POSTMASBURG WWTW

Proposed relocation of the Postmasburg wastewater treatment works and associated infrastructure, ZF Mgcawu District Municipality, Tsantsabane Local Municipality (Northern Cape Province).

BIODIVERSITY & BOTANICAL SCAN

Biodiversity and botanical scan of the proposed pipeline route and WWTW site

30 October 2014

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INDEPENDENCE & CONDITIONS

PB Consult is an independent consultant and has no interest in the activity other than fair remuneration for services rendered. Remuneration for services is not linked to approval by decision making authorities and PB Consult has no interest in secondary or downstream development as a result of the authorization of this proposed project. There are no circumstances that compromise the objectivity of this report. The findings, results, observations and recommendations given here are based on the author's best scientific and professional knowledge and available information. PB Consult reserves the right to modify aspects of this report, including the recommendations if new information becomes available which may have a significant impact on the findings of this report.

RELEVANT QUALITFICATIONS & EXPERIENCE OF THE AUTHOR

Mr. Peet Botes holds a BSc. (Hons.) degree in Plant Ecology from the University of Stellenbosch (Nature Conservation III & IV as extra subjects). Since qualifying with his degree, he has been employed for more than 20 years in the environmental management field, first at the Overberg Test Range (a Division of Denel) managing the environmental department of OTB and being responsible for developing and implementing an ISO14001 environmental management system, ensuring environmental compliance, performing environmental risk assessments with regards to missile tests and planning the management of the 26 000 ha of natural veld, working closely with CapeNature (De Hoop Nature Reserve). In 2005 he joined Enviroscientific, an independent environmental consultancy specializing in wastewater management, botanical assessments and developing environmental management plans and strategies, environmental control work as well as doing environmental compliance audits. He was also responsible for helping develop the botanical part of the Farming for the Future audit system implemented by Woolworths. During his time with Enviroscientific he performed more than 400 botanical and environmental legal compliance audits. During 2010 he joined EnviroAfrica in order to move back to the biodiversity aspects of environmental management. Experience with EnviroAfrica includes NEMA applications, biodiversity- and botanical assessments, environmental compliance audits and environmental control work.

Mr. Botes is also a registered Professional Environmental and Ecological Scientists at SACNASP (South African Council for Natural Scientific Professions) as required in terms of Section 18(1)(a) of the Natural Scientific Professions Act, 2003, since 2005.

SUMMARY - MAIN CONCLUSIONS

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SUMMARY OF POSSIBLE SIGNIFICANT BIODIVERSITY FEATURES			
Potential impacts on biophysical environment			
Geology & soils	Geology & soils vary only slightly in the larger study area.	No special features have been encountered (e.g. true quartz patches or broken veld) and the impact on geology and soils is expected to be very localised and low. Mitigation will entail minimising footprint.	
		Without mitigation: Low	**With mitigation: Low**
Land use and cover	The proposed route will have a permanent impact on approximately 10 ha of grazing area.	The grazing potential of the land is low and the impact is considered localised. Mitigation will minimising disturbance footprint associated with the pipeline construction.	
		Without mitigation: Low	**With mitigation: Low**
Potential impacts on threatened or protected ecosystems			
Vegetation type(s)	Two vegetation types were encountered (Refer to Table 2):	Both vegetation types are classified as "Least threatened" but poorly protected. According to the Draft Siyanda EMF, both vegetation types have a high conservation priority (being poorly protected) but a low/medium sensitivity index (more than 98% remaining and low species turnover). It is thus highly unlikely that small localised impacts will have any significant impact on any specific species, local and regional conservation targets or threatened ecosystems. Mitigation will entail minimising footprint where possible.	
		Without mitigation: Low	**With mitigation: Low**
Corridors and conservation priority areas/networks.	Draft Environmental Management Framework (EMF) for the Siyanda District Municipality.	According to the Draft Siyanda EMF, both vegetation types have a high conservation priority (being poorly protected) but a low/medium sensitivity index (more than 98% remaining and low species turnover). It is thus highly unlikely that small localised impacts will have any significant impact on any specific species, local and regional conservation targets or threatened ecosystems. The impact on river corridors will be short term and temporary of nature, but is likely to impact on the riparian vegetation. Mitigation will entail minimising the impact on riparian vegetation and to ensure erosion control through good rehabilitation. Correct alien eradication will also be important.	
		Without mitigation: Medium/Low	**With mitigation: Low**
Protected plant species	No SA red list species was observed. Two tree NFA protected tree species were encountered and 3 NCNCA protected plant species were observed.	No *Acacia erioloba* individual should be impacted, but two *Boscia albitrunca* shrubs in poor condition will be impacted. In addition a number of *Aloe* individuals and one *Pachypodium* will be impacted. Mitigation will entail excellent environmental control and application for permits in terms of the NFA and the NCNCA.	
		Without mitigation: Medium/Low	**With mitigation: Low**
Fauna & Avi-fauna	The proposed route will follow existing road reserves and with low impact on habitat.	Because of the temporary and localised nature of the activity it is considered highly unlikely that it will have any significant impact on fauna or avi-fauna. Mitigation will entail staying within the road reserve and minimising footprint and the impact on mature indigenous tree species.	

