. The tables below serve to present the rehabilitation and management plan for the affected freshwater resources. Both general and specific mitigation and rehabilitation actions are outlined in the tables below. These mitigation measures, unless otherwise specified, are applicable to all aspects of the construction and operational phase respectively.

These measures must be undertaken in order to mitigate the impacts of the proposed activities on the freshwater resources. The action plans for the project area are prioritised as follows:

Table 3: Prioritisation of rehabilitation/management actions applicable to the project area.

SIGNIFICANCE OF IMPACTS	
HIGH	Disturbance of area with importance conservation value, destruction of rare or endangered species. No possible mitigation or mitigation is difficult, expensive, time consuming.
MODERATE	Disturbance of are with potential conservation value or of use as a resource; complete change in species occurrence or variety.
LOW	Disturbance of degraded area with little conservation value; minor change in species occurrence or variety. Mitigation easily achieved or little required.

5.1 Management measures pertaining to the rehabilitation phase of the proposed activities

Table 4: Control and mitigation measures for the rehabilitation phase of the proposed activities

	Objectives requirements	Protective measures	Significance of Impacts	Key Performance Indicator (KPI)
1	Site establishment and access	• The construction site must have strict access control to ensure that no unauthorised persons are onsite; • Adequate signage must be placed around the construction area to ensure that the public has been notified of the activities taking place; • The construction footprint areas, and stockpile areas within the 32m setback area of the freshwater resources should be barricaded with hessian curtains to prevent silt rich runoff into the river; • The construction footprint areas within the freshwater resources must remain as small as possible and should not encroach into upstream/downstream portions of these freshwater resources, except where planned and if absolutely essential; • Planning of temporary roads and access routes should avoid crossing the freshwater resources and be restricted to existing or planned roads where possible; • If crossings over the freshwater resources is necessary, crossings should take place at right angles to the system or some other acute angles, to minimise the extent of transformation within the freshwater resources; • All habitat connectivity must be maintained, and where possible improved, especially where the project footprint crosses the freshwater resources and its immediate surrounding habitat. At no point should the hydrological connectivity of the freshwater resources be disrupted completely by (construction) vehicle movement or diversion activities; • In areas where vegetation removal would occur as part of site establishment for construction activities, where possible, vegetation should be cut down to ground level instead of being removed completely to stabilise the soil during land-clearing operations; • Vegetation clearing should be kept to what is absolutely essential, to reduce the extent of bare soils, thus limiting erosion potential of the area; and • Dedicated parking area for construction vehicles must be located away from sensitive areas, and drip trays must be located beneath any leaking equipment and lubricant/fuel absorbing media (moss/peat type products) within drip trays must be used to contain spilled material. The absorbing material in the drip trays must be replaced regularly as to prevent over-saturation and potential spillage. This hazardous waste must be collected by an approved contractor/delivered to an approved waste disposal site.	Low	• Strict site access is implemented, and approval from the responsible person must be obtained; • Sensitive areas (i.e. the affected freshwater resources) are clearly demarcated and signage erected to indicate the areas in which no activities is to take place, as “no-go” areas; • All footprint areas temporarily barricaded and marked. Care taken not to influence faunal mitigatory measures; and • Appropriate parking areas for construction vehicles have been located outside of the demarcated freshwater resource zones and the setback areas

	Objectives requirements	Protective measures	Significance of Impacts	Key Performance Indicator (KPI)
2	Storage, handling and spills	• Adequate storage facilities for the storage of oils, paints, grease, fuel, chemical and hazardous materials to be utilised must be provided to prevent contamination of ground and surface water and soils; • Storage areas must be demarcated and fenced, not be located within 100m of the edge of the freshwater resources, and must be placed on impermeable surfaces such as concrete bund to prevent contamination; • Used cement bags are to be stored in weatherproof containers to prevent cement dust from being windblown into the freshwater resources;	Low	• All footprint areas temporarily barricaded and marked. Care is taken not to influence faunal migratory corridors; • Cement bags are stored in appropriate weatherproof containers; • Storage areas are clearly demarcated; and • All hazardous storage containers comply with the relevant SABS standards.
		• All fuel storage tanks must be designed in accordance to the relevant oil industry standards, SABS Code and other relevant requirements; • All waste must be removed from site and disposed of at a licensed landfill site; and • In areas where planned activities would occur, with specific mention of the excavation of trenches, litter and general waste must be removed from the soil prior to stockpiling.	Low	
		• Pre-cast concrete must be used whomsoever possible; • No mixed concrete shall be deposited outside of the designated construction footprint. A batter / dagga board mixing trays and impermeable sumps are to be provided, onto which any mixed concrete can be deposited whilst it awaits placing. Concrete spilled outside of the demarcated area must be promptly removed and taken to a suitably licensed waste disposal site; • Installation of concrete washouts: Concrete washouts are used to contain concrete and liquids when the chutes of concrete mixers and hoppers of concrete pumps are rinsed out after delivery. The washout facilities consolidate solids for easier disposal and prevent runoff of liquids. The wash water is alkaline and contains high levels of chromium, which can leach into the ground and contaminate groundwater. A washout area should be designated outside of the freshwater resources, and wash water should be treated on-site or discharged to a municipal sewer system; • Appropriate handling and disposal of concrete and cement-related mortars should minimize or eliminate discharges into the freshwater resources. Fresh concrete and cement mortar should not be mixed on-site, and both dry and wet materials should be stored away from the freshwater resources and storm drains. These materials should be covered and contained to prevent contact with rainfall or runoff; and • In the case of spillage (i.e. fuel, oil, concrete), the spill should be contained and the material together with any contaminated soil must be disposed of as hazardous waste.	Low	• Appropriate mixing trays and impermeable sumps are utilized during the mixing of concrete; • Concrete washouts are installed at appropriate demarcated areas; and • In the event of spillage, the spill and associated material has been removed from site and disposed of at licensed waste facilities.

