

FRESHWATER ASSESSMENT FOR THE PROPOSED POSTMANSBURG WASTEWATER TREATMENT WORKS

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EXECUTIVE SUMMARY

It is proposed that a new Waste Water Treatment Works (WWTW) be constructed on Farm Olynfontein No.475 Portion 3, Postmasburg to accommodate the growing population of Postmasburg and the growing costs of operating the existing waste water treatment works. This aquatic ecosystem assessment is intended to provide input into the environmental and water use authorisation for the proposed new WWTW and sewer line. Aquatic features which occur within the study area consist of the Groenwaterspruit and its smaller tributaries at Postmasburg; and some largely natural pans and artificial wetland areas. The ecological condition of the Groenwaterspruit at Postmasburg is considered to be largely modified, while the ecological importance and sensitivity of the stream is moderate. In terms of Freshwater Ecosystem Priority Areas (FEPA)s, the Groenwaterspruit is considered to be a River FEPA. Wetland FEPAs also occur within the study area near the existing WWTW.

The pans in the study area are subjected to some physical habitat modification with some flow and water quality modification largely as a result of the surrounding farming and peri-urban activities while the wetland areas have similar impacts but are also subjected to additional flow of treated wastewater from the existing WWTW. In terms of the current ecological state of the wetland areas, they are as a whole considered to be in a moderately modified state, with the smaller pans in general in a less impacted and largely natural ecological state. In terms of goods and services, the pans provide limited goods and services. This is largely due to the fact that they are relatively small in extent. In this sense, the wetland areas provide particular goods and services associated with mitigating the potential impact of the treated wastewater discharge, including some flood attenuation and sediment trapping functionality, as well as mitigating the water quality impacts of the treated wastewater discharge. The pans are all considered to have a moderate Ecological Importance and Sensitivity while the wetland areas associated with the WWTW are of low Ecological Importance and Sensitivity.

Without mitigation the cumulative impact of the new WWTW and sewer line could be expected result in some degradation of the condition of the stream. However, considering the current degraded state of the stream and the impacts of the existing activities, the relative impact would be low. With effective implementation of the recommended mitigation measures, the condition of the stream could be maintained at an acceptable level or even improved. In addition, the proposed new WWTW would result in the decommissioning of the existing WWTW which has altered to characteristic of the pans within the area from being largely ephemeral features to being primarily permanently inundated wetland areas. With the alteration of the proposed discharge of treated wastewater this existing impact on the freshwater features in the area would be eliminated.

Proposed mitigation measures consist of the following recommendations:

- *The proposed sewer pipeline should be constructed within the stream channel where the vegetation has already been completely transformed by past cultivation activities. There should be limited disturbance within the instream and riparian vegetation during the construction phase. After construction, the disturbed area should be rehabilitated, particularly to prevent erosion taking place as well as to prevent the potential colonisation of these areas with invasive alien plants. Rehabilitation requires removal of invasive alien plants from the riparian zone, some landscaping of the stream bank if required and re-vegetation with indigenous riparian plants.*
- *Contaminated runoff from the pipeline installation site should be prevented from directly entering the stream. Construction of the pipeline should preferably not be undertaken in the higher rainfall months when the water quality impacts from the construction activities may impact on the stream.*
- *The construction camp/laydown area should be located away from the stream. All materials on the associated with the construction activities should be properly stored and contained. Disposal of waste from the site should also be properly managed. Construction workers should be given ablution facilities at the*

construction sites that are located away from the river (at least 30m) and regularly serviced. These measures should be addressed, implemented and monitored in terms of the Environmental Management Plan (EMP) for the construction phase.

- All possible measures should be made in the construction of the sewer pipeline adjacent to the stream to prevent any future breakages as a result of flood damage or any spills/overflows from the pipeline from entering the stream. The pipeline should be regularly monitored and maintained to ensure that any problems with the pipeline are rectified before they can impact on the stream.*
- The wastewater from the WWTW should at least comply with the General Limits as required in the General Authorisations for water use. Considering the limited dilution of the final treated wastewater discharged to the stream, it would be preferable to reduce the nutrient concentrations (specifically phosphate) in the treated wastewater to reduce eutrophication of the stream, with the associated nuisance plant growth in downstream impoundments. This could be achieved either by ensuring that the WWTW achieves Special Limit quality in the final treated wastewater or to construct wetland areas within the receiving watercourse to further polish the treated wastewater. Another alternative would be to dispose of the wastewater in another way such as through reuse. To a certain extent the treated wastewater is in fact reused as it flows downstream in the Groenwaterspruit where it would be available for use downstream.*
- The use of the treated wastewater during the drier months should be encouraged to reduce the volumes that need to be discharged to the stream. Creation of a reed bed either within or adjacent to the stream at the discharge point would not only mitigate the quality of the treated wastewater discharged but also the extent of the flow impact on the stream.*
- Monitoring of the ecological state of the stream should take place to allow for adaptive management of the wastewater disposal practice.*

The Department of Water and Sanitation should be approached with regards to the water use authorisation requirements for the proposed activities.

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1. BACKGROUND

1.1. INTRODUCTION

This aquatic ecosystem assessment is intended to provide input into the environmental and water use authorisation for the proposed new wastewater treatment works (WWTW) and sewer line at Postmansburg in the Northern Cape. The total area of the new WWTW will be approximately 10 ha on Farm Olynfontein No.475 Portion 3, Postmasburg. The upgrade of the WWTW is in response to a need for the Tsantsabane Municipality to provide adequate wastewater treatment facilities for increasing development of Postmansburg and the growing costs of operating the existing waste water treatment works. The site is located along the Groenwaterspruit, a minor tributary of the Orange River System in the Lower Vaal Water Management Area.

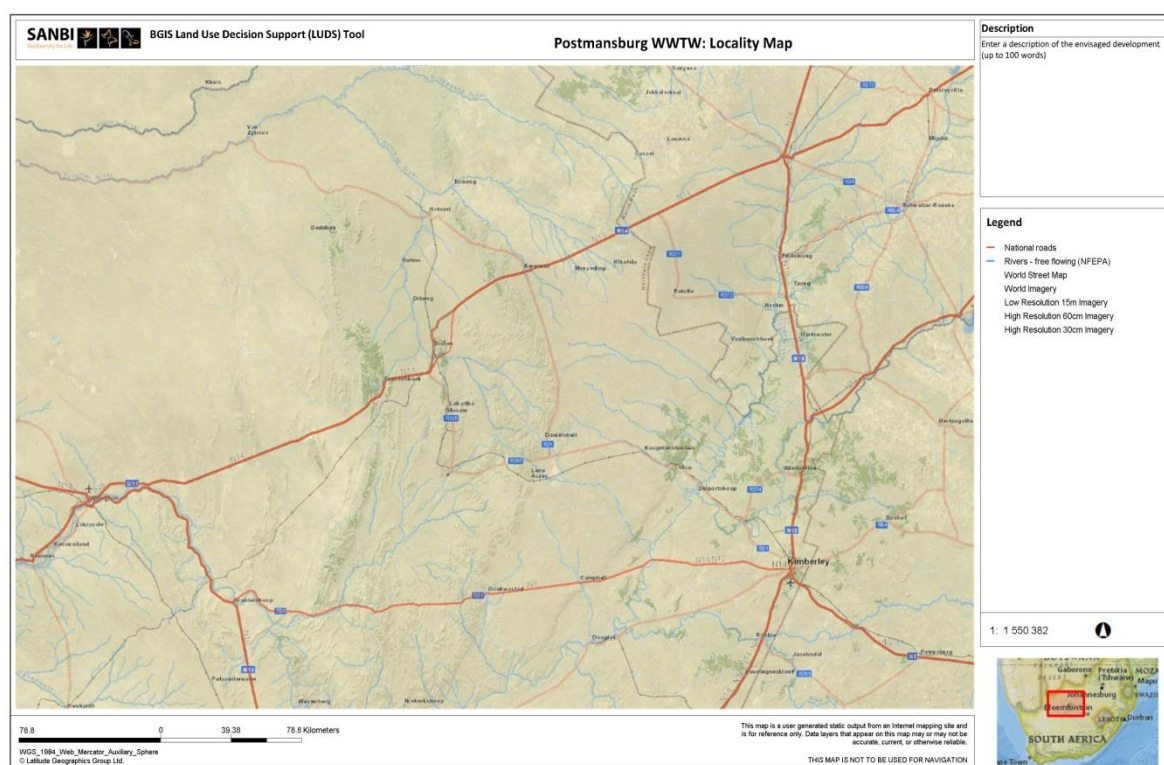


Figure 1: Locality map for the proposed Postmansburg WWTW (SANBI Biodiversity GIS, 2015)

1.2. DESCRIPTION OF PROPOSED DEVELOPMENT

Currently, all wastewater in Postmasburg drains to the Postmasburg Pump Station No.1, which is located to the south of Postmasburg within the Groenwaterspruit. The logical extension would be to extend the existing main sewer downstream to a point where it would daylight and then construct a new wastewater treatment plant there. Calculations have however indicated that the current main sewer, which is only a 300mm diameter pipe, would not be adequate to convey the existing and future flows.

The new wastewater treatment plant will utilize the modified Ludzack-Ettinger process which is a biological nutrient removal process for the removal of carbonaceous and nitrogen based soluble nutrients. This plant utilizes only aerobic processes and as such minimizes the risks for generating offensive odours. The gradient of

the site also allows the raw wastewater to be pumped once after which flow through the treatment plant can take place under gravity.

Given the planned developments in Postmasburg, a flow of 100 litres per second was calculated as being the future Average Dry Weather Flow for Postmasburg. This equates to a wastewater treatment plant with a minimum design capacity of 8 640m³/day. To allow for a percentage of future growth and expansion, 10 000m³/day is proposed as the Average Dry Weather Flow and the minimum required size for a new wastewater treatment plant for the future flows expected to be generated at Postmasburg. It is suggested that the treatment plant be designed in such a manner that modules capable of treating a peak flow of 5000m³/day each are constructed. The plant will have a common inlet works providing facilities for screenings removal, grit removal and flow measurement of a size capable of dealing with current and future peak flows of up to 250 litres per second which equates to a maximum daily flow of 21 600m³ / day.

It should be noted that this flow is not the design capacity of the plant, but the ultimate peak flow which could reasonably be expected during occurrences of high rainfall and as such, only the inlet works is to be designed for this capacity and not the process units within the treatment plant. Postmasburg is located in an arid region, but is subject to heavy thunder showers in summer which can cause flash floods. In addition, the natural water table in the area is quite shallow and the fact that the town's main sewer runs inside a watercourse lends itself to large volumes of water ingress during flood occurrences.

To convey these flows, a new main outfall sewer of at least 600mm diameter is required. Such a sewer will run at 80% capacity for a flow of 100 litres per second providing some space for future runoff. It is planned that this new sewer will be extended from the current position of Postmasburg Pump Station No.1 in a southerly direction following the run of the Groenwaterspruit to a point approximately 1 300m downstream of the town where the pipe will daylight at a gradient of 1 in 200. The proposed sewer line will cross the following erven in Postmasburg: Erf 1, Erf 123, Erf 125, Erf 126, Erf 127, Erf 764, Erf 779, Erf 1504.



Figure 2: Locality plan for the new WWTW and sewer line

1.3. TERMS OF REFERENCE

The terms of reference for the Freshwater assessment are as follows:

- Literature review and assessment of existing information;
- Site Assessment of the proposed activities and impact on the associated freshwater systems. This will include an assessment of the freshwater ecological condition, using river health indices such as in-stream and riparian habitat integrity, aquatic macro-invertebrates and riparian vegetation to determine set back lines and geomorphological condition of the streams, which will then determine the overall Ecstatus of the streams and provide data that will inform the Water Use Licence Application of the project. This will include both the stream to be impacted by the dam development and the pump station establishment;
- Describe ecological characteristics of freshwater systems and compile report based on the data and information collected in the previous two tasks, describe ecological characteristics of the freshwater systems, comment on the conservation value and importance of the freshwater systems and delineate the outer boundary of the riparian zones/riverine corridors;
- Evaluate the freshwater issues on the site and propose mitigation measures and measures for the rehabilitation of the site as well as setback lines for future development; and
- Compilation of the documentation for submission of the water use authorisation application (WULA) to the Department of Water and Sanitation (DWS).