		Without mitigation: Low	**With mitigation: Insignificant**
Rivers & wetlands	The proposed route will follow the Groenwater Spruit and are likely to impact on riparian vegetation.	Even though the riparian vegetation is in poor state and the impact will be localised and short term, uncontrolled excavation can have serious additional impacts on the riparian zone especially with regards to infestation escalation (specifically *Prosopis* infestation). Mitigation will entail excellent environmental control in order to minimise the impact on riparian zones, to ensure good rehabilitation and to reduce the risk of erosion.	
		Without mitigation: Medium	**With mitigation: Medium/Low**
Invasive alien infestation	A total of 14 alien species or indigenous weeds were observed of which the most concerning are the presence of *Prosopis* along the Groenwater Spruit and the Cactaceae species.	All listed invasive alien species must be removed during the construction. However, incorrect alien control methods used for especially *Prosopis* species may aggravate the situation and result in spreading in place of control of these species. Mitigation will entail correct alien control methods coupled with follow up work after rehabilitation.	
		Without mitigation: Medium/Low	**With mitigation: Positive**
Potential direct impacts			
Direct impacts	Refers to those impacts with a direct impact on biodiversity features.	The proposed activity will have a direct impact on natural vegetation, which is likely to include protected plant species in terms of the NFA and NCNCA, riparian vegetation of the Groenwater Spruit and vegetation with a potential high conservation value. The impact on soil, landuse, fauna and avi-fauna and veld fire is considered to be low. However, it is unlikely that the proposed project will have significant impact on local or regional conservation targets. Mitigation will include all the mitigation aspects discussed above.	
		Without mitigation: Medium/Low	**With mitigation: Low**
Potential indirect impacts			
Indirect impacts	Refers to impacts that are not a direct result of the main activity, but are impacts associated or resulting from the main activity.	It is very likely that the proposed project will have indirect impacts like the establishment of temporary lay-down areas, temporary construction sites and concrete mixing areas. However, with good environmental control it will be possible to minimise the impact of such indirect impacts. Mitigation will entail excellent environmental control, placement of temporary lay-down areas or construction sites within areas that are not environmentally sensitive and will not impact on protected plant species. It will also entail good waste and wastewater control.	
		Without mitigation: Medium/Low	**With mitigation: Low**
Potential cumulative impacts			
Cumulative impacts	Refers to the cumulative loss of ecological function and other biodiversity features on a regional basis.	The proposed project will have a localised impact, which should not result in significant additional permanent impacts. Overall it is not considered likely that the cumulative impact will result in any significant additional impact on regional biodiversity targets. Mitigation will entail excellent environmental control and all of the mitigation measures addressed above	
		Without mitigation: Medium	**With mitigation: Medium/Low**
Indirect impacts	Refers to impacts that are not a direct result of the main activity, but are impacts associated or resulting from the main activity.	It is very likely that the proposed project will have indirect impacts like the establishment of temporary lay-down areas, quarry sites for bedding and blanket material, temporary construction sites and concrete mixing areas. However, with good environmental control it will be possible to minimise the impact of such indirect impacts. Mitigation will entail excellent environmental control, placement of temporary lay-down areas or construction sites within areas that are not environmentally sensitive and will not impact on protected plant species. It will also entail good waste and wastewater control.	
		Without mitigation: Medium/high	**With mitigation: Low**

The No-Go Option		
The No-Go Option	The "No-Go alternative" does not signify significant biodiversity gain or loss especially on a regional basis. However, it will ensure that none of the potential impacts above occur.	The existing Waste Water Treatment Works operate at over maximum capacity which had led to numerous uncontrolled discharges through town and into the Groenwater Spruit, which resulted in significant environmental and public health risks. To accommodate the growing population of Postmasburg and the growing costs of operating the existing waste water treatment works must be upgraded or replaced. At present treated effluent at the existing WWTW, is discharged into two freestanding maturation ponds while a portion is used for irrigation. The remainder of the effluent is either evaporated or overflows to adjacent shallow pans. During years of high rainfall the storm water run-off flows into the maturation/evaporation ponds located on the high ground south east of Postmasburg. This high influx of storm water causes the treated effluent to overflow from the maturation ponds which then discharges down the hill in a north-westerly direction through the new Airfield residential development and the Postmasburg CBD where it eventually ends up in the Groenwater Spruit. This discharge is uncontrolled and poses a significant environmental and public health risk. Because of the location of the existing works (the highest point of the town property) there is a continual pumping cost in order to pump raw effluent from the main collection sump (Pump Station 1) at the lowest point in town (next to the Groenwater Spruit) to the treatment works (which involves more than one pump station). Pumping costs and continual maintenance of the system places a huge demand on the town's resources. Studies indicate that there will be significant long term benefits if the treatment works can be re-positioned on a lower-lying area. Pumping costs will be significantly reduced and maintenance will be easier and the existing pollution and especially health issues will be addressed (redirected away from the town). The No-Go option will result in continual pollution and health risks, coupled with huge maintenance costs. In addition the current WWTW will still have to be upgraded in order to handle the current and projected sewerage volumes expected. The location of the current works will remain problematic (uncontrolled discharge of raw effluent) and very expensive to operate (pumping costs).

RECOMMENDATION

Having evaluated the biodiversity aspects and associated impacts pertaining to the proposed development, the author is of the opinion that the proposed project will have a significant impact on cutting operational costs, pollution prevention and health risks. The improved treatment method should enable easy expansion in future without major footprint enlargements (or further work within the riparian zone). From a biodiversity perspective it will have very little impact on local or regional conservation targets, but will have a slight impact on protected species and a temporary impact on the Groenwater Spruit riparian vegetation. But the impact will be localised and with good environmental control and mitigation should not have any significant impact on conservation targets.

The evaluation of the potential environmental impacts indicates the most significant potential impacts identified where:

- The potential impact on two NFA Boscia albitrunca individuals;
- The impact on a number of species protected in terms of the NCNCA;
- The potential impact on vegetation with a high conservation priority as a result of its current poor conservation status (fortunately more than 98% of both these vegetation types remains);
- The potential impact on the riparian vegetation associated with the Groenwater Spruit.

With mitigation it is considered highly unlikely that the proposed project will contribute significantly to any of the following:

- Significant loss of vegetation type and associated habitat.
- Loss of ecological processes (e.g. migration patterns, pollinators, river function etc.) due to development and operational activities.
- Loss of local biodiversity and threatened plant species.
- Loss of ecosystem connectivity

With the available information to the author's disposal it is recommended that project be approved, provided that mitigation is adequately addresses.