	Objectives requirements	Protective measures	Significance of Impacts	Key Performance Indicator (KPI)
3	Rubble and Waste Removal	• During the field assessment conducted by STS (2017), it was evident that debris and litter/rubble was present within the freshwater resources, specifically along the unnamed tributary of the Apies River. All rubble and litter located within the freshwater resources in the vicinity of the proposed construction activities should be removed and disposed of at a registered waste facility; and • Any waste concrete and other foreign material used or generated during construction must be demolished and removed from site. All rubble and waste will be disposed of at a suitably registered landfill site.	Low	• All rubble and litter associated with the construction activities has been cleared, and no litter or rubble remains after construction has been completed
4	Control of alien and invasive plant species	• The removal of the alien and weed species encountered within the zone of influence of the proposed bulk service pipelines prior to any construction taking place, 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); • The appointed ECO should advise on plant identification and invasive categories, should there be any queries on species during the alien vegetation control process, and develop an alien and invasive species control program incorporating the methods and recommendation, especially on the use of chemicals, herbicides, pesticides and fertilizers, in Annexure B; • Proliferation of alien and invasive species is expected within any disturbed areas, and the vegetation component of the freshwater resources in the vicinity of the proposed development is already transformed as a result of alien plant invasion; therefore, these species should be eradicated and controlled to prevent their spread beyond the zone of influence of the development; • Alien vegetation should be manually removed and chemical control is not recommended in order to prevent chemical contamination of the freshwater resources; • Alien vegetation that is removed from the ground must not be allowed to lay on unprotected ground as seeds might disperse upon it. Additionally, all care should be taken in the removal of alien vegetation from the ground so as to prevent seeds from falling on it, including (if necessary and practical) the use of temporary sheeting around the base of the plant; • None of the removed alien species may be chipped and used as mulch as there may be seeds present within the mulch that will spread to areas beyond the present alien floral communities; • No alien plants may be introduced to the development area and surrounding areas during the construction phase of the project and particular attention must be paid to ensure that any imported material, such as topsoil used for rehabilitation purposes, is certified weed-free; • In the removal of smaller alien shrubs and groundcovers, Category 1b, 2 and 3 alien species are to be prioritised in eradication. Non-listed alien species may also be hand-	Low	• An Alien vegetation control program has been developed by a qualified specialist and a suitably qualified and experienced contractor has been appointed for the alien vegetation control; and • All alien vegetation is removed from site and disposed of at appropriate facilities.