1.4. LIMITATIONS AND ASSUMPTIONS

Input into this report was informed by a combination of desktop assessments of existing freshwater ecosystem information for the study area and catchment, as well as by a more detailed assessment of the freshwater features at the dam site. The site was visited in March 2014. During the field visit, the characterisation and integrity assessments of the freshwater features were undertaken. Mapping of the freshwater features was undertaken using a Garmin Colorado 300 GPS and mapped in PlanetGIS Professional. The SANBI Biodiversity GIS website was also consulted to identify any constraints in terms of fine-scale biodiversity conservation mapping as well as possible freshwater features mapped in the Freshwater Ecosystem Priority Areas maps. This information/data was used to inform the resource protection related recommendations as well as the instream flow requirement determination.

The Reserve or environmental water requirement determination was undertaken at a rapid level (Rapid Reserve) utilising the guidelines for the South African methodologies for water resource protection as outlined in the documentation "Resource Directed Measures for Protection of Water Resources" (DWAF, 1999). Hydrology utilised for the determination of the Reserve was obtained from Water Resources 2005 and was thus undertaken at a desktop level.

Limitations and uncertainties often exist within the various techniques adopted to assess the condition of ecosystems. The following limitations apply to the techniques and methodology utilized to undertake this study:

- Analysis of the freshwater ecosystems was undertaken at a rapid level and did not involve detailed habitat and biota assessments;

- The river health assessment was carried out using South African Department of Water and Sanitation developed methodologies. River Health assessments were carried out to provide information on the ecological condition and ecological importance and sensitivity of the river systems impacted.
- The guideline document, “A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas” document, as published by DWAF (2005) was followed for the delineation of the wetland areas. According to the delineation procedure, the wetlands were delineated by considering the following wetland indicators: terrain unit indicator; Soil form indicator; Soil wetness indicator; and vegetation indicator.
- The wetlands were subsequently classified according to their hydro-geomorphic determinants based on a classification system devised by Kotze *et al* (2004) and SANBI (2009). Notes were made on the levels of degradation in the wetlands based on field experience and a general understanding of the types of systems present.
- A Present Ecological State (PES) assessment was conducted for each hydro-geomorphic wetland unit identified and delineated within the study area. For the purpose of this study, the tool WET-Health as defined in the WET Health Series developed for the Water Research Commission was used to assess the present ecological state of each wetland unit. Each hydro-geomorphic (HGM) unit was thus assessed based on three modules, namely hydrology, geomorphology and vegetation. Once the HGM units were assessed, the results for each assessment unit were then combined to obtain an indication of the health of the wetland system as a whole.
- The functional wetland assessment technique, WET-EcoServices, developed by Kotze *et al* (2009) was used to provide an indication of the ecological benefits and services provided by delineated wetland habitat. This technique consists of assessing a combination of desktop and infield criteria in order to identify the importance and level of functioning of the wetland units within the landscape.
- The ecological importance and sensitivity assessment was conducted according to the guidelines as developed by DWAF (1999).
- Recommendations are made with respect to the adoption of buffer zones within the development site, based on the wetlands/river's functioning and site characteristics.
- A rapid level of environmental water requirements or instream flow requirements was undertaken utilising SPATSIM which relied on modelled hydrological data. This hydrology was extrapolated from the larger D73A catchment hydrology and scaled a portion of the catchment relevant to the proposed activities. It should be noted that the instream flow requirement provided is only determined for the sustainable functioning of the aquatic ecosystem at a desired ecological state.

The level of aquatic assessment and environmental water requirement determination undertaken was considered to be adequate for this study.

1.5 USE OF THIS REPORT

This report reflects the professional judgment of its authors. The full and unedited content of this should be presented to the client. Any summary of these findings should only be produced in consultation with the authors.

2. PHYSICAL CHARACTERISTICS OF THE STUDY SITE

2.1. DESCRIPTION OF FRESHWATER ECOSYSTEMS

Postmasburg is located in the Northern Cape some 180 km east of Upington and 170 km north-west of Kimberley. The surrounding rural landscape is relatively flat rising eastward from the town to approximately 1 300 mamsl. North of the town are the Klipfontein Hills. The proposed new WWTW are located south-west of the town of Postmasburg. The topography slopes down from Postmasburg towards the proposed WWTW and the Groenwaterspruit. In terms of rivers, the study area lies within the valley of the Groenwaterspruit, which discharges into the Orange River as the Soutloop River near Boegoeberg.

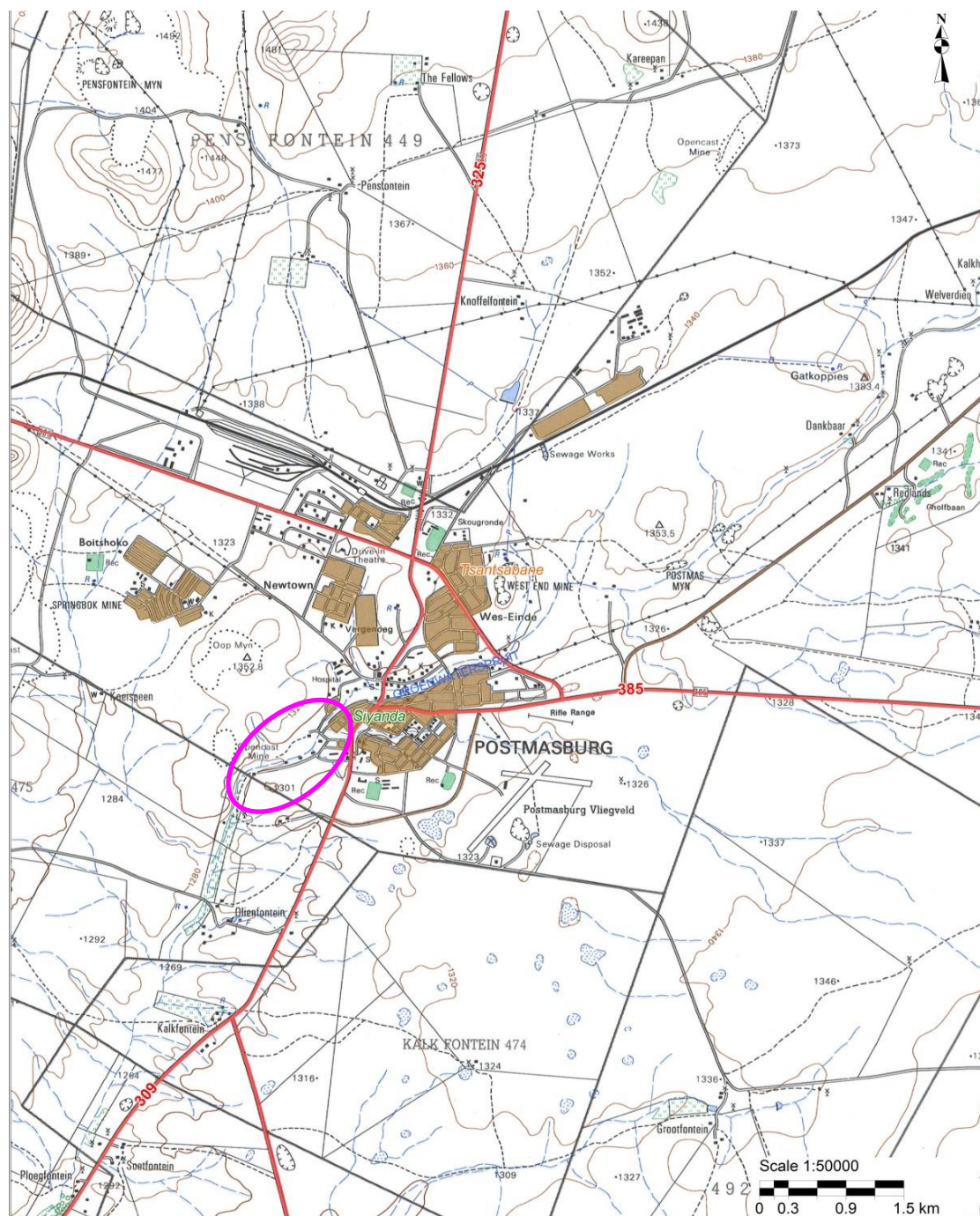


Figure 3. The catchment surrounding Postmansburg (1in 50000 topographical map 3118DA)

Table 1 provides a summary of the main features of the freshwater and hydrological features of the area.

Table 1: Summary of key information related to the water resources which may be impacted by the proposed activities

Descriptor	Name / details	Notes
Water Management Area	Lower Vaal WMA	
Catchment Area	Groenwaterspruit Tributary of the Orange River	
Quaternary Catchment	D73A	
Present Ecological state	Groenwaterspruit (D73A) = A/B (Largely natural)	DWA 1999
EISC – Ecological Importance and Sensitivity	Groenwaterspruit (D73A) = Low	DWA 2013
Type of water resource	Stream and small drainage lines	
Latitude	28°19'55.0"S	Start of Sewer line
Longitude	24°11'59.3"E	
Latitude	28°07'51.5"S	Location of proposed WWTW
Longitude	23°06'11.5"E	
Status of Environmental authorisation process	This freshwater assessment report is prepared as input into the EIA process	
Site visit	Mr Dana Grobler and Ms Toni Belcher	March 2014

2.2 CLIMATE

The area normally receives about 269mm of rain per year, with most rainfall (80%) occurring mainly during summer and autumn (November to April – Figure 4) with very dry winters. The lowest rainfall (0mm) occurs in July and the highest (76mm) in February. The rainfall commonly takes place in the form of thunder showers with a rapid increase in storm water run-off. The average midday temperatures range from 17°C in June to 30°C in January. The region is the coldest during July when the mercury drops below 1°C on average during the night.

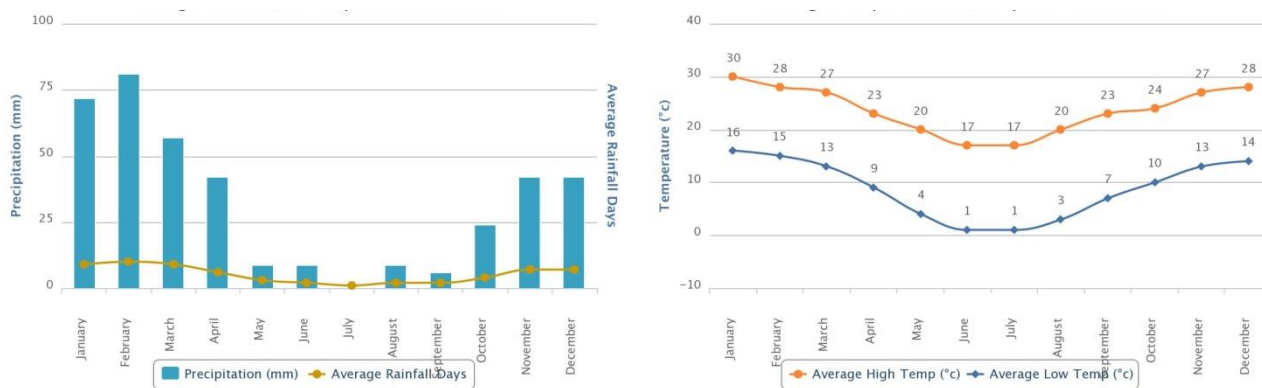


Figure 4: Average monthly rainfall and temperature graphs for the area (worldweatheronline.com)

2.3 GEOLOGY/SOIL

The study area is largely underlain by dolomitic limestone and coarsely crystalline dolomite, chert and limestone of the Ghaap Plateau Formation. The area is covered by relatively recent deposits of surface limestone, calcrete and windblown sand. The windblown sand occurs particularly to the east, west and south of the town along the flanks of the Asbestos Hills Formation.