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1. INTRODUCTION

It is proposed that a **NEW** Waste Water Treatment Works be constructed on Portion 3 of the Farm Olynfontein No.475, Postmasburg (replacing the existing plant located on Erf 1, Postmasburg), to accommodate the growing population of Postmasburg and the growing costs of operating the existing waste water treatment works. Calculations have indicated that the current main sewer, which is only a 300 mm diameter pipe, would not be adequate to convey the existing and future flows and that the existing plant will also not have the capacity to treat the higher sewerage volumes. 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 640m^3/day. A decision was taken to allow for a percentage of future growth and expansion and a figure of 10 000m^3/day was arrived at 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.

At present treated effluent at the existing WWTW, is discharged into two freestanding maturation ponds located north of the existing works. A portion of the treated effluent is pumped from the maturation ponds with two pump stations for re-use to several parks in Postmasburg as well as the high school sports fields where it is used for irrigation. The remainder of the effluent is either evaporated or overflows to adjacent shallow pans. During years of high rainfall the storm water run-off also flows into the maturation/evaporation ponds located on the high ground south east of Postmasburg. This high influx of storm water causes the treated effluent to overflow from the maturation ponds which then discharges down the hill in a north-westerly direction through the new Airfield residential development and the Postmasburg CBD where it eventually ends up in the Groenwater Spruit. This discharge is uncontrolled and poses a significant environmental and public health risk. Because of the location of the existing works (the highest point of the town property) there is a continual pumping cost in order to pump raw effluent from the main collection sump (Pump Station 1) at the lowest point in town (next to the Groenwater Spruit) to the treatment works (which involves more than one pump station). Pumping costs and continual maintenance of the system places a huge demand on the town's resources. BVi engineers have been appointed to investigate the best long term solution which will include addressing the continual pollution issues (the main issues being the phased pumping costs and maintenance).

Studies indicate that there will be significant long term benefits if the treatment works can be re-positioned on a lower-lying area (almost level with the lowest collection sump). Pumping costs will be significantly reduced and maintenance will be easier and the existing pollution and especially health issues will be addressed (redirected away from the town). Currently, all sewerage from Postmasburg drains to the Postmasburg Pump Station No. 1, located to the south of Postmasburg right next to the Groenwater Spruit. The logical solution would be to extend the existing main sewer downstream to a point where it would daylight (through gravity feed) and then construct a new wastewater treatment plant near this location.

It is proposed that 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 proposed site will significantly reduce pumping costs, since it will only needed to be pumped once (up to the inlet structure of the new WWTW) after which flow through the treatment plant can again take place under gravity. It is suggested that the treatment plant be designed in such a manner that modules capable of treating 5000m^3/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. The design of the new treatment works allows for beneficial irrigation of the existing agricultural land next to the Groenwater Spruit or for controlled discharge into the Groenwater Spruit downstream of the greater Postmasburg (thus eliminating the possibility of uncontrolled discharge into the Postmasburg residential area). A new connection pipeline is proposed which will connect the existing main collection sump on the municipal commonage known as Postmasburg Erf No.1 with the new proposed treatment works.

Since the proposed pipeline and wastewater treatment works will be placed within areas still containing natural vegetation a biodiversity study was commissioned.

1.1 TERMS OF REFERENCE

EnviroAfrica (Pty) Ltd was appointed by BVi Engineers (Pty) Ltd as the independent Environmental Assessment Practitioner (EAP) to undertake the Basic Assessment (EIA) Process for the proposed development. PB Consult was appointed by EnviroAfrica to conduct a biodiversity and botanical scan of the proposed route.

PB Consult was appointed within the following terms of reference:

- *Complete a biodiversity scan of the proposed site in order to evaluate the potential impact of the proposed pipeline route on specifically botanical features.*
- *Make recommendations on impact minimisation should it be required*
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- *Consider short- to long-term implications of impacts on biodiversity and highlight irreversible impacts or irreplaceable loss of species.*

The study includes the following:

- *A brief discussion of the local environment in order to provide background on the ecological factors influencing the ecological drivers associated with the specific area.*
- *A brief discussion of the vegetation types expected and encountered with emphasis on protected species encountered.*
- *A list of plant species encountered during the site visit.*
- *Determination of the occurrence, or possible occurrence of threatened or sensitive plant species, and sensitive plant communities, on the basis of the field survey and records obtained from the South African National Biodiversity Institute (SANBI) and available literature.*
- *Assessment of habitat sensitivity, incorporating faunal distribution based on the field survey and from available literature.*
- *An evaluation of the potential impact of the proposed project on habitat and species.*
- *A discussion of significant impacts focusing on possible mitigation and amendments to the development proposal.*

2. APPLICABLE LEGISLATION

Constitution of the Republic of South Africa (1996): of special relevance in terms of environment is section 24

Conservation of Agricultural Resources Act 43 of 1983 (CARA): supports conservation of natural agricultural resources (soil, water, plant biodiversity) by maintaining the production potential of the land and combating/preventing erosion; for example, by controlling or eradicating declared weeds and invader plants.

Hazardous Substances Act 15 of 1973: to control substances that may cause injury, ill-health, or death through their toxic, corrosive, irritant, strongly sensitizing or flammable nature, or by the generation of pressure

National Environmental Management Act 107 of 1998 (as amended): replaces the Environmental Conservation Act (ECA) and establishes principles for decision-making on matters affecting the environment, and for matters connected therewith.

- **Environmental Impact Assessment Regulations** (R543 of 2010): procedures to be followed for application to conduct a listed activity.

National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA): replaces the Atmospheric Pollution Prevention Act (No. 45 of 1965).

National Environmental Management: Biodiversity Act 10 of 2004 (NEMBA): supports conservation of plant and animal biodiversity, including the soil and water upon which it depends.

- **National list of ecosystems that are threatened and in need of protection** (GN 1002 of 9 December 2011).

National Environmental Management: Protected Areas Act 57 of 2003 (as amended Act 31 of 2004) (NEMPAA): To provide for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes.

National Environmental Management: Waste Act 59 of 2008 (NEMWA): To reform the law regulating waste management in order to protect health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development.