	Objectives requirements	Protective measures	Significance of Impacts	Key Performance Indicator (KPI)
		pulled. It is important that the guidelines as outlined in Annexure B of this document be followed in terms of eradication methods and integrated into an alien and invasive plant species control program. In all instances physical/ manual eradication techniques must be preferred over chemical treatment; • All removed alien plant species must be disposed of at a registered garden refuse site and may not be burned on site; and • Should any alien invasive plants existent on site be trees or bushes greater than 1.5m tall they should be very carefully removed and the ground immediately reseeded and covered with a biodegradable hessian curtain in order to reduce erosion.		
5	Rehabilitation of excavated of trenches	• Where trenches have been excavated, water must not be allowed to flow along it, but water must be diverted away from the trench to reduce erosion and sedimentation of the downstream areas; • When the excavated trench areas are backfilled the surface must be level with the surrounding land surface, unless stated otherwise, to ensure that the area is free draining and to minimise soil erosion from the areas when the construction is complete; • Any areas compacted as a result of construction activities, where applicable, shall be ripped to a depth of approximately 150mm, impact compaction equipment, prior to being infilled with topsoil; • Any excess topsoil or soils excavated from the open trenches left in the construction footprint must be levelled into the site or should be removed and disposed of at a registered disposal site; and • Areas that has been disturbed, should be reseeded with indigenous species in order to stabilise the soil and to re-establish vegetation.	Medium	• The natural bed and banks of the freshwater resources have been reinstated during the construction activities; • Disturbed areas have been ripped, and reprofiled with topsoil; and • Areas disturbed due to maintenance activities have been reseeded with indigenous seeds.
6	Stormwater Management	• Storm water on the site and surface run-off from cleared areas must be managed so as to reduce the silt loads and runoff peaks into the freshwater resources. Therefore, curtains should be installed within the applicable footprint areas, to prevent runoff of silt rich storm water into the freshwater resources; • The marginal and non-marginal zone of the freshwater resources should be monitored for erosion and incision. In the event that erosion is evident, a suitably qualified specialist should be informed and the erosion control plan must be amended in accordance to the mitigation measures provided and initiated; • As far as possible, all construction activities occurring within the freshwater resources should occur in the low flow season, during the drier winter months; • Excavations should be limited in extent (only to what is necessary for where open trenches within the freshwater resources and in its marginal zone are necessary) to ensure that drainage patterns within the freshwater resources returns to normal as soon as possible after construction; • Reduce airborne dust at construction sites through:	Low	• Regular inspection is done by the ECO to identify issues or potential infrastructure encroaching in the no-go areas (the freshwater resources); and • Excavation and vegetation clearance is limited to what absolutely essential.

	Objectives requirements	Protective measures	Significance of Impacts	Key Performance Indicator (KPI)
		○ Damping dust generation areas with freshwater (although not in sufficient quantities to generate runoff); and ○ Use of cloth or brush barrier fences.		
7	Stormwater management: Erosion and Topsoil	• All areas where the bulk service pipelines were installed within the freshwater resources must be monitored for erosion and incision, and further disturbance should not be permitted; • Where required, erosion berms should be installed below access roads and informal road ways, in order to prevent siltation and erosion of the freshwater resources. The following points should serve to guide the placement of erosion berms: ○ Where the track has slope of less than 2%, berms every 50m should be installed; ○ Where the track slopes between 2% and 10%, berms every 25m should be installed; ○ Where the track slopes between 10%-15%, berms every 20m should be installed; and ○ Where the track has slope greater than 15%, berms every 10m should be installed. • The footprint for horizontal drilling should remain as small as possible, to limit the disturbance to the receiving freshwater environment; • Extensive monitoring of manholes situated within close proximity to the freshwater resources should take place, to ensure that erosion and incision does not occur in the vicinity of the manholes which would lead to instability of the structure and leakage; • All excavated soil must be stripped and stockpiled within a designated area, in the vicinity of the construction site, outside of the freshwater resources, for subsequent use at a later stage (for backfilling excavated trenches with material which was originally removed from the freshwater environment); Stockpiles must be protected from the wind and rain with the use of tarpaulins, where necessary; • It must be ensured that weeds/invasive alien species are eradicated from topsoil prior to spoiling; • All/any erosion and silt control mechanisms need to be regularly maintained for the duration of the construction phase.	Low	• Newly constructed infrastructures within the freshwater resources are being monitored for erosion and incision at regular intervals; • Berms have been created where necessary and monitored for erosion and incision at regular intervals; • Excavated soil has been stripped and stockpiled at appropriate designated areas in the vicinity of the construction site, outside the freshwater resources and setback area; • No significant erosion or incision observed; and • Maintenance and desilting done at the end of the dry season and prior to the first rains.
8	Retain faunal and floral diversity	• It should be ensured that the permanent zone of the freshwater resources have inundated soil conditions throughout the year extending to the soil surface, and that the seasonal zones should have water logged soils within 300mm of the soil surface at all times. This will ensure that habitat conditions provided by the freshwater resources remain intact after the construction phase; • No fires should be permitted in or near the construction area; and • Trapping, hunting or collection of faunal species must be prohibited.	Low	• A qualified specialist has developed an Alien vegetation control program and a suitably qualified and experienced contractor has been appointed for the alien vegetation control.