The soils are shallow on hard or weathering rock with lime present (Figure 5). In general these soils within study area are freely drained, structure-less red soils with a high base status that may have restricted soil depth, excessive drainage, high erodibility and low natural fertility.

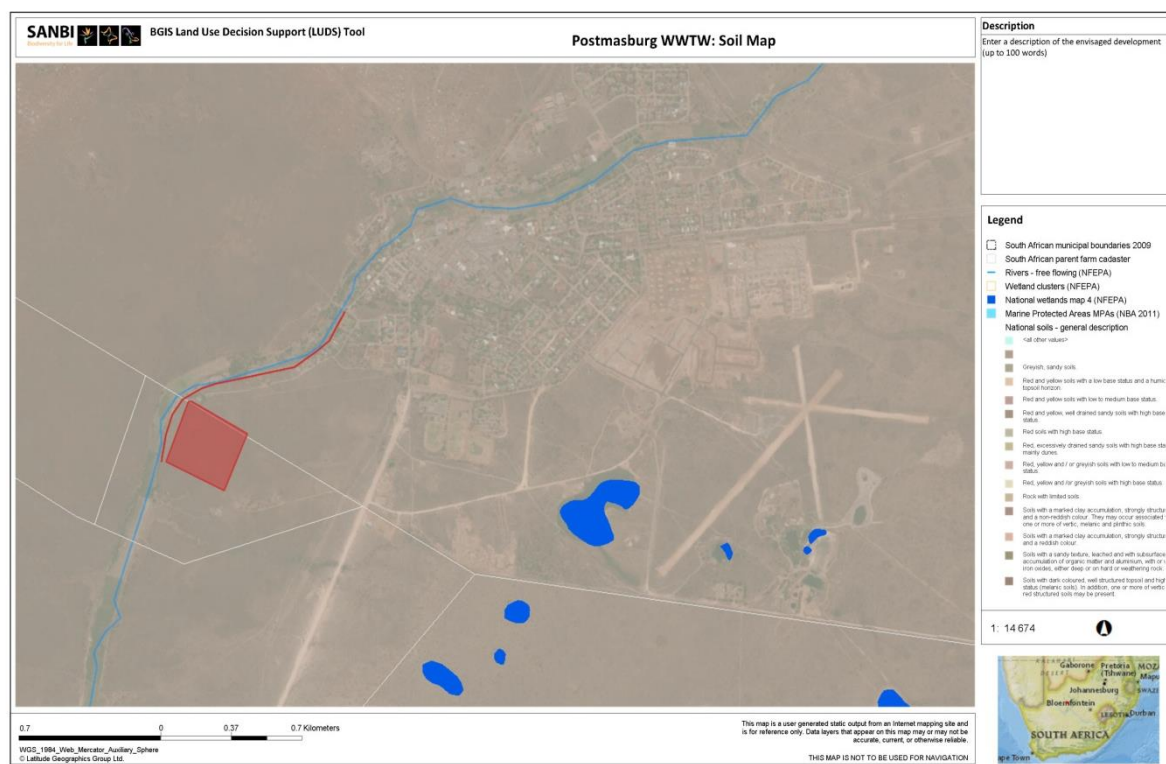


Figure 5: Soils map for the area and surroundings (SANBI Biodiversity GIS, 2015)

2.4. VEGETATION

The study area consists of the following natural vegetation types: Kuruman Thornveld in the north-western portion (tan in Figure 6) and Postmasburg Thornveld in the south-eastern portion (light olive in Figure 6). Kuruman Thornveld occurs on the flat rocky plains and some sloping hills and consists of a closed shrub layer with an open tree cover in which *Acacia erioloba* dominates.

Postmasburg Thornveld is described as an open, shrubby thornveld characterized by a dense shrub layer, often lacking a tree layer, with a sparse grass layer. Shrubs are normally low with a karroid affinity. There are still large portions of these vegetation types remaining and as a result they are both considered to be Least Threatened vegetation types.

Much of the natural vegetation in and surrounding Postmasburg itself have however been lost to urban and peri-urban / agricultural activities. Similarly, the riparian vegetation along the stream is in a modified condition within and immediately upstream and downstream of the town as a result of farming activities taking place along the stream. Trees such as sweet thorn *Acacia karoo*, camel thorn *A. erioloba*, buffalo thorn *Ziziphus mucronata* and a number of alien invasive trees such as mesquite *Prosopis glandulosa* and weeping willow *Salix babylonica* occur.

The instream and wetland vegetation consist largely of exotic grasses and shrubs with the common reed *Phragmites australis* in the wetter areas and the salt marsh rush *Juncus kraussii*. More detail on the vegetation occurring associated with the streams and wetland areas in the study area is provided in the following section.

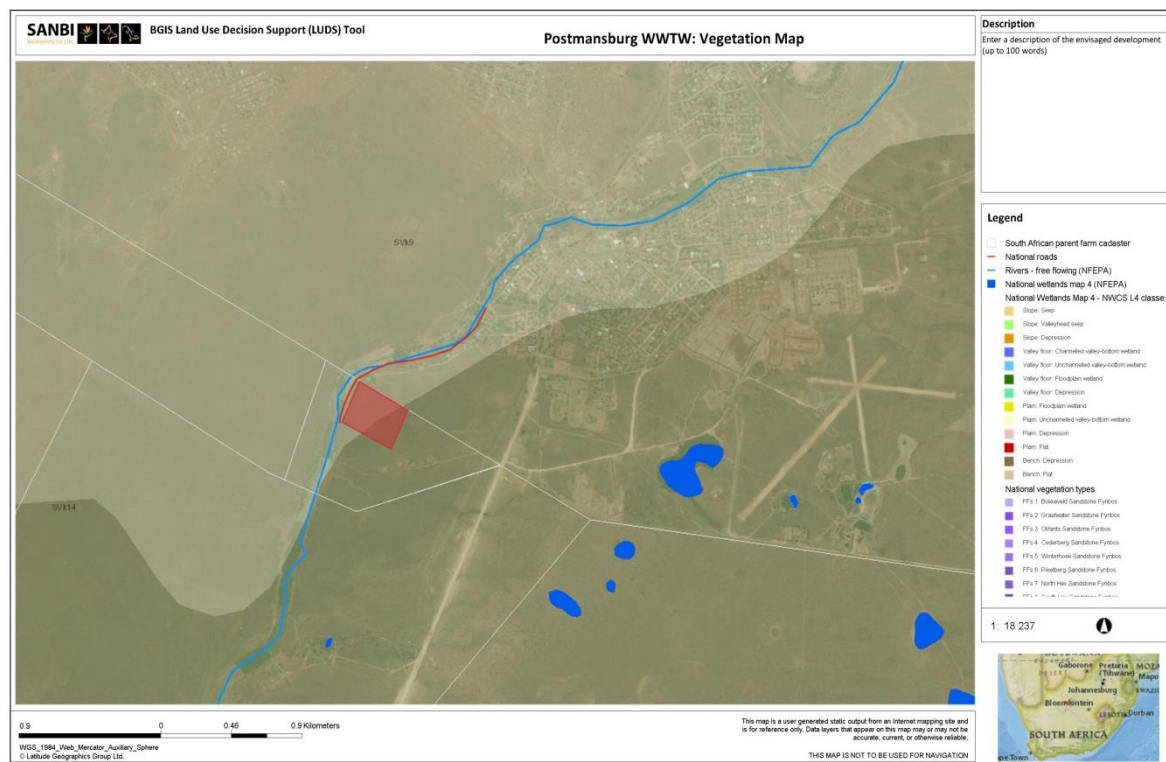


Figure 6. Vegetation types and biodiversity features for the area (Obtained from the SANBI Biodiversity GIS database 2007)

2.5. AQUATIC FEATURES

Aquatic features which occur within the study area include the following (Figure 7):

- The Groenwaterspruit and its smaller tributaries at Postmasburg; and
- Some largely natural pans and artificial wetland areas.

The Groenwaterspruit is a south-west flowing tributary of the Skeifontein River which discharges into the Orange River as the Soutloop River near Boegoeberg. The stream has been significantly modified within the town, with much of the natural indigenous vegetation have been removed and replaced by grassed and cultivated areas. Patches of natural vegetation remain within the Groenwaterspruit and its tributary within the town that tend to be dominated by *A. Karoo* along the banks and *P. australis* and *J. kraussii* within the stream channel. Small ephemeral tributaries and drainage lines also occur within the study area. These features consist of small channels with terrestrial vegetation and little to no visible aquatic habitat.

The wetland areas consist of some natural depression wetland features as well as artificial wetland areas that are associated with the existing WWTW and dominated by *P. australis*. The freshwater features tend to be seasonal, mostly only carrying during the rainy season (March-April) although more permanent wetland areas exist that are linked to the existing WWTW. The freshwater features are described in more detail in the following section.

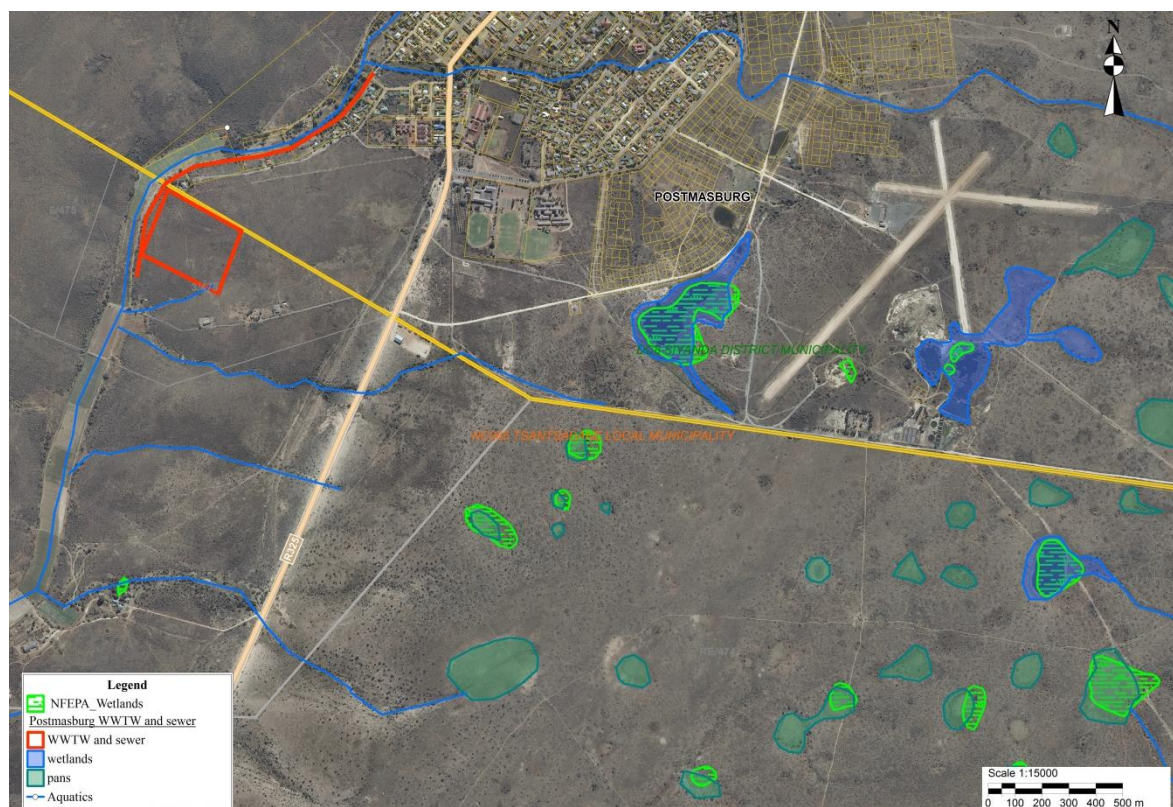


Figure 7: Wetland and river features within the study area



Figure 8. The Groenwaterspruit upstream (top) and downstream (bottom) of Postmasburg



Figure 9. Small tributary of the Groenwaterspruit that drains from the existing WWTW into the stream



Figure 10: The large depression wetland area south of Postmasburg, near the WWTW

2.6. PROTECTED AREAS

In South Africa two sets of mapping initiatives are available for the study area that are of relevance to the conservation and biodiversity importance of the aquatic ecosystems, that is, the Critical Biodiversity Areas (CBA) map and the Freshwater Ecosystem Priority Areas (FEPA) map. Currently no CBA map exists for the study area. Mapping of the threatened ecosystems has been utilized instead to identify conservation worthy areas. This mapping is however largely associated with terrestrial vegetation types. All of the vegetation types in the area are however considered to be least threatened vegetation types.