- **List of Waste Management Activities that have, or are likely to have a detrimental effect on the environment** (GN 718 of 3 July 2009): Identifies activities in respect of which a waste management license is required.

National Forests Act 84 of 1998 (as amended): supports sustainable forest management and the restructuring of the forestry sector.

- **List of protected tree species** (GN 716 of 7 September 2012)

National Heritage Resources Act 25 of 1999: supports an integrated and interactive system for the management of national heritage resources, including supports soil, water and animal and plant biodiversity.

National Veld and Forest Fire Act 101 of 1998 (NVFFA): protects soil, water and plant life through the prevention and combating of veld, forest, and mountain fires

National Water Act 36 of 1998 (NWA): promotes the protection, use, development, conservation, management, and control of water resources in a sustainable and equitable manner.

Northern Cape Nature Conservation Act 9 of 2009 (NCNCA): which provides for the sustainable utilization of wild animals, aquatic biota and plants.

3. DEFINITIONS & ABBREVIATIONS

3.1 DEFINITIONS

Contaminated water: means water contaminated by the activities associated with construction, *e.g.* concrete water and runoff from plant/ personnel wash areas.

Environment: means the surroundings within which humans exist and that are made up of:

- the land, water and atmosphere of the earth;
- micro-organisms, plant and animal life;
- any part of the combination of the above two bullets and the interrelationships between them;
- the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being

Environmental Aspect: any element of any construction activity, product or services that can interact with the environment.

Environmental Control Officer: a suitably qualified environmental agent responsible for overseeing the environmental aspects of the Construction phase of the EMP.

Environmental Impact: any change to the environment, whether adverse or beneficial, wholly or partially resulting from any construction activity, product or services.

No-Go Area(s): an area of such (environmental/aesthetical) importance that no person or activity are allowed within a designated boundary surrounding this area.

Owner: the owner, or dedicated person, responsible for the management of the property on which the proposed activity will be performed.

Solid waste: means all solid waste, including construction debris, chemical waste, excess cement/concrete, wrapping materials, timber, tins and cans, drums, wire, nails, food and domestic waste (e.g. plastic packets and wrappers).

Precautionary principle: means the basic principle, that when in doubt or having insufficient or unreliable information on which to base a decision, to then limit activities in order to minimise any possible environmental impact.

Watercourse: in this report the author uses a very simplified classification system to define the difference between a river, a water course and an ephemeral stream as encountered in the study area.

- River: A river is a natural watercourse with a riverbed wider than 3m, usually freshwater, flowing toward an ocean, a lake, a sea or another river. In a few cases, a river simply flows into the ground or dries up completely before reaching another body of water. The flow could be seasonal or permanent.
- Water course: A small river or natural watercourse with a riverbed of less than 3 m, usually freshwater, flowing toward an ocean, a lake, a sea or another river. In a few cases, a river simply flows into the ground or dries up completely before reaching another body of water. The flow could be seasonal or permanent.

- Ephemeral stream: A very small and poorly defined watercourse, mostly on relatively flat areas, which only flows for a short period after heavy rains, usually feeding into a stream or river or dries up completely before reaching another body of water.

3.2 ABBREVIATIONS

ADWF	Average Dry Weather Flow
BGIS	Biodiversity Geographical Information System
CARA	Conservation of Agricultural Resources Act 43 of 1983
CBA	Critical Biodiversity Areas (Municipal)
DEA	Department of Environmental Affairs
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMF	(Municipal) Environmental Management Framework
EMP	Environmental management plan
IDP	Integrated development plan
NCNCA	Northern Cape Nature Conservation Act, Act 9 of 2009
NEMA	National Environmental Management Act, Act 107 of 1998
NEMAQA	National Environmental Management Air Quality Act 39 of 2004
NEMBA	National Environmental Management Biodiversity Act, Act 10 of 2004
NEMPAA	National Environmental Management Protected Areas Act 57 of 2003
NEMWA	National Environmental Management Waste Act 59 of 2008
NFA	National Forests Act 84 of 1998
NSBA	National Spatial Biodiversity Assessment
NVFFA	National Veld and Forest Fire Act 101 of 1998
NWA	National Water Act 36 of 1998
SABIF	South African Biodiversity Information Facility
SANBI	South African National Biodiversity Institute
SIBIS	SANBI's Integrated Biodiversity Information System
SKEP	Succulent Karoo Ecosystem Project
WWTW	Wastewater Treatment Works

4. PROJECT DESCRIPTION

At present all sewerage in Postmasburg drains to the Postmasburg pump station No. 1, located to the south of Postmasburg within the Groenwater Spruit. From this pump station sewerage are pumped to at least one further pump station before being delivered into the treatment works. This project proposes to construct a new wastewater treatment works downstream of pump station 1 (allowing gravity feed). The pump station and new WWTW will be connected via a new pipeline from the pump station downstream, following the Groenwater Spruit, for approximately 1.3 km to the new proposed WWTW location where it will daylight at a gradient of 1 in 200 (refer to Figure 2). To convey these flows, a new main outfall sewer of at least 600 mm diameter is required. Such a sewer will run at 80% capacity for a flow of 100 litres per second providing some space for future expansion.