5.2 Management measures pertaining to the operational phase of the proposed activities

Table 5: Control and mitigation measures for the duration of the operational phase of the proposed activities

		Protective measures	Significance of Impacts	KPI
1	Stormwater Management	• Edge effects of activities in the freshwater resources, including erosion and alien/weed control, need to be strictly managed and continued for at least three months post construction, and should be inspected during maintenance activities; • Manholes located within close proximity to the freshwater resources should be monitored at regular intervals, to ensure that the structures did not move during heavy rainfall events and to ensure that no erosion or leakage are evident; and • The bulk service pipelines must be inspected regularly, to ensure that no leakage or blockage of the pipelines occurs.	Low	• Erosion and alien / weed control occurs for three months post construction and during maintenance activities on the bulk service pipelines; • Maintenance of the pipelines occur at regular intervals; and • The manholes are intact and regular maintenance thereof takes place.
2	Retaining faunal and floral diversity	• It must be ensured that no additional impacts such as indigenous vegetation clearing are allowed to occur in the vicinity of the freshwater resources; • No trapping, hunting or collection of faunal species must be allowed during maintenance or monitoring activities; • Disposal of waste or litter must be prohibited in the freshwater resources. Any waste noted must be cleared immediately during maintenance activities; • If vegetation adjacent to the bulk service pipelines is to be removed, it must be mowed or cut short to between approximately 6 – 9 inches as a maintenance procedure (at this height basal erosion of the grasses will be minimised (VDoT, 2007; CoB, 2014). and the grass must not be ploughed, as ploughing disturbs the soils creating conditions for alien plant species to invade the area, as well as increasing the possibility of soil erosion by water runoff. The grass cuttings must be carefully collected and disposed of at a separate waste facility and not be allowed to enter the river, as high grass loads can impair the water quality during the low flow season; and • All maintenance vehicles must remain on designated roads paths as far as possible with no indiscriminate driving through the freshwater resources.	Low	• Only single access roads/existing roads to the freshwater resources is used during maintenance activities; • No additional waste or litter is present within the freshwater resources habitat after maintenance activities has taken place; and • Alien vegetation is monitored and removed for at least three months post construction, as well as during any maintenance activities of the bulk service pipelines.

6 OUTCOMES OF RISK ASSESSMENT

The Risk Assessment was undertaken using the DWS approved Method and Risk Assessment Tool. The risk assessment was applied for the activities associated with the proposed pipeline installation, considering impacts during both the construction and operational phases (Table 6). It is assumed that all mitigation as described in the Freshwater Ecological Assessment (STS, 2017) and those stipulated in the tables above will be implemented and adhered to.

Table 6: Summary of Risk Assessment Results, as per GN509 of the National Water Act, 1998 (Act 36 of 1998).

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	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.	5	7	8	56	L
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.	5	8	9	72	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.	5	7	9	63	M

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating
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.	5	7	8	56	L
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	5	7	8	56	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	5	7	8	56	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	5	7	8	56	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	5	7	8	56	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.	5	8	9	72	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	5	7	8	56	L

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating
				sulphide gas as well as increased alien and invasive species encroachment.					
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	**5**	**8**	**9**	**72**	**M**
11			Operation of the sewer pipeline	<u>Latent impacts</u>: 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.	**5**	**7**	**8**	**56**	**L**
12				<u>Cumulative impact</u>: Increased urban development in the area will likely place increased pressure upon the sewerage infrastructure (including the capacity of the receiving waste water 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.	**5**	**7**	**8**	**56**	**L**

7 MONITORING PLAN

7.1 Monitoring Philosophy and Requirements

Prudent monitoring of the rehabilitated freshwater resources is of utmost importance, as this will ensure a continual flow of data, enabling all parties involved to accurately assess and manage the progress of the rehabilitation interventions and any arising issues. To ensure the accurate gathering of data, the following techniques and guidelines should be followed:

- Site walk through surveys should be applied as the preferred method of monitoring (at specified frequencies) with specific focus on:
  - Erosion monitoring (for the duration of the raining season);
  - Sedimentation (for the duration of the raining season);
  - Alien and invasive vegetation proliferation (at the start and end of the growing season);
  - Spills events (regularly at the direction of the relevant engineer);
  - Surface water monitoring; and
  - Waste and litter problems.
- General habitat unit overviews should also be undertaken;
- Stability and appropriateness of stormwater controls;
- All data gathered should be measurable (qualitative and quantitative);
- Monitoring actions should be repeatable;
- Data should be auditable; and
- Reports should present and interpret the data obtained.

The table below illustrates data capturing for the monitoring plan.
The monitoring plan comprises but is not limited to the following:

- Identification of areas of concern. These are areas that are affected by disturbances such as:
  - Erosion;
  - Waste dumping;
  - Alien vegetation species encroachment;
  - Soil compaction; and
- Ensuring that the management/rehabilitation measures as stipulated in Section 5 of this report are adhered to;
- A list of all alien vegetation species must be compiled as well as possible control methods such as manual, chemical or mechanical.
- Gathering all equipment required for the monitoring process; and

- Compiling a monitoring report.

This monitoring plan must be implemented by a competent person and submit the findings to the responsible authority for evaluation.

Table 7: Monitoring actions for the proposed development.