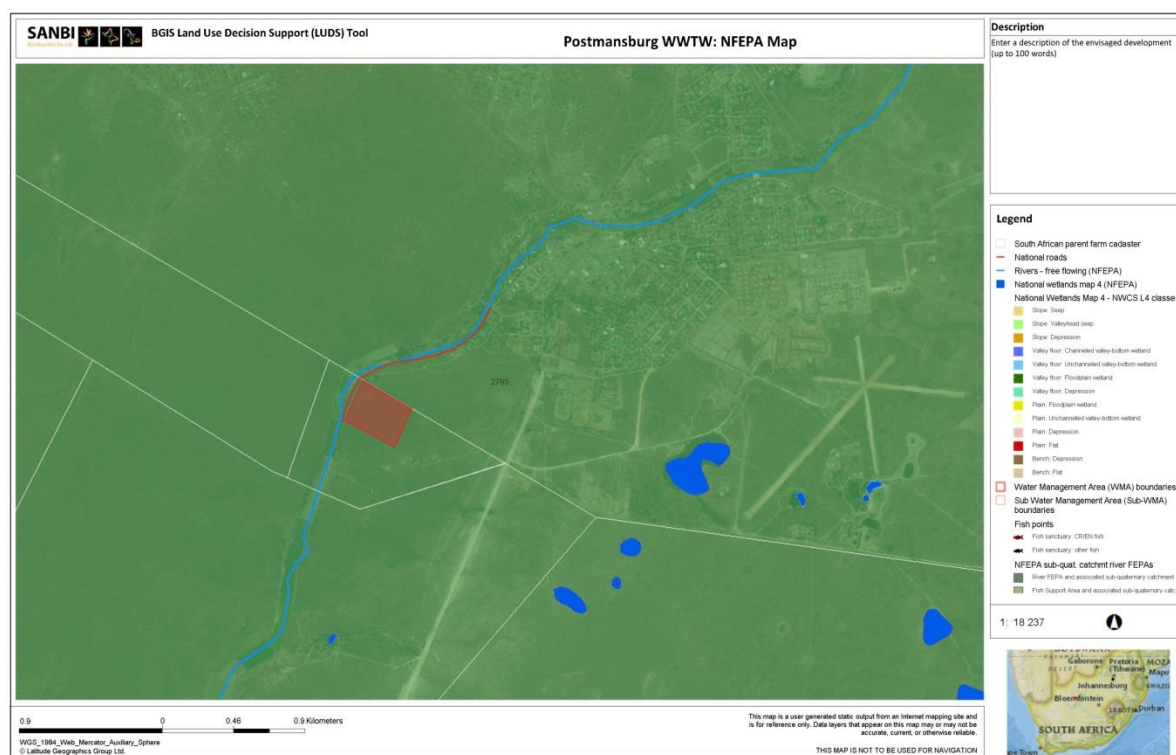


Figure 11: FEPA and threatened ecosystems map for the study area

In terms of FEPAs (Figure 14), the Groenwaterspruit is considered to be a River FEPA (dark green area in Figure 11). River FEPAs are intended to ensure that biodiversity targets for river ecosystems and threatened/near-threatened fish species are achieved, and were identified in rivers that are currently in a good condition (A or B ecological category). Their FEPA status indicates that they should remain in a good condition in order to contribute to the biodiversity goals of the country. Wetland FEPAs also occur within the study area (blue areas in Figure 14). Although wetland condition was a factor in selection of wetland FEPAs, wetlands selected were not necessary in a good condition (A or B ecological category) to be chosen as a FEPA. Wetland FEPAs currently in an A or B ecological condition should be managed to maintain their good condition. Those currently in a condition lower than A or B should be rehabilitated to the best attainable ecological condition.

2.7. LAND USE

The wider Tsantsabane Local Municipal consists of a mixture of land uses of which agriculture and mining is dominant land use within the rural areas. The area is however becoming increasingly urbanised as a result of increased mining (manganese) mining. The residential areas vary from the relatively large town of Postmasburg to small scattered rural communities. There are no formally protected areas within the immediate vicinity. Land use within the study area consists largely of natural areas (pale green areas in Figure 12) to the west of the site, with the urban and peri-urban areas and small holdings to the north and east of the site. Agriculture mainly occurs to the south of the site.

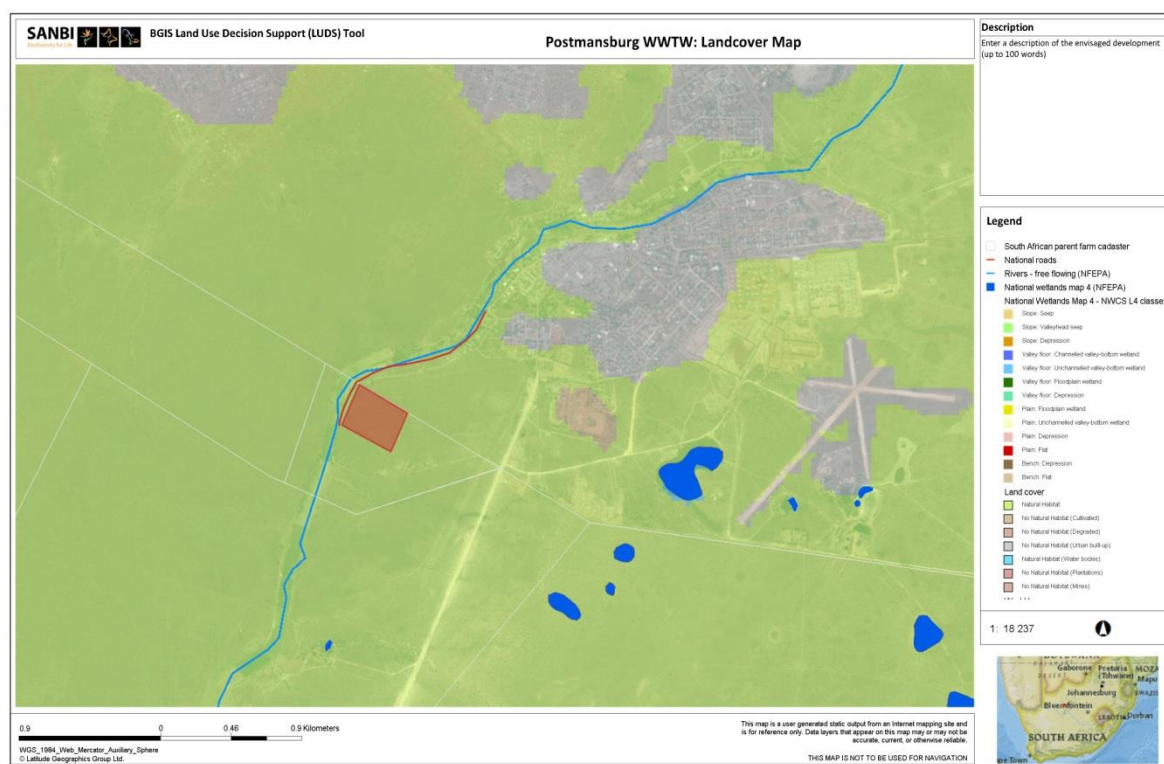


Figure 12. Landcover map for the area (SANBI Biodiversity GIS, 2015)

3. AQUATIC ECOSYSTEM ASSESSMENT

The purpose of the freshwater assessment is to determine the relative importance, sensitivity and current condition (ecological state) of the significant freshwater features in order to assess the impact of proposed development activities on those freshwater resources. The assessment is also required to make recommendations in terms of mitigation measures that can be used to prevent or minimise the impact on the freshwater resources. This assessment of the streams and wetlands identified within the study area is based on existing information as well as the field assessment.

3.1. ASSESSMENT OF THE STREAMS IN THE STUDY AREA

3.1.1. RIVER TYPING AND CHARACTERISATION

The Index for Habitat Integrity (IHI) and Site Characterisation assessments were utilised to provide information on the ecological condition and physical characteristics of the streams and significant drainage lines in the study area (Table 2).

River typing or classification involves the hierarchical grouping of rivers into ecologically similar units so that inter- and intra-river variation in factors that influence water chemistry, channel type, substratum composition and hydrology are best accounted for. Any comparative assessment of river/stream condition should only be done between rivers or streams that share similar physical and biological characteristics under natural conditions. Thus, the classification of rivers/streams provides the basis for assessing their ecological condition and allows comparison between similar river/stream types. The primary classification of rivers and streams is a division into Ecoregions. Rivers within an ecoregion are further divided into sub-regions.

Ecoregions: groups of rivers and streams within South Africa, which share similar physiography, climate, geology, soils and potential natural vegetation (DWAF 1999). For the purposes of this study, the ecoregional classification presented in DWAF (1999), which divides the country's rivers into ecoregions, was used. The area lies within the Southern Kalahari and Ghaap Plateau Ecoregions.

Characteristics of the Southern Kalahari Ecoregion: Lowlands, open hills and mountains with moderate to high relief and plains with low relief. Altitude varies from 500 – 1700m amsl. The natural terrestrial vegetation is a mixture of bushveld types. Rainfall varies from 0 - 500 mm a^{-1} and mean annual temperature is between 14 - 22 °C.

Sub-regions: sub-regions (or geomorphological zones) are groups of rivers, or segments of rivers, within an ecoregion, which share similar geomorphological features, of which gradient is the most important (Rowntree and Wadeson 1999). The use of geomorphological features is based on the assumption that these are a major factor in the determination of the distribution of the biota.

Table 2. Geomorphological and Physical features for the rivers/streams and any significant drainage lines within the study area

River	Groenwaterspruit and its tributaries at Postmasburg
Geomorphological zone	Foothill streams
Lateral mobility or entrenchment	Largely unconfined
Channel form	Simple channel
Channel pattern	Single thread: low sinuosity
Channel type	alluvium
Hydrological Type	Seasonal to ephemeral

3.1.2. HABITAT INTEGRITY

The evaluation of Habitat Integrity (HI) provides a measure of the degree to which a river or stream has been modified from its natural state. The methodology (DWAF, 1999) involves a qualitative assessment of the number and severity of anthropogenic perturbations on a river and the damage they potentially inflict upon the system. These disturbances include both abiotic and biotic factors, which are regarded as the primary causes of degradation of a river. The severity of each impact is ranked using a six-point scale with 0 (no impact), 1 to 5 (small impact), 6 to 10 (moderate impact), 11 to 15 (large impact), 16 to 20 (serious impact) and 21 to 25 (critical impact).

The Habitat Integrity Assessment is based on assessment of the impacts of two components of the river, the riparian zone and the instream habitat. Assessments are made separately for both components, but data for the riparian zone are interpreted primarily in terms of the potential impact on the instream component. The estimated impact of each criterion is calculated as follows:

Rating for the criterion/maximum value (25) x weight (percent)

The estimated impacts of all criteria calculated in this way are summed, expressed as a percentage and subtracted from 100 to arrive at an assessment of habitat integrity for the instream and riparian components respectively. The total scores for the instream and riparian zone components are then used to place the habitat integrity of both in a specific habitat category (Table 3).