The proposed new WWTW will allow for all planned developments in Postmasburg and for expected future growth (a design capacity of 10 000m^3/day). Typically a 5000m^3/day module for such a plant would comprise the following units (and approximate sizes):

- Anoxic Zone: 430m^2
- Aeration Basin: 1 446m^2
- Clarifier: 625m^2
- Chlorine Contact Tank: 650m^2
- Sludge Drying Beds: 9 000m^2
- Total Area for units: 12 151m^2
- No. of Modules: 2
- Area occupied by units: 50%
- Area Required: 4.86ha

Units Common to all Modules:

- Inlet works: 100m^2
- Return Activated Sludge Pump Station 45m^2
- Waste Activated Sludge Pump Station 60m^2
- Office and laboratory Building 175m^2
- Cloakrooms and change house 120m^2
- Maturation Pond 20 000m^2
- Equalization Basin / Night Storage Pond 5 000m^2
- Area occupied by units: 50%
- Area Required: 5.10ha

Total Area required for the proposed new WWTP: **10ha**

4.1 METHODS USED

Desktop studies were conducted, coupled by a physical site visit (22nd of October 2014). During the desktop study significant biodiversity features associated with the larger surroundings were identified, and researched. The desktop study also took into account the biodiversity status as classified in the National Spatial Biodiversity Assessment (2004) as well as the 2011 National Spatial Assessment or National List of Threatened Ecosystems (GN 1002, December 2011), promulgated in terms of the National Environmental Management Biodiversity

Act (NEM: BA), Act 10 of 2004. It also aims to take, Municipal Environmental Management Frameworks (EMF's), Municipal Biodiversity Sector Plans and Municipal Critical Biodiversity Areas (CBA's) into account where applicable. In the case of the Tsantsabane Local Municipality, the Municipal Biodiversity Summaries Projects (2010) was the most relevant Biodiversity conservation plans (SANBI: BGIS). However, a draft Environmental Management Framework (EMF) for the Siyanda District Municipal was published in 2008, and even though this report was never formally approved, the findings were also used to guide decision making for this report.

The site survey was conducted by walking the proposed pipeline route and the proposed wastewater treatment site, examining, marking and photographing any area of interest. Confidence in the findings is high. During the site visit the author endeavoured to identify and locate all significant biodiversity features, including rivers, streams or wetlands, special plant species and or specific soil conditions which may indicate special botanical features (e.g. salt marsh areas, rocky outcrops or silcrete patches). The timing of the site visit was relatively good (being October), but the area was very dry and few bulbs or annual species were observed.

However, all perennial plants and a good number of seasonal plants were identifiable and although the possibility remains that a few species may have been missed, the author is confident that a fairly good understanding of the vegetation status in the area was obtained.

5. DESCRIPTION OF ENVIRONMENT

The aim of this description is to place the study area in context with regards to all significant biodiversity features which are expected and or were encountered within the study area. The study area has been taken as the proposed pipeline route, WWTW and its immediate surroundings.

5.1 LOCATION & LAYOUT

Postmasburg is located in the Northern Cape Province (Tsantsabane Local Municipality), just south of the N14 between Upington and Kuruman, approximately 220km east of Upington and 130 km west of Kuruman (Refer to Figure 1). The existing Postmasburg Wastewater Treatment Works (WWTW) is positioned on a hill above and to the southeast of Postmasburg (refers to Figure 2).

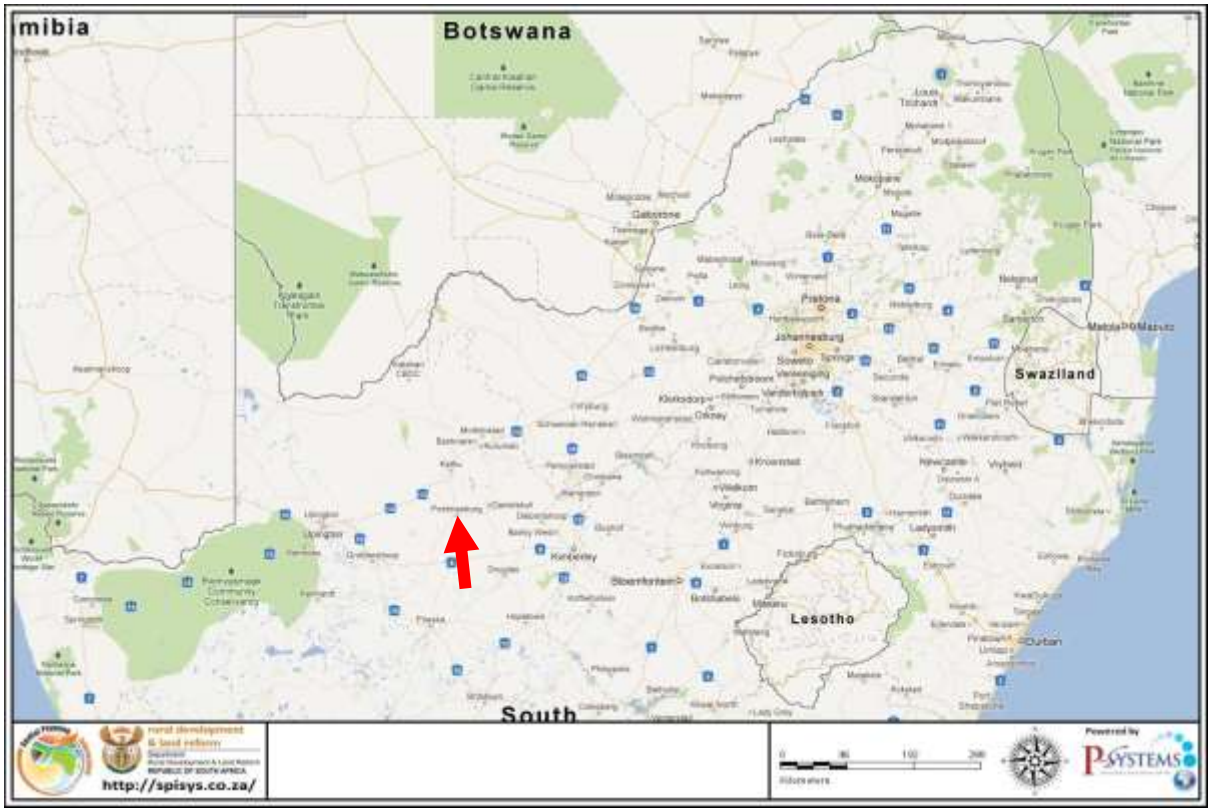

Figure 1: A map indicating the location of Postmasburg within South Africa

The new proposed WWTW will be located approximately 1.3 km to the south west of Postmasburg next to the Groenwater Spruit. The proposed new pipeline will connect the main collection sump (Pump Station 1) with the new WWTW, following the contours of the Groenwater Spruit for approximately 1.3 km, before connecting to the WWTW (Refer to Figure 2).