Aspect	Monitoring Location	Frequency of sampling	Frequency of Reporting	Report Content	Equipment
Erosion					
Rehabilitation, construction and operation phases	1. Cleared and compacted areas where the bulk service pipelines are to be installed. 2. The downstream areas of the freshwater resources located within the zone of influence of the proposed development.	Monitoring of erosion should occur during construction after every rainstorm and / flood, and during the operational phase monthly during first the wet season or during routine maintenance inspections, as applicable.	After every major rainstorm / flood. Monthly monitoring report compiled by the appointed ECO during the construction phase.	1. Brief indication of the method of assessment; 2. Assumptions and Limitations must be listed; 3. Fixed point photography an GPS point location taken of existing erosion in the freshwater resources prior to, during and post rehabilitation; and 5. Map indicating where erosion is present.	1.GPS 2. Camera 3. Field Form 4. Measuring Tape
Surface Water Quality					
Pre-Construction	Immediately upstream and downstream of the proposed locality where the bulk service pipelines are to be installed. GPS co-ordinates of the monitoring locality to be recorded.	Water must be tested at least once a month for a minimum of three months before construction commences. GPS co-ordinate of the monitoring point must be recorded so that monitoring takes place consistently at the same point.	Report must be compiled following completion of fieldwork.	Results of the following must be discussed in detail: Physio-Chemical Water Quality including pH, electrical conductivity, dissolved oxygen content as well as turbidity.	1.GPS 2. Camera 3. Field Form 4. Handheld multi probe 5. Clarity tube 6. DO Probe (only essential if high turbidity is apparent).
Construction	Monitoring must be undertaken at precisely the same locality as the pre-construction monitoring.	Water monitoring must be undertaken on a two-weekly basis.	Report must be compiled on a monthly basis for all data collected.	Compare results to pre-construction assessments and aspects as listed in pre-construction report content.	As listed in Pre-Construction Equipment
Post Construction	Monitoring must be undertaken at precisely the same locality as the pre-construction monitoring.	Once a month for three months after completion of construction.	A once-off report to be compiled.	Compare results of pre-construction, construction and post construction assessments and aspects as listed in pre-construction report content.	As listed in Pre-Construction Equipment
Leakage events					
All phases	Roads and areas where vehicles commute and areas where chemical storage containers are located. Areas where leakage is visible/detected on the bulk service pipelines	1. Identification of any leakages events should occur monthly during the rehabilitation and construction phase, or 2. Directly after a leakage has been detected; and 3. For the operational phase, during maintenance activities	1.Monthly monitoring report compiled by the appointed ECO during the rehabilitation and construction phase; and 2. Report should be compiled for three	1. Brief indication of the method of assessment; 2. Discuss type and extent of leakage; 3. Photographs and GPS point locations taken of the leakage in the freshwater resource; 4. Map indicating where the spills/leakage have occurred; and 6. Recommended mitigation should be presented.	1. GPS; 2. Field Form; and 3. Camera

Aspect	Monitoring Location	Frequency of sampling	Frequency of Reporting	Report Content	Equipment
			months post rehabilitation.		
Waste and litter problems					
All phases	Construction camp and all areas where construction is taking place. All areas, which are frequently traversed by vehicles and personnel.	1. Identification of waste or litter problems should occur daily where construction is taking place; and 2. For the operational phase, during maintenance activities.	1. Monthly monitoring report compiled by the appointed ECO during the construction phase; and 2. Report should be compiled for three months post rehabilitation.	1. Photographs of construction sites where litter and waste is present or not; 2. Map of monitored construction sites; and 3. If litter and waste was observed; recommended mitigations should be presented.	1. GPS; 2. Field Form; and 3. Camera
Alien Vegetation Control					
Pre-Construction, Construction and Post-Construction	1. Within the freshwater resources which would be directly intersected by the proposed bulk service pipelines 2. Upgradient areas of the freshwater resources which would be directly intersected by the proposed bulk service pipelines.	1. Regrowth of alien vegetation should be monitored monthly during the construction phase; and 2. Thereafter monitoring must be undertaken for three months post construction, once at the end of the first growing season, and during maintenance activities.	1 Monthly monitoring report must be compiled by the appointed ECO during the construction phase and alien vegetation reported on at least quarterly	1. Provide a list of species occurring within the study area; 2. Discuss the density of invasion; 3. Freshwater habitat integrity and risk to be discussed; 4. Fixed point photography (Taking photo at specific point at facing the same direction each time within priority area to show effect of alien vegetation control.); and 5. Map indicating where alien vegetation is present.	1. GPS; 2. Field Form; and 3. Camera

8 SURFACE WATER REHABILITATION AND MANAGEMENT PLAN REVIEW

- The ECO is authorised to change and re-issue the FRRMP should site specific conditions and/or detailed design specific conditions require amendment of any aspect of the FRRMP;
- The provincial authority, the local authority, site supervisor, project manager and Environmental Site Officer is to be informed of any changes made by the ECO;
- The site supervisor or contractor is responsible for ensuring construction personnel are complying with procedures, and for informing the work crew of any changes. The site supervisor is responsible for ensuring the work crew is aware of changes before starting any works; and
- If the contractor cannot comply with any of the activities as described above, they should inform the ECO with reasons within 7 working days in order to allow the ECO to adjust the FRRMP.