Table 3. Habitat Integrity categories (From DWAF, 1999)

Category	Description	Score (%)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. Large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In worst instances, basic ecosystem functions have been destroyed and changes are irreversible.	0

Table 4. Index of Habitat Integrity Assessment results and criteria assessed for Instream and Riparian Habitat of the streams in the study area

Instream Habitat Integrity	Score	Riparian Zone Habitat Integrity	Score
Water Abstraction	10	Vegetation Removal	13
Flow Modification	8	Exotic Vegetation	11
Bed Modification	11	Bank Erosion	8
Channel Modification	14	Channel Modification	14
Water Quality	12	Water Abstraction	9
Inundation	7	Inundation	7
Exotic Macrophytes	12	Flow Modification	8
Exotic Fauna	4	Water Quality	8
Rubbish Dumping	8		
Integrity Class	D	Integrity Class	D

The habitat integrity of the Groenwaterspruit and its tributary are in a largely modified ecological state. The riparian habitat of the stream and its tributary are more impacted by the surrounding farming and urban activities.

3.1.3. ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)

The EIS assessment considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a scale (Table 5). The median of the resultant score is calculated to derive the EIS category (Table 6).

Table 5. Definition of the scale used to assess biotic and habitat determinants indicate either importance or sensitivity

Scale	Definition
1	One species/taxon judged as rare or endangered at a local scale.
2	More than one species/taxon judged to be rare or endangered on a local scale.
3	One or more species/taxon judged to be rare or endangered on a Provincial/regional scale.
4	One or more species/taxon judged as rare or endangered on a National scale (i.e. SA Red Data Books)

Table 6. Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General description	Range of median
Very high	Quaternaries/delineations that are considered to be unique on a national and international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3-4
High	Quaternaries/delineations that are considered to be unique on a national scale based on their biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases may have substantial capacity for use.	>2-≤3
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are not usually very sensitive to flow modifications and often have substantial capacity for use.	>1-≤2
Low/marginal	Quaternaries/delineations that are not unique on any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have substantial capacity for use.	≤1

Table 7. Results of the EIS assessment for the tributaries within the study area

Biotic Determinants	Groenwaterspruit
Rare and endangered biota	1
Unique biota	1
Intolerant biota	1
Species/taxon richness	1
Aquatic Habitat Determinants	
Diversity of aquatic habitat types or features	2
Refuge value of habitat type	2
Sensitivity of habitat to flow changes	2
Sensitivity of flow related water quality changes	2
Migration route/corridor for instream and riparian biota	2
National parks, wilderness areas, Nature Reserves, Natural Heritage sites & areas, PNEs	0
Median	1.3
EIS CATEGORY	Moderate

The ecological importance and sensitivity of the Groenwaterspruit within the study area is deemed to be moderate.

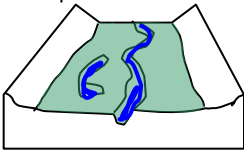
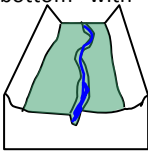
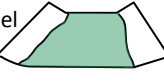


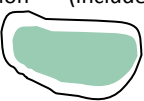
3.2. WETLAND ASSESSMENT

The wetland assessment consists of the following aspects: Wetland classification; Wetland integrity; and Ecosystem services supplied by the wetland.

3.2.1. WETLAND CLASSIFICATION

The classification of the wetlands in the study area into different wetland types was based on the WET-EcoServices technique (Kotze *et al*, 2005). The WET-EcoServices technique identifies seven main types of wetland based on hydro-geomorphic characteristics (Table 8).

Table 8. Wetland hydro-geomorphic types typically supporting inland wetlands in South Africa

Hydro-geomorphic types	Description	Source of water maintaining the wetland ¹	
		Surface	Sub-surface
	Valley bottom areas with a well-defined stream channel, gently sloped & characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
	Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***
	Valley bottom areas with no clearly defined stream channel usually gently sloped and characterized by alluvial sediment deposition, generally leading to accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
	Slopes on hillsides, which are characterized by colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel.	*	***
	A basin shaped area with a closed elevation contour that allows for accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.	*/ ***	*/ ***

¹ Precipitation is an important water source and evapotranspiration an important output

Water source: * Contribution usually small

*** Contribution usually large

*/ *** Contribution may be small or important depending on local circumstances

 Wetland

According to Table 8 the pans/wetland features within the study area can be classified as follows:

Table 9: Classification of wetland areas within study area

Name	Pans south of Postmasburg	Wetland areas south of Postmasburg
System	Inland	
Ecoregion	Southern Kalahari Ecoregion	
Landscape setting	Depression on a slopes or benches	
Longitudinal zonation	Not applicable	
Drainage	Endorheic (water mostly exists by means of infiltration and evaporation)	
Seasonality	Seasonal to Ephemeral	Seasonal to Permanent
Anthropogenic influence	Some disturbances due to farming, peri-urban and infrastructure development	Agricultural and peri-urban disturbance as well as treated wastewater discharge
Geology	dolomites, limestone and chert	
Vegetation	Primarily Kuruman Thornveld	Primarily Postmasburg Thornveld
Substrate	Sand/loam	Clay
Salinity	Fresh becoming saline	Fresh

3.2.2. WETLAND INTEGRITY

The Present Ecological Status (PES) Method (DWAf 2005) was used to establish the integrity of the wetlands/pans in the study area and was based on the modified Habitat Integrity approach developed by Kleynhans (DWAf, 1999; Dickens *et al*, 2003). Tables 10 and 11 show the criteria and results from the assessment of the habitat integrity of the wetlands. These criteria were selected based on the assumption that anthropogenic modification of the criteria and attributes listed under each selected criterion can generally be regarded as the primary causes of the ecological integrity of a wetland.

Table 10. Habitat integrity assessment criteria for palustrine wetlands (Dickens *et al*, 2003)

Criteria & Attributes	Relevance
Hydrologic	
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.
Water Quality	
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.
Hydraulic/Geomorphic	
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities that reduce or change wetland habitat directly in inundation patterns.
Biota	
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.
Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).
Alien Fauna	Presence of alien fauna affecting faunal community structure.
Over utilisation of Biota	Overgrazing, over fishing, etc.

Table 11. Wetland habitat integrity assessment (score of 0=critically modified to 5=unmodified)

Criteria & Attributes	Depression pans	Wetlands associated with the WWTW
Hydrologic		
Flow Modification	3.8	2.0
Permanent Inundation	3.5	1.8
Water Quality		
Water Quality Modification	3.4	2.7
Sediment Load Modification	3.5	2.9
Hydraulic/Geomorphic		
Canalisation	3.6	3.0
Topographic Alteration	3.6	2.7
Biota		
Terrestrial Encroachment	3.6	2.5
Indigenous Vegetation Removal	3.5	2.7
Invasive Plant Encroachment	3.5	3.0
Alien Fauna	3.0	3.0
Over utilisation of Biota	3.5	2.5
Total Mean	3.5	2.6
Category	B (largely natural)	C (moderately modified)

The pans in the study area are subjected to some physical habitat modification with some flow and water quality modification largely as a result of the surrounding farming and peri-urban activities while the wetland areas have similar impacts but are also subjected to additional flow of treated wastewater from the existing WWTW. In terms of the current ecological state of the wetland areas, they are as a whole considered to be in a moderately modified state, with the smaller pans in general in a less impacted and largely natural ecological state.

Table 12. Relation between scores given and ecological categories

Scoring Guidelines Per Attribute*	Interpretation of Mean* of Scores for all Attributes: Rating of Present Ecological Status Category (PESC)
Natural, unmodified - score=5.	Within general acceptable range CATEGORY A >4; Unmodified, or approximates natural condition.
Largely natural - score=4.	CATEGORY B >3 and <4; Largely natural with few modifications, but with some loss of natural habitats.
Moderately modified - score=3.	CATEGORY C >2 and <3; moderately modified, but with some loss of natural habitats.
Largely modified - score=2.	CATEGORY D <2; largely modified. A large loss of natural habitats and basic ecosystem functions has occurred. OUTSIDE GENERALLY ACCEPTABLE RANGE
Seriously modified - rating=1.	CATEGORY E >0 and <2; seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
Critically modified - rating=0.	CLASS F 0; critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

3.2.3. ECOSYSTEM SERVICES SUPPLIED BY THE WETLANDS

The assessment of the ecosystem services supplied by the wetland / pan areas was conducted according to the guidelines as described by Kotze *et al* (2005). An assessment was undertaken that examines and rates the services listed in Table 13. The characteristics were scored according to the general levels of services provided. It is important to ensure that these pans and wetland area can continue to provide the valued goods and services.

Table 13. Goods and services assessment results for wetland (high=4; low=0)

Goods and services	Depression pans	Wetlands associated with the WWTW
Flood attenuation	2.0	2.5
Stream flow regulation	1.5	2.5
Sediment trapping	1.5	2.5
Phosphate trapping	1.5	2.5
Nitrate removal	1.0	2.0
Toxicant removal	1.0	2.0
Erosion control	1.0	1.5
Carbon storage	1.0	1.0
Maintenance of biodiversity	2.5	2.0
Water supply for human use	0.5	1.0
Natural resources	0.5	1.0
Cultivated foods	0.0	0.5
Cultural significance	0.0	0.5
Tourism and recreation	0.0	0.0
Education and research	0.0	0.0

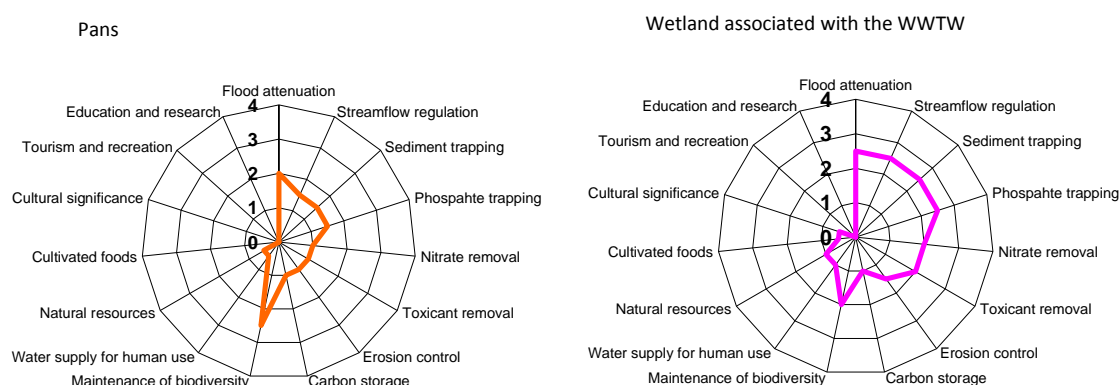


Figure 13. Ecosystem services provided by the wetland area in the study area

From Figure 13 it can be seen that, in terms of goods and services, the pans provide limited goods and services. This is largely due to the fact that they are relatively small in extent. In this sense, the wetland areas provide particular goods and services associated with mitigating the potential impact of the treated wastewater discharge, including some flood attenuation and sediment trapping functionality, as well as mitigating the water quality impacts of the treated wastewater discharge.

3.2.4. ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)

The EIS assessment undertaken for the wetland areas follows the same approach as that undertaken for the river and streams in the area and described in Section 3.1.3.

Table 14: Results of the EIS assessment for the wetlands assessed

Biotic Determinants	Depression pans	Wetlands associated with the WWTW
Rare and endangered biota	0	0
Unique biota	1.0	0
Intolerant biota	1.5	0
Species/taxon richness	1.0	1.4
Aquatic Habitat Determinants		
Diversity of aquatic habitat types or features	1.0	1.1
Refuge value of habitat type	1.0	1.5
Sensitivity of habitat to flow changes	2.0	0.5
Sensitivity of flow related water quality changes	2.0	0.5
Migration route/corridor for instream and riparian biota	0.5	0.5
National parks, wilderness areas, Nature Reserves, Natural Heritage sites, Natural areas, PNEs	0.5	0.5
EIS Category	Moderate/low	low

The pans are all considered to have a moderate Ecological Importance and Sensitivity while the wetland areas associated with the WWTW are of low Ecological Importance and Sensitivity.