Figure 2: The proposed new pipeline route (red) and location of the new WWTW (blue)

Table 1: GPS coordinates for the existing and the proposed new Postmasburg WWTW

DESCRIPTION	LATITUDE AND LONGITUDE	ALTITUDE
Postmasburg	S28 19 57.6 E23 03 44.5	1 300 m
Postmasburg Existing WWTW	S28 20 46.1 E23 04 44.1	1 330 m
Pump station 1	S28 20 03.8 E23 03 29.8	1 290 m
New Postmasburg WWTW	S28 20 25.5 E23 02 58.8	1 280 m

5.2 TOPOGRAPHY

The proposed pipeline will follow the Groenwater Spruit (Erf 1, Postmasburg) for approximately 1.3 km towards the location of the new proposed WWTW site. The elevation of Pump station 1 is approximately 1290 m above sea level. The pipeline will daylight just south of the proposed new WWTW site at an elevation of approximately 1 280 m above sea level (gravity feed).

However the proposed new WWTW will be located at a slightly elevated location next to the Groenwater Spruit (1 292 m) and will thus have to be pump up to the treatment works. The site on which the proposed WWTW will be located (approximately 10 ha) will be located against a slight slope (average slope of approximately 17%) draining towards the Groenwater Spruit (east to west) (refer to Figure 3).

Figure 3: Google image showing the pipeline elevation from Pump station 1 towards the WWTW

5.3 CLIMATE

All regions with a rainfall of less than 400 mm per year are regarded as arid. This area normally receives about 106 mm of rain per year (the climate is therefore regarded as arid to very arid). Postmasburg normally receives about 241 mm of rain per year, with most rainfall occurring mainly during summer. It receives the lowest rainfall (0 mm) in July and the highest (57 mm) in March. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Postmasburg range from 17°C in June to 32°C in January. The region is the coldest during July when the mercury drops to 0°C on average during the night (www.saexplorer.co.za).

Average weather data shows that:

- The hottest months are from October to March.
- The driest months are from May to October.
- On average, the warmest month is January.
- On average, the coolest month is July.
- March is the wettest month.
- July / August are the driest months.

5.4 GEOLOGY & SOILS

The ZF Mgcawu (Siyanda) District lies on the great African plateau which was uplifted during the great Mesozoic and Tertiary earth movements. This plateau forms the largest part of the ancient continent of Gondwanaland which formally included eastern Brazil, southern India, Western Australia and Antarctica. In each of these fragments the general foundation is the same with an ancient surface of old rocks which together form the "fundamental complex" of the ancient land-mass. Over time this surface was covered by sedimentary beds1 in a freshwater inland lake and by means of windblown sand (Draft Siyanda EMF, 2008). Four physical geographical regions are identified within this district namely:

- The Kalahari;
- Bushmanland;
- the Griqua fold belt; and
- the Ghaap Plateau.

Postmasburg falls within the Griqua fold belt, which is a Highveld sub-region that lies in a roughly triangular shape to the west of the Ghaap Plateau, to the south of the Kalahari Basin and to the east of Bushmanland. It includes the scenic Langberg/Korana Mountains. The low Gamagara ridge between Postmasburg and Sishen is economically important because of the rich iron and manganese deposits it contains (Draft Siyanda EMF, 2008). According to Mucina *et al* (2006), Rutherford *et al* (2006) and the SANBI Biodiversity Geographical Information System, the geology and soils for this area Soils are described as soils with minimal development, usually shallow, on hard or weathering rock, with or without intermittent diverse soils. Lime generally present in part or most of the landscape. In some areas it may have restricted soil depth, excessive drainage, high erodibility, low natural fertility.

5.5 LANDUSE AND COVER

According to BGIS, the area is expected to still support mainly natural veld (Refer to Figure 4). Unfortunately, the BGIS spatial data does not indicate the Groenwater Spruit (which is a seasonal stream).

Photo 1: Images showing the condition of the riparian vegetation along the Groenwater Spruit

The proposed pipeline route follows the Groenwater Spruit, which has been heavily impacted over time. The riparian vegetation is mostly replaced by alien species. For the most part the stream and riparian zone has

been transformed as a result of urban creep and agricultural (and associated) practices. Agriculture includes intensive irrigation cultivation (e.g. Lucerne) and grazing (refer to Photo 1). The proposed new WWTW location however, still supports natural veld dominated by Swarthaak (*Acacia mellifera*) and Driedoring (*Rhigozum trichotomum*). This veld is mainly used for stock grazing (e.g. sheep) which can be seen in the way most of the vegetation has been grazed and the numerous pathways established through the veld (refer to Photo 2).