9 CONCLUSION

Scientific Terrestrial Services (STS) was appointed to develop a Freshwater Resource Rehabilitation and Management Plan (FRRMP) for the proposed development of bulk services, namely bulk sewer and potable water pipelines, for Hammanskraal X10 within the Gauteng Province. It was found by STS (2017) that the proposed bulk service pipelines would directly traverse an unnamed tributary of the Apies River and an ephemeral drainage line.

With the implementation of the FRRMP procedures outlined in this report, the potential negative impacts of the proposed bulk service pipeline development on the affected sections of the freshwater resources should be reduced to an acceptable level. If all mitigation measures as stipulated in this plan, along with those stipulated in the Freshwater Assessment report (STS, 2017) are adhered to, impacts during both the construction and operation phase can be reduced.

The FRRMP further assists in the adequate protection of the downstream freshwater resources and maintenance and enhancement of the PES and function of the freshwater resources. The information gathered through monitoring programs will assist managing impacts on the ecology of the affected freshwater resources in the vicinity of the proposed

bulk service pipeline development and ensure proactive management of risks to the receiving environment associated with the proposed development.

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ANNEXURE A – LEGAL REQUIREMENTS

The sections below present each legislative document and the aspects which are pertinent to water resource management including the rehabilitation of disturbed areas to a level that will promote water resource.

- ***National Environmental Management Act, 1998 (NEMA, Act 107 of 1998)***

The guiding principles of NEMA refer specifically to biodiversity management in the following Clause:
(4) (a) *Sustainable* development requires the consideration of all relevant factors including the following:
(i) That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied.

NEMA (Act 107 of 1998) and the associated 2014 Regulations (Listing No R. 983, No R. 984 and R. 985) as amended, 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 process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact.

This FRRMP has been developed in fulfilment of the requirements as defined in the EIA Regulations, 2014 (No. R. 982) where a "maintenance management plan" is defined as a management plan maintenance purposes defined or adopted by the competent authority.

- ***National Environmental Management Biodiversity Act, 2004 (NEMBA, Act 10 of 2004)***

The objectives of this act are (within the framework of the National Environmental Management Act) to provide for:

- the management and conservation of biological diversity within the Republic of South Africa and of the components of such diversity;
- the use of indigenous biological resources in a sustainable manner;
- the fair and equitable sharing among stakeholders of benefits arising from bio prospecting involving indigenous biological resources;
- to give effect to 'ratified international agreements' relating to biodiversity which are binding to the Republic;
- to provide for co-operative governance in biodiversity management and conservation; and
- to provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act.

This act alludes to the fact that management of biodiversity must take place to ensure that the biodiversity of surrounding areas are not negatively impacted upon, by any activity being undertaken, in order to ensure the fair and equitable sharing among stakeholders of benefits arising from indigenous biological resources.
Furthermore, a person may not carry out a restricted activity involving either:

a) a specimen of a listed threatened or protected species;
b) specimen of an alien species; or
c) a specimen of a listed invasive species without a permit.

Permits for the above may only be issued after an assessment of risks and potential impacts on biodiversity is carried out. Before issuing a permit, the issuing authority may in writing require the applicant to furnish it, at the applicant's expense, with such independent risk assessment or expert evidence as the issuing authority may determine. The Minister may also prohibit the carrying out of any activity, which may negatively impact on the survival of a listed threatened or protected species or prohibit the carrying out of such activity without a permit. Provision is made for appeals against the decision to issue/refuse/cancel a permit or conditions thereof.

- ***National Environmental Management Biodiversity Act (NEMBA) (Alien and Invasive Species Regulations, 2014)***

NEMBA is administered by the Department of Environmental Affairs and aims to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA. In terms of alien and invasive species. This act in terms of alien and invasive species aim to:

- Prevent the unauthorized introduction and spread of alien and invasive species to ecosystems and habitats where they do not naturally occur,
- Manage and control alien and invasive species, to prevent or minimise harm to the environment and biodiversity; and
- Eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Alien species are defined, in terms of the National Environmental Management: Biodiversity Act, 2004 (Act no 10 of 2004) as:

(a) a species that is not an indigenous species; or
(b) an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention.

Categories according to NEMBA (Alien and Invasive Species Regulations, 2014):

- **Category 1a**: Invasive species that require compulsory control.
- **Category 1b**: Invasive species that require control by means of an invasive species management programme.
- **Category 2**: Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread.
- **Category 3**: Ornamentally used plants that may no longer be planted.