4. ENVIRONMENTAL WATER REQUIREMENTS

4.1 WATER QUANTITY

This section provides recommendations on the environmental water requirements (EWR) or ecological Reserve for the upper Groenwaterspruit Stream downstream of the proposed Postmasburg WWTW. The Desktop Reserve model was used to determine the flow requirements, where it was extrapolated to the catchment area of the Groenwaterspruit Stream Catchment downstream of the WWTW (816 km² as shown in Figure 14) which equates to approximately 25% of the Quaternary Catchment D73A.

The mean annual runoff (MAR) for the quaternary catchment was estimated in Water Resources 1990 (WR90) to be 47.2 million cubic meters (MCM). During the update in 2005 (WR2005) the catchment was indicated to be entirely endorheic with a MAR of 0 MCM. However if one looks at the stream at the WWTW, it is clear that this is not the case for this upper portion of the catchment. The MAR for WR90 was thus utilized to determine the EWR.

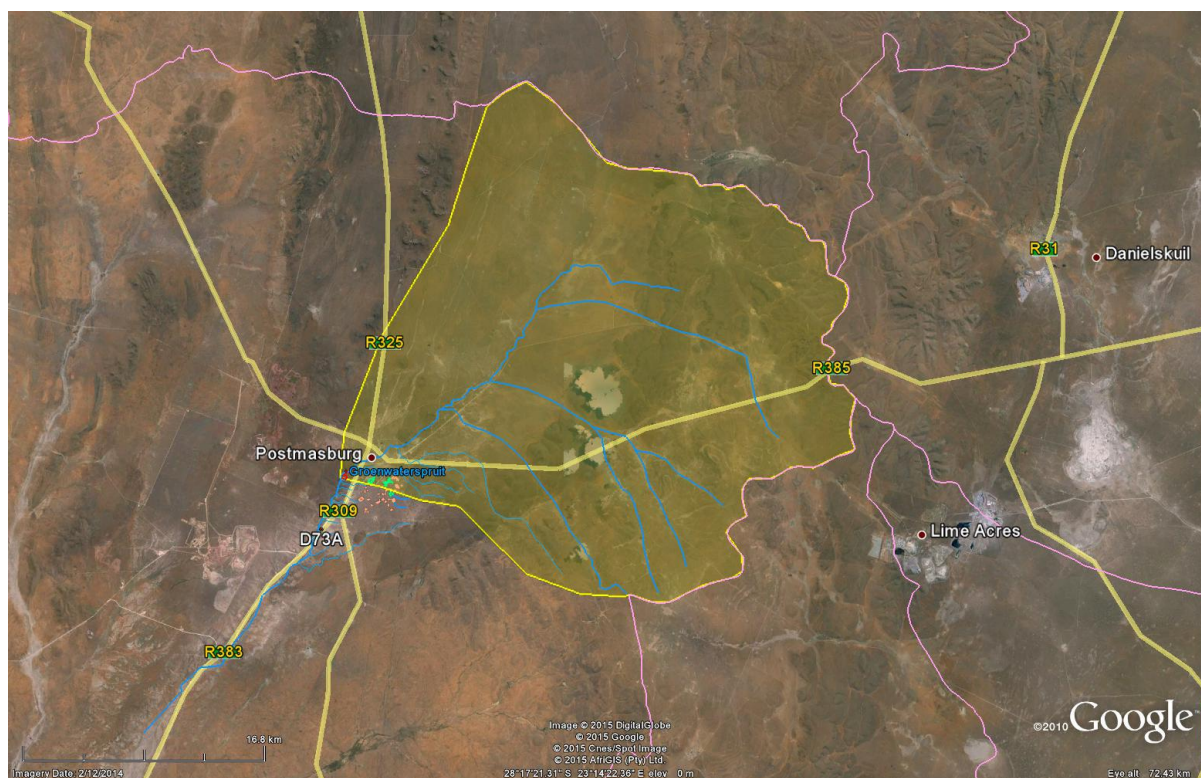


Figure 14. The Groenspruit Catchment Area, delineated in Google Earth

The following distribution curves (Figure 15), Reserve table (Table 15) and rule curves (Table 16) were generated for the Groenwaterspruit for a C category ecological state. It should be noted that the output from the Desktop Reserve model does not provide recommendations relating to the capping of flows which is the more applicable criteria for decision making regarding the impact of treated wastewater releases on the downstream ecosystem.

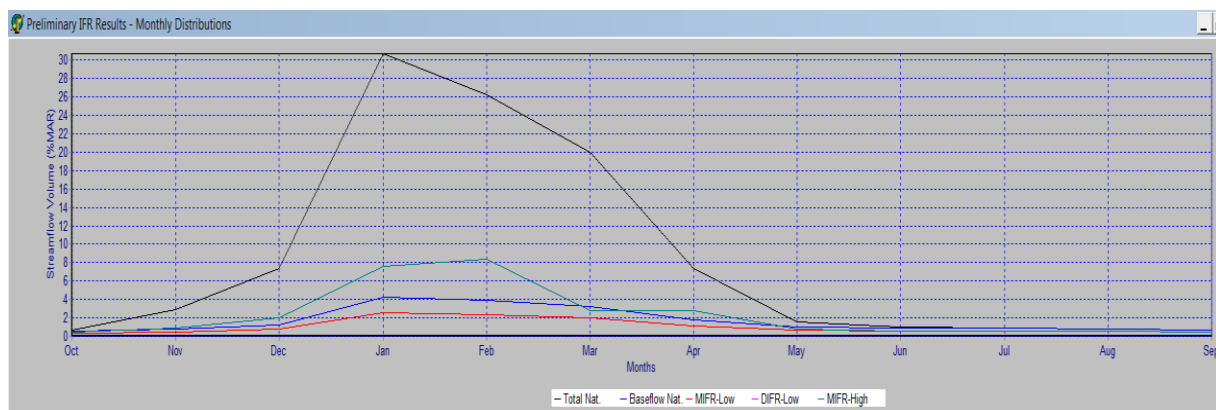


Figure 15. Monthly Distribution curve

Where:

The black line is the natural flow distribution

The blue line is the natural baseflow (mostly groundwater contribution)

MIFR – Low is the Maintenance Low Flow Environmental requirement (red line on graph)

DIFR – Low is the Drought Low Flow Environmental requirement (pink line on graph)

MIFR – High is the Maintenance High Flow Environmental requirement –larger floods and freshets within year (green line on graph)

Table 15. Environmental flow requirement for the Upper Groenwaterspruit downstream of the proposed Postmasburg WWTW

Summary of Desktop (Version 2) estimate for the Upper Groenwaterspruit downstream of the proposed Postmasburg WWTW (Quaternary Catchment Areas D73A extrapolated to 28°20'27"S and 23°02'55"E):							
Annual Flows (Mill. cu. m or index values):							
MAR = 0.435							
S.Dev. = 0.772							
CV = 1.774							
Q75 = 0.000							
Q75/MMF = 0.000							
BFI Index = 0.199							
CV(JJA+JFM) Index = 4.258							
Ecological Category = C							
Total IFR = 0.081 (18.62 %MAR)							
Maint. Lowflow = 0.030 (6.86 %MAR)							
Drought Lowflow = 0.000 (0.00 %MAR)							
Maint. Highflow = 0.051 (11.75 %MAR)							
Monthly Distributions (Mill. cu. m.)							
Distribution Type : E.Karoo							
Month	Natural Flows			Modified Flows (IFR)			
	Mean	SD	CV	Low flows		High Flows	Total Flows
				Maint.	Drought	Maint.	Maint.
Oct	0.003	0.006	2	0.001	0	0	0.001
Nov	0.012	0.035	2.808	0.001	0	0.001	0.003
Dec	0.032	0.097	3.051	0.002	0	0.004	0.006
Jan	0.134	0.388	2.904	0.006	0	0.017	0.023
Feb	0.114	0.34	2.98	0.006	0	0.02	0.026
Mar	0.087	0.18	2.076	0.005	0	0.003	0.008
Apr	0.032	0.065	2.033	0.003	0	0.006	0.008
May	0.007	0.016	2.341	0.002	0	0	0.002
Jun	0.004	0.007	1.565	0.001	0	0	0.001
Jul	0.003	0.006	1.624	0.000	0	0	0.000
Aug	0.002	0.005	1.626	0.000	0	0	0
Sep	0.002	0.005	1.765	0.000	0	0	0

Table 16. Environmental flow requirement for the Upper Groenwaterspruit downstream of the proposed Postmasburg WWTW

Summary of Desktop (Version 2) estimate for the Upper Groenwaterspruit downstream of the proposed Postmasburg WWTW (Quaternary Catchment Areas D73A extrapolated to 28°20'27"S and 23°02'55"E): Regional Type : E.Karoo Ecological Category = C										
Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.001	0	0	0	0	0	0	0	0	0
Nov	0.002	0.001	0.001	0	0	0	0	0	0	0
Dec	0.003	0.003	0.001	0.001	0	0	0	0	0	0
Jan	0.013	0.011	0.007	0.003	0.001	0.001	0.001	0.001	0	0
Feb	0.031	0.02	0.005	0.003	0.001	0.001	0.001	0	0	0
Mar	0.007	0.004	0.001	0.001	0	0	0	0	0	0
Apr	0.009	0.005	0.001	0	0	0	0	0	0	0
May	0.001	0.001	0	0	0	0	0	0	0	0
Jun	0.001	0.001	0	0	0	0	0	0	0	0
Jul	0.001	0.001	0	0	0	0	0	0	0	0
Aug	0.001	0.001	0	0	0	0	0	0	0	0
Sep	0.001	0.001	0	0	0	0	0	0	0	0
Reserve Flows without High Flows										
Oct	0.001	0	0	0	0	0	0	0	0	0
Nov	0.001	0.001	0	0	0	0	0	0	0	0
Dec	0.001	0.001	0.001	0	0	0	0	0	0	0
Jan	0.004	0.003	0.002	0.001	0	0	0	0	0	0
Feb	0.004	0.003	0.002	0.001	0	0	0	0	0	0
Mar	0.003	0.002	0.001	0	0	0	0	0	0	0
Apr	0.002	0.001	0.001	0	0	0	0	0	0	0
May	0.001	0.001	0	0	0	0	0	0	0	0
Jun	0.001	0.001	0	0	0	0	0	0	0	0
Jul	0.001	0.001	0	0	0	0	0	0	0	0
Aug	0.001	0.001	0	0	0	0	0	0	0	0
Sep	0.001	0.001	0	0	0	0	0	0	0	0
Natural Duration curves										
Oct	0.004	0.002	0.001	0.001	0	0	0	0	0	0
Nov	0.018	0.004	0.002	0.001	0.001	0	0	0	0	0
Dec	0.035	0.011	0.007	0.004	0.003	0.001	0.001	0	0	0
Jan	0.117	0.048	0.018	0.007	0.004	0.002	0.001	0.001	0	0
Feb	0.188	0.043	0.019	0.008	0.003	0.001	0.001	0	0	0
Mar	0.137	0.032	0.02	0.008	0.003	0.001	0.001	0.001	0	0
Apr	0.042	0.019	0.009	0.003	0.001	0.001	0.001	0	0	0
May	0.007	0.004	0.002	0.001	0.001	0.001	0	0	0	0
Jun	0.005	0.003	0.002	0.001	0.001	0	0	0	0	0
Jul	0.001	0.001	0.001	0	0	0	0	0	0	0
Aug	0.001	0.001	0.001	0	0	0	0	0	0	0
Sep	0.001	0.001	0.001	0	0	0	0	0	0	0

Normally, the implication of the environmental flow requirements for a treated wastewater discharge into the river is that the seasonal variability within the river should be maintained as far as possible through the capping of treated wastewater discharges to the river particularly during the drier winter months. This would mean that as far as possible, the treated wastewater should rather be reused in summer than releasing it to the river. For the Groenwaterspruit Stream however, the catchment is entirely endorheic which implies that flow in the stream will tend to infiltrate into subsurface rather than remain as surface water flow. The impact

of the proposed treated wastewater is thus likely only have a limited impact in terms of the extent of aquatic habitat that would be negatively impacted by the elevated flows during the dry period.