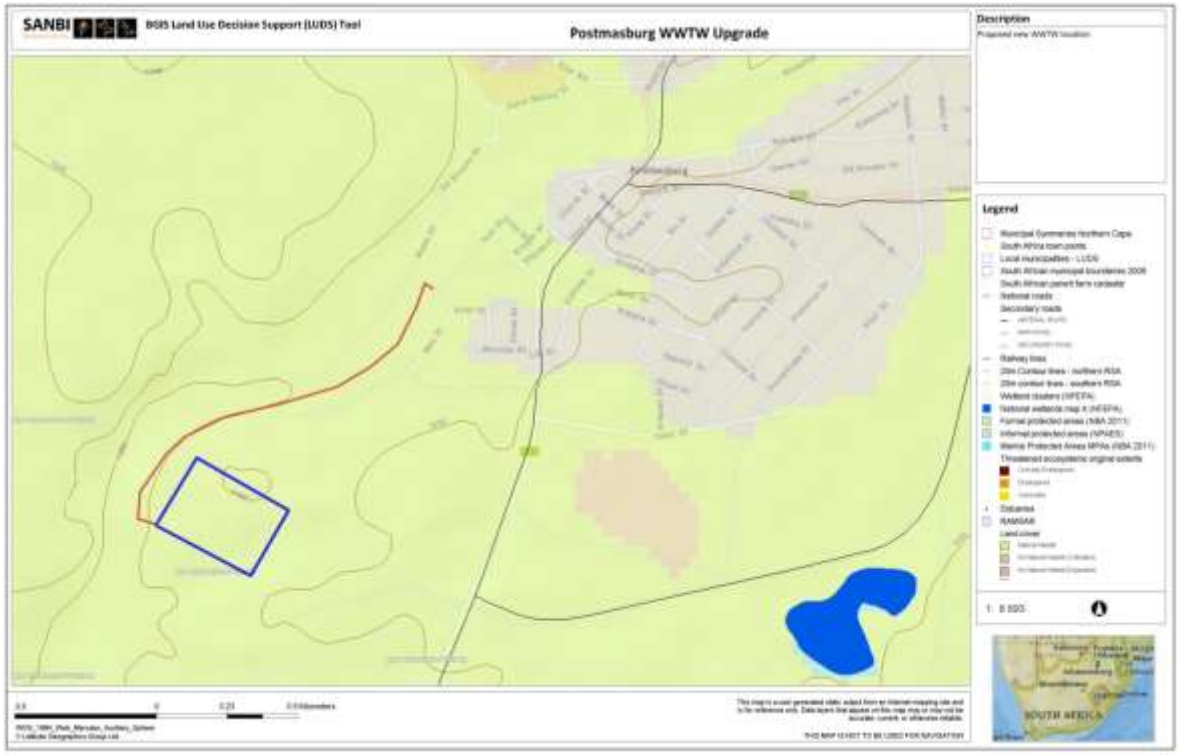

Figure 4: Land-use map for the proposed sites and surroundings

Photo 2: A photo showing the natural vegetation encountered on the proposed WWTW (Groenwater Spruit in the background)

5.6 BROAD SCALE VEGETATION EXPECTED

According to the Vegetation Map of South Africa (Mucina & Rutherford, 2006) two vegetation types, both part of the Savanna Biome are expected along the study area (Pipeline route and WWTW site), namely: Postmasburg Thornveld (SVk 14)and Kuruman Thornveld (SVk 9) (refer to Figure 5). The status of these vegetation types according to the 2004 National Spatial Biodiversity Assessment and the 2011 National Spatial Assessment or National List of Threatened Ecosystems (GN 1002, December 2011) are Least Threatened (refer to Table 2).

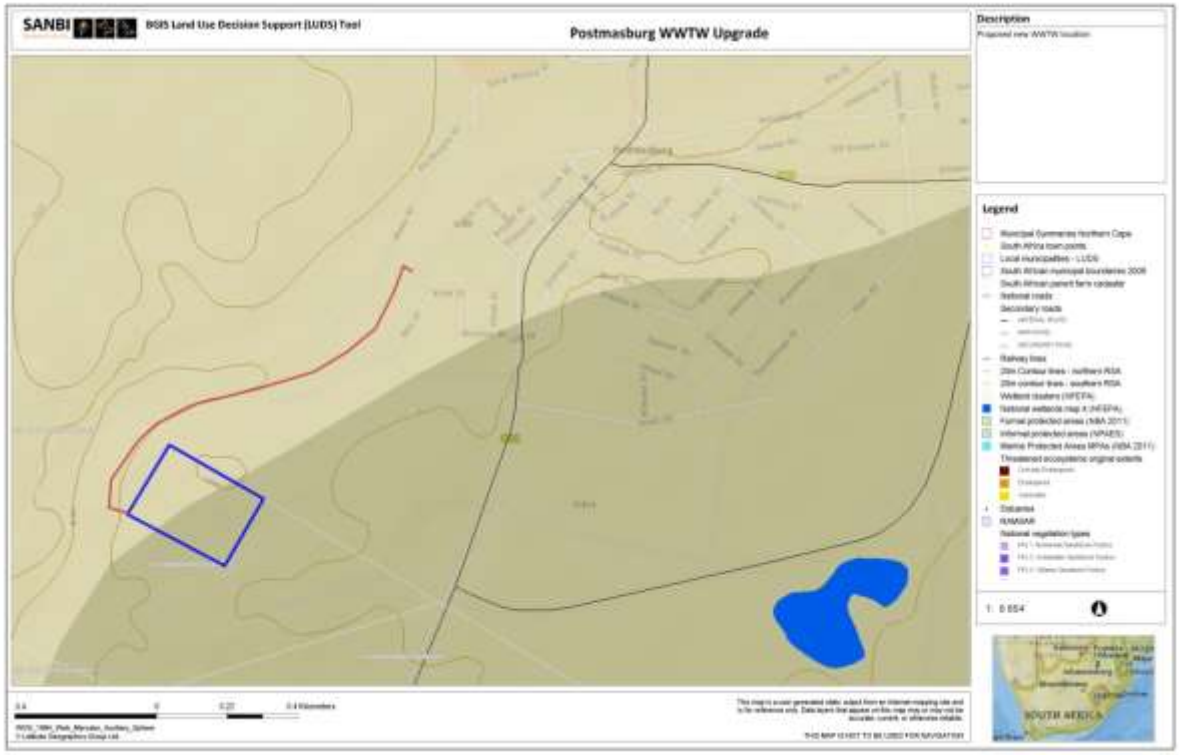

Figure 5: Vegetation map of South Africa, showing the expected vegetation types

The Savanna Biome is the most widespread Biome in Africa and also occupies most of the far-northern part of the Northern Cape, including the Kalahari Duneveld. According to Rutherford *et al* (2006), the Savanna in South Africa has a low species to area ratio, and become even lower in the southern Kalahari part of the biome (with a sharply decreasing diversity of trees from east to west). On the other hand, Savanna is well known for its diversity of mammals. Rainfall seasonality and frequency are too unpredictable and winter temperatures too low to enable leaf succulents to dominate (like in the Succulent Karoo), while summers are too dry for dominance by perennial grasses alone, and the soils are generally too shallow and rainfall too low for trees.