See **Appendix C** for further details pertaining to Alien and Invasive Vegetation control.

- ***Conservation of Agricultural Resources Act, 1983 (CARA, Act 43 of 1983)***

Amendments to regulations under the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) ensures that landowners are legally responsible for the control of invasive alien plants on their properties. The CARA legislation divides alien plants into weeds and invader plants, with *weeds* regarded as alien plants with no known useful economic purpose, while *invader plants* may serve useful purposes as ornamentals, as sources of timber and may provide many other benefits, despite their aggressive nature.

- ***The National Water Act, 1998 (Act 36 of 1998)***

The purpose of the National Water Act, 1998 (Act 36 of 1998) (NWA) is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled.
The NWA, 1998 also provides for water use licenses, which an operation will have to apply for, before commencing with any Section 21 water use activity. Various conditions may be attached to these licenses and a breach thereof will result in criminal and civil liability. The conditions attached to water use licenses will function alongside the additional protective measures, duty of care and statutory liability provisions provided by the NWA and other legislation to regulate a whole array of water issues. Accordingly, and in terms of the *Guide to the National Water Act*, "water use" refers to doing something that has an impact on the water resource, for example:

- The amount of water in the resource;
- The quality of water in the resource; and
- The environment surrounding the resource.

Section 4 governs the entitlement to use water and states that water may only be used if it is a Schedule 1 use, a continuance of an existing lawful use (ELU), or authorised in terms of a general authorisation (GA) or license. A water use may therefore not be implemented unless it is properly authorised through one of these types of authorisations.

Furthermore, in accordance with 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, 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.

The 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.

ANNEXURE B – ALIEN FLORAL SPECIES CONTROL

The dominant alien floral species are predominantly associated with agricultural activities and should be identified by the ECO prior to the commencement of construction. An Alien and Invasive Plant (AIP) species control program should be developed for control of these species. The basic principles of a control program are presented below.
AIP control programs must include the following three phases (Campbell, 2000):

- Initial Control Phase: The existing population must be drastically reduced.
- Follow-up Control Phase: Control of coppice regrowth, root suckers and seedlings.
- Maintenance Phase: Low AIP density and numbers with a low annual control cost. During this phase, AIP are no longer considered a problem. It is important to monitor the situation of infestation during the growing season of the plants as to avoid re-infestation and to keep the control cost at a minimum.

Control Methods
In order to control AIP successfully, one must use a number of control methods. When using herbicides, the recommendations that are stated on the label of the specific product must be adhered to (Campbell, 2000).

Integrated control strategies
A combination of the most suitable and effective methods should be used to control a specific species in a particular situation. The following selection of suitable control methods should take into account the following (Campbell, 2000):

- Species of alien and invasive weeds;
- The type of growth form (i.e. seedling, sapling, shrub or tree);
- The density of infestation;
- Terrain where the infestation is present;
- Rehabilitation requirements
- What resources are available;
- Speed or urgency that the control of the infestation requires – physical removal and biological control will take longer than chemical control.

- **Initial control phase**
  - **Hand pull:** saplings and seedlings must be pulled out by hand and regrowth must be controlled with herbicide (Campbell, 2000). All guidelines for the application of herbicide listed in this Rehabilitation Plan must be adhered to;
  - **Frill:** a cane knife is used to cut frills into the stem. Herbicide must be applied (1-2 mm per frill) and must be done in 30min after frilling;
  - **Soil application:** herbicide is applied to the soil and taken up by the plants roots

Methods for controlling Coppice, saplings and seedlings:
AIP infestation can comprise of different growing forms, and some of the growth forms cannot be utilised. These plants need to be cut with a brush cutter and the stumps treated with herbicide that was mixed with a dye to show where treatment was done (however stumps must not be removed as they significantly contribute to soil stability).

Integrated strategies to control alien shrubs

- **Alien shrubs that are less than 1 m in height**:
  - Foliar application must be used in the general control of alien shrubs that are less than 1 m in height.
  - Registered herbicide must be used and where grass is present, selective broadleaf herbicide that will not impact on the grass. When grass is not present, a selective or non-selective registered herbicide must be used.
  - For dense seedling growth that are of uniform height a flat fan nozzle with knapsack must be used.
  - For seedling growth that are of uneven height, root suckers, short saplings, and coppice growth a cone nozzle must be used.
- **Alien shrubs that are taller than 1 m (Campbell, 2000):**
  - Shrubs that are taller than 1 m must be reduced cutting using brush cutter or cane knifes.