4.2 WATER QUALITY

The most recent final treated wastewater analysis results are presented in Table 17 along with the general limit for the discharge of treated wastewater to a water resource.

Table 17. Physical water quality and nutrients of the final treated wastewater

Constituent	General Limit	Special Limit	Final Treated Wastewater
pH	5.5-9.5	5.5-7.5	7.6
Electrical Conductivity (EC) mS/m	70 mS/m above background to a max of 150 mS/m	50 mS/m above background to a max of 100 mS/m	120
Ammonia mg/l	6	2	4
Nitrate/Nitrite (NO ₂ /NO ₃) mg/l	15	1.5	5.1
OrthoPhosphate (PO ₄) mg/l	10	1	7.7
Suspended Solids (SS) mg/l	25	10	4
Chemical Oxygen Demand (COD)	75	30	8.7
Fluoride mg/l	1	1	1
Faecal coliforms (per 100ml)	1000	0	0
Free chlorine mg/l	0.25	0	0

There is no surface water data available for the water resources in the area, only groundwater. The electrical conductivity of the groundwater is about 110 mS/m while nutrients (NO₂/NO₃ and PO₄) are mostly less than 10 mg/l and 1 mg/l respectively. Considering that there will be little to no dilution of the treated wastewater discharged into the stream and that the treated wastewater will infiltrate into the ground rather than flow within the stream for most of the year, the final quality of the treated wastewater should comply with the General Limit as provided above as a minimum. As the stream channel will to a large extent become a final treatment pond of the WWTW, it is recommended that the phosphates within the final effluent be removed as much as possible over and above that required for the General Limit. The establishment of a reed bed adjacent to or within the stream channel would assist to mitigate the potential impact of the treated wastewater discharge on the stream system.

5. LEGISLATIVE AND CONSERVATION PLANNING REQUIREMENTS

This proposed Postmasburg WWTW needs to take cognizance of the legislative requirements, policies, strategies, guidelines and principals of the relevant regulatory documents such as the National Water Act (NWA) and the National Environmental Management Act (NEMA).

5.1. NEMA AND ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS

NEMA is the overarching piece of legislation for environmental management in South Africa and includes provisions which must be considered in order to give effect to the general objectives of integrated environmental management. These provisions are contained in Section 24 (4)(a)(b) of the Act, and will be considered during the EIA process. Chapter Seven of the NEMA states that:

“Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or

recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment”.

The Act also clearly states that the landowner, or the person using or controlling the land, is responsible for taking measures to control and rectify any degradation. These may include measures to:

- “(a) investigate, assess and evaluate the impact on the environment;
- (b) inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;
- (c) cease, modify or control any act, activity or process causing the pollution or degradation;
- (d) contain or prevent the movement of pollutants or degradation: or
- (e) eliminate any source of pollution or degradation: or
- (f) remedy the effects of the pollution or degradation.”

Activities listed in terms of Chapter 5 of NEMA in Government Notice No. R. 983, 984 and 985, dated 4 December 2014, trigger a mandatory Basic Assessment, or even a full scoping EIA process, prior to development.

The National Environmental Management Second Amendment Act (Act No.8 of 2004) provided for formal procedures for offenders in terms of Section 24G to apply for rectification of the unlawful commencement of listed activities.

5.2. NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998)

The NWA guides the management of water in South Africa as a common resource. The Act aims to regulate the use of water and activities (as defined in Part 4, Section 21 of the NWA), which may impact on water resources through the categorisation of ‘listed water uses’ encompassing water abstraction and flow attenuation within catchments as well as the potential contamination of water resources, where the DWS is the administering body in this regard.

Defined water use activities require the approval of DWS in the form of a General Authorisation or Water Use Licence authorisation. Government Notice No. 665 of 6 September 2013 provides for General Authorisations for certain specified water use activities in terms of the disposal of wastewater which then do not require a licensing process. There are restrictions on the extent and scale of listed activities for which General Authorisations apply.

Section 22(3) of the National Water Act allows for a responsible authority (DWS) to dispense with the requirement for a Water Use Licence if it is satisfied that the purpose of the Act will be met by the grant of a licence, permit or authorisation under any other law.

Potential water use activities that are of relevance to the proposed upgrade activities for the WWTW are:

- Section 21(c): Impeding or diverting the flow of water in a watercourse;
- Section 21(e): Engaging in a controlled activities, identified as such in Section 37(1)(a): Irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterwork;

- Section 21(f): Discharge of waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit;
- Section 21(g): Disposing of waste in a manner which may detrimentally impact on a water resource; and
- Section 21(i): Altering the bed, banks, course or characteristics of a watercourse.

DWS will need to be approached to provide guidance on which water uses would need to be applied for an authorised.

6. IMPACT ASSESSMENT

6.1. DESCRIPTION OF POTENTIAL IMPACTS

This section provides an assessment of the impacts to freshwater ecosystems that are likely to be associated with proposed new Postmasburg WWTW and sewer line. The description of the impacts is divided up into the various proposed activities, that is:

- Sewer line adjacent to the Groenwaterspruit; and
- The disposal of treated wastewater from the proposed new WWTW into the Groenwaterspruit.

6.1.1 DESCRIPTION OF IMPACTS FOR THE PROPOSED PIPELINE:

Impact - loss of riparian/wetland habitat and bed/bank modification: With the proposed construction of the sewer pipeline along the Groenwaterspruit, it is probable that the instream and riparian vegetation of the stream may be impacted.

Significance of impacts without mitigation: Low negative impact - As the instream and riparian vegetation are in a degraded state, the potential impact on this already degraded system is expected to be small and largely limited to the corridor of the pipeline.

Proposed mitigation: The proposed pipeline should be constructed within the stream channel where the vegetation has already been completely transformed by past cultivation activities. There should be limited disturbance within the instream and riparian vegetation during the construction phase. After construction, the disturbed area should be rehabilitated, particularly to prevent erosion taking place as well as to prevent the potential colonisation of these areas with invasive alien plants. Rehabilitation requires removal of invasive alien plants from the riparian zone, some landscaping of the stream bank if required and re-vegetation with indigenous riparian plants.

Significance of impacts after mitigation: A negative impact of a very low significance

Impact - water quality impairment: With construction activities in and adjacent to the stream, there is a short-term risk of water quality impacts on the downstream aquatic ecosystem. These relate mostly to increased turbidity as result of increased availability of sediment from the disturbance of the vegetated cover which may be transported to the stream in the runoff water. Over the longer term, there is a risk of sewerage spills or overflows into the stream.

Significance of impacts without mitigation: Short and longer term medium to low negative impact

Proposed mitigation: Contaminated runoff from the pipeline installation site should be prevented from directly entering the stream. Construction of the pipeline should preferably not be undertaken in the higher rainfall months when the water quality impacts from the construction activities may impact on the stream.

The construction camp/laydown area should be located away from the stream. All materials on the associated with the construction activities should be properly stored and contained. Disposal of waste from the site should also be properly managed. Construction workers should be given ablution facilities at the construction sites that are located away from the river (at least 30m) and regularly serviced. These measures should be addressed, implemented and monitored in terms of the Environmental Management Plan (EMP) for the construction phase.

All possible measures should be made in the construction of the sewer pipeline adjacent to the stream to prevent any future breakages as a result of flood damage or any spills/overflows from the pipeline from entering the stream. The pipeline should be regularly monitored and maintained to ensure that any problems with the pipeline are rectified before they can impact on the stream.

Significance of impacts after mitigation: Provided that the mitigation measures are effectively implemented, the water quality-related impacts of the proposed pipeline construction should be limited to the construction phase with a low positive significance over the longer term.

6.1.2 DESCRIPTION OF IMPACTS FOR THE DISPOSAL OF TREATED WASTEWATER FROM THE PROPOSED NEW WWTW

Impact - water quality impairment: The nature of this impact is highly dependent on the level of treatment achieved and the effluent water quality standards that would be met by the proposed WWTW. As a minimum, it is assumed that General Limit will be met. Wastewater treated to the General Limit still contains elevated nutrient and ammonia concentrations, while the Special Limits specifically has reduced nutrient and ammonia levels. Preferably the Roth-phosphate concentrations in the final treated wastewater should be further reduced to minimise eutrophication of the receiving aquatic ecosystem.

Significance of impacts without mitigation: Medium negative impact

Proposed mitigation: The wastewater from the WWTW should at least comply with the General Limits as required in the General Authorisations for water use. Considering the limited dilution of the final treated wastewater discharged to the stream, it would be preferable to reduce the nutrient concentrations (specifically phosphate) in the treated wastewater to reduce eutrophication of the stream, with the associated nuisance plant growth in downstream impoundments. This could be achieved either by ensuring that the WWTW achieves Special Limit quality in the final treated wastewater or to construct wetland areas within the receiving watercourse to further polish the treated wastewater. Another alternative would be to dispose of the wastewater in another way such as through reuse. To a certain extent the treated wastewater is in fact reused as it flows downstream in the Groenwaterspruit where it would be available for use downstream.

Significance of impacts after mitigation: Provided that the mitigation measures are effectively implemented, the water quality-related impacts should be limited and of a low significance.

Impact - flow modification: The discharge of treated wastewater to the stream will result in an increase in the flow in the stream, particularly during the dry months.

Significance of impacts without mitigation: Medium to low negative impact on the stream.

Proposed mitigation: The use of the treated wastewater during the drier months should be encouraged to reduce the volumes that need to be discharged to the stream. Creation of a reed bed either within or adjacent to the stream at the discharge point would not only mitigate the quality of the treated wastewater discharged but also the extent of the flow impact on the stream.

Significance of impacts after mitigation: Low negligible impact.

6.2. CUMULATIVE IMPACTS

The surrounding farming activities have already had a significant impact on the stream and wetland features in the area. Without mitigation the cumulative impact of the new WWTW and sewer line could be expected result in some degradation of the condition of the stream. However, considering the current degraded state of the stream and the impacts of the existing activities, the relative impact would be low. With effective implementation of the recommended mitigation measures, the condition of the stream could be maintained at an acceptable level or even improved.

In addition, the proposed new WWTW would result in the decommissioning of the existing WWTW which has altered to characteristic of the pans within the area from being largely ephemeral features to being primarily permanently inundated wetland areas. With the alteration of the proposed discharge of treated wastewater this existing impact on the freshwater features in the area would be eliminated.

6.3. CONSIDERATION OF ALTERNATIVES

6.3.1. THE 'NO-GO' ALTERNATIVE

The 'No-Go' alternative would imply not developing the proposed WWTW. This alternative would result in no additional potential negative environmental impacts as a result of the new WWTW and sewer line, however one could expect that there would be impacts associated with the limited capacity of the existing WWTW to treat the wastewater arising from the expanding town as well as increased loading (greater quantities of poor quality water) of the wetland areas and tributary of the Groenwaterspruit Tributary near the WWTW that would result in a gradual degradation of these aquatic ecosystems.

6.3.2. ALTERNATIVE 2 (ALTERNATIVE 1 IS THE PREFERRED ALTERNATIVE AS DESCRIBED IN THE PROJECT DESCRIPTION)

This alternative would entail extending the capacity of the existing wastewater treatment plant (4.8MI/day) by doubling its capacity to 9.8MI/day. This would also entail an increased loading of the aquatic ecosystems adjacent to the existing WWTW with a higher volume of treated wastewater from the upgraded WWTW. This option would at least have less of an impact on the freshwater features in the area due to the fact that the treated wastewater would be of a better quality. The freshwater features within the area are however largely of a seasonal to ephemeral nature. One could thus expect that a large number of the still largely natural

ephemeral pans surrounding the WWTW would become more permanently wet and dominated by *P. australis* reeds.

6.4. SUMMARY OF ASSESSMENT OF POTENTIAL IMPACTS

Potential impact on freshwater features	Proposed wastewater pipeline and the new WWTW
Nature of impact:	A limited loss of freshwater related habitats
Extent and duration of impact:	Localised short and longer term impacts
Intensity of Impact	Medium to low
Probability of occurrence:	Highly Probable / Definite
Degree to which impact can be reversed:	Partially to fully reversible
Irreplaceability of resources:	Medium to Low
Cumulative impact prior to mitigation:	Low due to the degraded state of the stream and the fact that the activity will result in a loss of aquatic habitat at the existing WWTW
Significance of impact pre-mitigation	Low
Degree of mitigation possible:	Very low
Proposed mitigation:	The proposed pipeline should be constructed within the stream channel where the vegetation has already been completely transformed by past cultivation activities. There should be limited disturbance within the instream and riparian vegetation during the construction phase. After construction, the disturbed area should be rehabilitated, particularly to prevent erosion taking place as well as to prevent the potential colonisation of these areas with invasive alien plants. Rehabilitation requires removal of invasive alien plants from the riparian zone, some landscaping of the stream bank if required and re-vegetation with indigenous riparian plants.
Cumulative impact post mitigation:	Very Low
Significance after mitigation	Very Low

Potential impact on freshwater features	Construction of proposed wastewater pipeline and new WWTW
Nature of impact:	Downstream water quality impacts
Extent and duration of impact:	Localised short and longer term impacts
Intensity of Impact	Medium to Low
Probability of occurrence:	Medium to low probability
Degree to which impact can be reversed:	Fully reversible
Irreplaceability of resources:	Low
Cumulative impact prior to mitigation:	Low due to the degraded state of the stream
Significance of impact pre-mitigation	Medium to Low
Degree of mitigation possible:	Low
Proposed mitigation:	Contaminated runoff from the pipeline installation site should be prevented from directly entering the stream. Construction of the pipeline should preferably not be undertaken in the higher rainfall months when the water quality impacts from the construction activities may impact on the stream. The construction camp/laydown area should be located away from the stream. All materials on the associated with the construction activities should be properly stored and contained. Disposal of waste from the site should also be properly managed. Construction workers should be given ablution facilities at the construction sites that are located away from the river (at least 30m) and regularly serviced. These measures should be addressed, implemented and monitored in terms of the Environmental Management Plan (EMP) for the construction phase. All possible measures should be made in the construction of the sewer pipeline adjacent to the stream to prevent any future breakages as a result of flood damage or any spills/overflows from the pipeline from entering the stream. The

	<p>pipeline should be regularly monitored and maintained to ensure that any problems with the pipeline are rectified before they can impact on the stream.</p> <p>The wastewater from the WWTW should at least comply with the General Limits as required in the General Authorisations for water use. Considering the limited dilution of the final treated wastewater discharged to the stream, it would be preferable to reduce the nutrient concentrations (specifically phosphate) in the treated wastewater to reduce eutrophication of the stream, with the associated nuisance plant growth in downstream impoundments. This could be achieved either by ensuring that the WWTW achieves Special Limit quality in the final treated wastewater or to construct wetland areas within the receiving watercourse to further polish the treated wastewater. Another alternative would be to dispose of the wastewater in another way such as through reuse. To a certain extent the treated wastewater is in fact reused as it flows downstream in the Groenwaterspruit where it would be available for use downstream.</p>
Cumulative impact post mitigation:	Very Low
Significance after mitigation	Very Low

Potential impact on freshwater features	Construction of proposed wastewater pipeline and new WWTW
Nature of impact:	Downstream flow modification impacts as a result of WWTW final effluent discharge to stream
Extent and duration of impact:	Local long term impacts
Intensity of Impact	Medium to Low - localised
Probability of occurrence:	Highly Probable / Definite
Degree to which impact can be reversed:	Partially reversible
Irreplaceability of resources:	Medium
Cumulative impact prior to mitigation:	Low
Significance of impact pre-mitigation	Medium to Low
Degree of mitigation possible:	Low
Proposed mitigation:	The use of the treated wastewater during the drier months should be encouraged to reduce the volumes that need to be discharged to the stream. Creation of a reed bed either within or adjacent to the stream at the discharge point would not only mitigate the quality of the treated wastewater discharged but also the extent of the flow impact on the stream.
Cumulative impact post mitigation:	Low
Significance after mitigation	Low

7. CONCLUSIONS AND RECOMMENDATIONS

Aquatic features which occur within the study area consist of the Groenwaterspruit and its smaller tributaries at Postmasburg; and some largely natural pans and artificial wetland areas. The ecological condition of the Groenwaterspruit at Postmasburg is considered to be largely modified, while the ecological importance and sensitivity of the stream is moderate. In terms of FEPAs, the Groenwaterspruit is considered to be a River FEPA. Wetland FEPAs also occur within the study area.

The pans in the study area are subjected to some physical habitat modification with some flow and water quality modification largely as a result of the surrounding farming and peri-urban activities while the wetland areas have similar impacts but are also subjected to additional flow of treated wastewater from the existing WWTW. In terms of the current ecological state of the wetland areas, they are as a whole considered to be in a moderately modified state, with the smaller pans in general in a less impacted and largely natural ecological

state. In terms of goods and services, the pans provide limited goods and services. This is largely due to the fact that they are relatively small in extent. In this sense, the wetland areas provide particular goods and services associated with mitigating the potential impact of the treated wastewater discharge, including some flood attenuation and sediment trapping functionality, as well as mitigating the water quality impacts of the treated wastewater discharge. The pans are all considered to have a moderate Ecological Importance and Sensitivity while the wetland areas associated with the WWTW are of low Ecological Importance and Sensitivity.

Without mitigation the cumulative impact of the new WWTW and sewer line could be expected result in some degradation of the condition of the stream. However, considering the current degraded state of the stream and the impacts of the existing activities, the relative impact would be low. With effective implementation of the recommended mitigation measures, the condition of the stream could be maintained at an acceptable level or even improved. In addition, the proposed new WWTW would result in the decommissioning of the existing WWTW which has altered to characteristic of the pans within the area from being largely ephemeral features to being primarily permanently inundated wetland areas. With the alteration of the proposed discharge of treated wastewater this existing impact on the freshwater features in the area would be eliminated.

Proposed mitigation measures consist of the following recommendations:

- The proposed sewer pipeline should be constructed within the stream channel where the vegetation has already been completely transformed by past cultivation activities. There should be limited disturbance within the instream and riparian vegetation during the construction phase. After construction, the disturbed area should be rehabilitated, particularly to prevent erosion taking place as well as to prevent the potential colonisation of these areas with invasive alien plants. Rehabilitation requires removal of invasive alien plants from the riparian zone, some landscaping of the stream bank if required and re-vegetation with indigenous riparian plants.
- Contaminated runoff from the pipeline installation site should be prevented from directly entering the stream. Construction of the pipeline should preferably not be undertaken in the higher rainfall months when the water quality impacts from the construction activities may impact on the stream.
- The construction camp/laydown area should be located away from the stream. All materials on the associated with the construction activities should be properly stored and contained. Disposal of waste from the site should also be properly managed. Construction workers should be given ablution facilities at the construction sites that are located away from the river (at least 30m) and regularly serviced. These measures should be addressed, implemented and monitored in terms of the Environmental Management Plan (EMP) for the construction phase.
- All possible measures should be made in the construction of the sewer pipeline adjacent to the stream to prevent any future breakages as a result of flood damage or any spills/overflows from the pipeline from entering the stream. The pipeline should be regularly monitored and maintained to ensure that any problems with the pipeline are rectified before they can impact on the stream.
- The wastewater from the WWTW should at least comply with the General Limits as required in the General Authorisations for water use. Considering the limited dilution of the final treated wastewater discharged to the stream, it would be preferable to reduce the nutrient concentrations (specifically phosphate) in the treated wastewater to reduce eutrophication of the stream, with the associated nuisance plant growth in downstream impoundments. This could be achieved either by ensuring that the WWTW achieves Special Limit quality in the final treated wastewater or to construct wetland areas within the receiving watercourse to further polish the treated wastewater. Another alternative would be to dispose of the wastewater in another way such as through reuse. To a certain extent the treated wastewater is in fact reused as it flows downstream in the Groenwaterspruit where it would be available for use downstream.

- The use of the treated wastewater during the drier months should be encouraged to reduce the volumes that need to be discharged to the stream. Creation of a reed bed either within or adjacent to the stream at the discharge point would not only mitigate the quality of the treated wastewater discharged but also the extent of the flow impact on the stream.
- Monitoring of the ecological state of the stream should take place to allow for adaptive management of the wastewater disposal practice.

The Department of Water and Sanitation should be approached with regards to the water use authorisation requirements for the proposed activities.

8. REFERENCES

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Kleynhans CJ, Louw MD, Graham M. (2008). *Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical manual)* Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08

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Mucina, L. and M. Rutherford. Eds. (2006). Vegetation map of South Africa, Lesotho, and Swaziland. *Strelitzia 19*. South African National Biodiversity Institute, Pretoria.

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SANBI Biodiversity GIS: <http://bgis.sanbi.org/>

APPENDIX A: DECLARATION OF INDEPENDENCE

I Antonia Belcher, as the appointed independent specialist hereby declare that I:

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- have and will not have no vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2010 (specifically in terms of regulation 17 of GN No. R. 543) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- have ensured that the names of all interested and affected parties that participated in terms of the specialist input/study were recorded in the register of interested and affected parties who participated in the public participation process;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favorable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543.

Signature of the specialist: 

Date: 26 June 2015

APPENDIX B: BACKGROUND AND QUALIFICATIONS OF SPECIALIST CONSULTANT

Contact details: 60 Dummer Street, Somerset West, 7130

Names: Antonia Belcher and Dana Grobler

Profession: Aquatic Scientists

Fields of Expertise: Specialist in freshwater assessments, monitoring and reporting

Relevant work experience:

Due to involvement in the development and implementation of the River Health Programme in the Western Cape, as well as numerous freshwater assessments through the province and greater Southern Africa, we have taken part in many 'state-of-river' assessments as well as routine monitoring and specialized assessments of rivers and wetlands in the area.

Recent publications:

- Freshwater Ecological Assessment for Paternoster Wastewater Treatment Works Upgrade, Saldanha Bay Municipality, 2008.
- Freshwater Assessment: Proposed Upgrading of the Grabouw Wastewater Treatment Works, 2009.
- Freshwater Assessment for Matzikama Municipality for the Proposed Upgrade of Vredendal North Wastewater Treatment Works (Portion 386 of the Farm Vredendal no 292), 2009.
- Water Quality Management Report: Upgrade and Emergency Rehabilitation Measures for Existing Velddrif Waste Water Treatment Works, 2010.
- Freshwater Assessment and Water Quality Management Report: Proposed Upgrading of Riebeek West, Riebeek Kasteel and PPC Wastewater Treatment Works, 2012. Freshwater Assessment for the Proposed Upgrade and Extension of the Koringberg Wastewater Treatment Works, 2012.
- Freshwater Assessment for the Proposed Upgrade and Extension of Stellenbosch Wastewater Treatment Works, 2012.
- Freshwater Assessment for the Proposed Upgrade and Extension of Villiersdorp Wastewater Treatment Works, 2012.
- Freshwater Assessment for the Proposed Process and Other Improvements to the Cape Flats Wastewater Treatment Works and Future Associated Infrastructure, Cape Town, 2013.
- Freshwater Assessments for the Proposed Upgrades to the Zandvliet, Macassar and Kraaifontein Wastewater Treatment Works, 2015.