- When large areas with dense growth are present a tractor mounted gyro-motor must be used.
- For low – medium density infestation a cut stump treatment must be used. Stumps that are must be treated immediately. The best time to treat is during the active growing season.
- Medium – High-density infestations must be slashed to knee height so that the plants can coppice. The best time to do this is during the winter months as the plants are dormant and the coppice will come out during the active growing period after good rain. The coppice must be sprayed when enough leaves are present to absorb the herbicide and a dye must also be used to indicate treated areas.
- Pathways must be cut to increase exposed areas so that a foliar spray treatment is more effective without compromising the indigenous vegetation.
- Mechanical uprooting of shrubs is not always a preferred method because the soil is disturbed and this increases the risk of alien vegetation infestation. Erosion is also promoted by this activity, and soil loss will occur. Mechanical uprooting can be done in areas that have a dense grass cover, as the roots of the grass will keep the soil intact. After uprooting the soil must be leveled and if grass seeds are present, some grass seeds must be placed on these areas to promote grass regrowth.

Integrated strategies to control alien herbs (Campbell, 2000)

- **Chemical Control:**
  - Alien herbs are soft non-woody species.
  - Some of the alien herbs have registered herbicides to control them and are either pre- or post-emergent herbicides.
  - When alien herbs are associated with woody alien plant, herbicides that are registered to control woody alien species are often used to control alien herbs. Alternatively, glyphosate can be used as it is often registered for both alien herb and alien woody species.

Follow up control (Campbell, 2000)

Introduction

Follow-up control is essential to control alien saplings, seedlings and coppice regrowth to achieve and sustain the progress that was made with the initial control work in the initial phase. If the follow up control phase is neglected, the alien infestation will become worse and denser than before the eradication process started. It is essential to sustain the follow up phase because it will prevent the suppression of alien seedlings on planted grasses.

Follow up treatment control must use the following methods:

- Chemical control methods: Only use registered herbicides to control any alien species. Instruction on the herbicide labels must be followed carefully.
- Mechanical control methods
- Biological control methods that are available.

Control methods for dense regrowth

After initial control operations dense regrowth may arise as new regrowth will sprout in the form of stump coppice, seedlings and root suckers.

- **Chemical control / foliar application:**
  - Plants that are less than 1 m in height must be controlled by foliar application.
  - Dense seedling growth must be controlled with knapsack sprayers with a flat fan nozzle.
  - If grass is present, the use of a registered selective herbicide must be used so as to not harm the grass, and if grass is not present a registered non-selective or selective herbicide can be used.
  - Suitable dye must be used at all times to limit over- or under spray of areas.
- **Mechanical control:**
  - Areas with dense seedlings should not be uprooted or hoed out, as these areas will result in soil disturbance and will in return promote flushes and germination of alien seedling growth.
  - When stump density is high, plants should not be cut. This is impractical and there will be many untreated stumps. Instead cut the stumps in dense areas with brush cutters and remove the top growth. Stumps will start to coppice and foliar spay must be used to control the coppice regrowth.

Control methods for low-medium density regrowth

Neglecting to control low-medium density regrowth will result in densification and spreading as well as additional control costs.

- **Chemical control:**
  - Cut stump method must be used and stumps must be cut up to a height of 15 cm and must be sprayed within an hour of cutting the plant with a registered herbicide. Herbicide must be applied with knapsack sprayers set to a low pressure, using cone nozzles e.g. TG1 or CE1. Hand sprayers can also be used to apply herbicide. A suitable dye must be used to ensure all stumps are treated. Only the cut surface must be treated with herbicide and the side of the stumps must not be treated.
  - Foliar spray can be applied to regrowth that is up to the height of 1m. Herbicide must be applied using knapsacks with solid cone nozzle and must be mixed with a suitable dye to prevent over- or under spraying of treated areas.
- **Mechanical control:**
  - Seedlings can be removed from wet soil by hand pulling. Gloves can be used for hand protection during the operation.

ANNEXURE C - TRAINING AND AWARENESS

Training of Construction Workers

Construction workers must receive basic training in environmental awareness, including minimisation of disturbance to all of the freshwater resources and in particular those of increased ecological Importance and sensitivity and the area below the 1:100 year floodline. Construction workers must also be made aware of impacts upon fauna and flora through implementation of a no poaching and collection policy, management of waste and prevention of water pollution.

Contractor Performance

The Contractor must ensure that the conditions of the FRRMP are adhered to. Should the Contractor require clarity on any aspect of the FRRMP the Contractor must contact the Environmental Control Officer (ECO) for advice.
The ECO must regularly audit the operation, and as deemed necessary on a proactive basis, to establish whether the measures in the FRRMP were applied and adhered to. The audit report of the ECO must be submitted to the lead project manager immediately upon completion. The lead project manager must ensure that the FRRMP is implemented and that suitable penalties are in place for non-conformance to the FRRMP by contractors. The ECO should be the designated authority to issue a stop work order if severe non-compliance is taking place by the contractor.

ANNEXURE D – SPECIALIST INFORMATION

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

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, Bedfordview		
Postal code:	1401	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Natural 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

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.