Table 2: Vegetation status according to the 2004 National Spatial Biodiversity Assessment and 2011 National Biodiversity Assessment

VEGETATION TYPE	NATIONAL STATUS 2011	REMAINING (2004)	CONSERVATION TARGET	FORMALLY CONSERVED
Postmasburg Thornveld (SVk 14)	Least Threatened	99.1%	16%	0%
Kuruman Thornveld (SVk 9)	Least Threatened	98.1%	16%	0%

5.6.1 Postmasburg Thornveld

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. It has a limited distribution and is only found on flats surrounded by mountains in the Northern Cape around Postmasburg, along the short valley of the Groenwater Spruit to the northeast and southwest, west to Bermolli and around Heuningkrans at altitudes varying between 1180 – 1440 m (Mucina & Rutherford, 2006). Acocks (1953) described this vegetation as Kalahari Thornveld invaded by Karoo, while Low & Rebelo (1996) described this vegetation as Kalahari Mountain Bushveld. This vegetation type includes the following important taxon: Trees: *Acacia erioloba, Acacia karroo, Acacia tortilis, Searsia lancea, Ziziphus mucronata*. Tall Shrubs: *Diospyros lycioides, Ehretia rigida, Grewia flava, Tarchonanthus camphoratus*. Low Shrubs: *Acacia hebeclada, Felicia muricata, Gomphocarpus fruticosus, Lantana rugosa, Melolobium microphyllum, Sutera halimifolia*. Succulent Shrubs: *Kalanchoe rotundifolia, Lycium cinereum.* Graminoids: *Digitaria* sp*., Enneapogon* sp*., Eragrostis* sp., *Aristida* sp*., Heteropogon* sp., *Stipagrostis* sp., *Dicoma* species, *Geigeria* sp. etc.

Important taxa: No red data or endemic taxa are identified with this vegetation type, but three protected tree species can possibly be found in this area namely: *Acacia erioloba* (Kameeldoring), *Acacia haematoxylon* (Vaalkameeldoring) and *Boscia albitrunca* (Shepherds Tree).

5.6.2 Kuruman Thornveld

Kuruman Thornveld is described as occurring on flat rocky plains and slopping hills with a very well-developed, closed shrub layer and well-developed open tree stratum consisting of *Acacia erioloba* (Mucina & Rutherford, 2006) with *Tarchonanthus camphoratus* prominent in the shrub layer. Acocks (1953) described this vegetation as Kalahari Thornveld and Shrub Bushveld while Low & Rebelo (1996) described this vegetation as Kalahari Plains Thorn Bushveld. According to Mucina & Rutherford (2006) important taxa includes the following: Tall tree: *Acacia erioloba;* Small trees: *Acacia mellifera* subsp. *detinens and Boscia albitrunca;* Tall shrubs: *Grewia flava*, *Lycium hirsutum*, *Tarchonanthus camphoratus* and *Gymnosporia buxifolia*; Low shrubs: *Acacia hebeclada, Monechma divaricatum, Gnidia polycephala, Helichrysum zeyheri, Hermannia comosa, Pentzia calcarea* and *Plinthus sericeus;* Graminoids: *Aristida meridionalis, A. stipitata*, *Eragrostis lehmanniana*, *E. echinochloidea* and *Melinis repens*; Herbs: *Dicoma schinzii*, *Gisekia africana*, *Harpagophytum procumbens, Indigofera daleoides*, *Limeum fenestratum*, *Nolletia ciliaris*, *Seddera capensis, Tripteris aghillana* and *Vahlia capensis*.

5.7 FINE-SCALE MAPPING (CBA'S)

The Municipal Biodiversity Summaries Projects (2010) are the most relevant Biodiversity conservation plans for the area (SANBI: BGIS). No fine-scale mapping is as yet available for this area and as a result no critical biodiversity areas or biodiversity support areas has been promulgated for this area. However, a draft Environmental Management Framework (EMF) for the Siyanda District Municipal was published in 2008, and

even though this report was never formally approved, the findings were used to guide decision making for this report.

The proposed priorities for conservation in the Siyanda District is depicted on Maps 12a (Refer Figure 9) and 12b of the EMF and are based on local occurrence, the national conservation target, the national ecosystem status and the national protection level of the vegetation types. A proposal is made for the prioritisation of vegetation types in the Siyanda District Municipality (now ZF Mgcawu District Municipality). The landcover of the Siyanda district reflects the results of the 2000 national landcover determination and is depicted on Map 13 of the EMF from which it is evident that most of the area is still in its natural state.

A sensitivity index is shown on Map 14 of the Draft EMF (Figure 10 of this report). The main factors that were used to compile the index include the erosion potential of soils, the conservation priority of veld types, topographical areas with a high variance in shape and form, all watercourses, drainage lines and pans (including a 32m buffer on either side) and transformed areas. Map 14 of the EMP give a scale of -1 (transformed) to 8, where 8 represent the highest environmental sensitivity.

Environmental control zones are depicted on Map 15 of the EMF. The purpose of environmental control zones is to indicate areas that require a specific type or regime of control due to unique environmental elements that occur in these areas. It may or may not be linked to the application of EIA legislation and should be dealt with at a more strategic level where it should serve as a guide for decision-making and planning.

5.7.1 Summary of findings according to the EMF

According to the Siyanda Environmental Management Framework the proposed site falls within the following categories (refer to Figure 6 and Figure 7).

Table 3: Siyanda Municipal Draft EMF (2008): Conservation priority classification of the route according to Vegetation type

VEGETATION TYPE	Conservation Priority	Sensitivity index	Control zones
Postmasburg Thornveld (SVk 14)	3 - High	2 – Low/medium	Zone 3 Potential high conservation
Kuruman Thornveld (SVk 9)	3 - High	2 – Low/medium	Zone 3 Potential high conservation

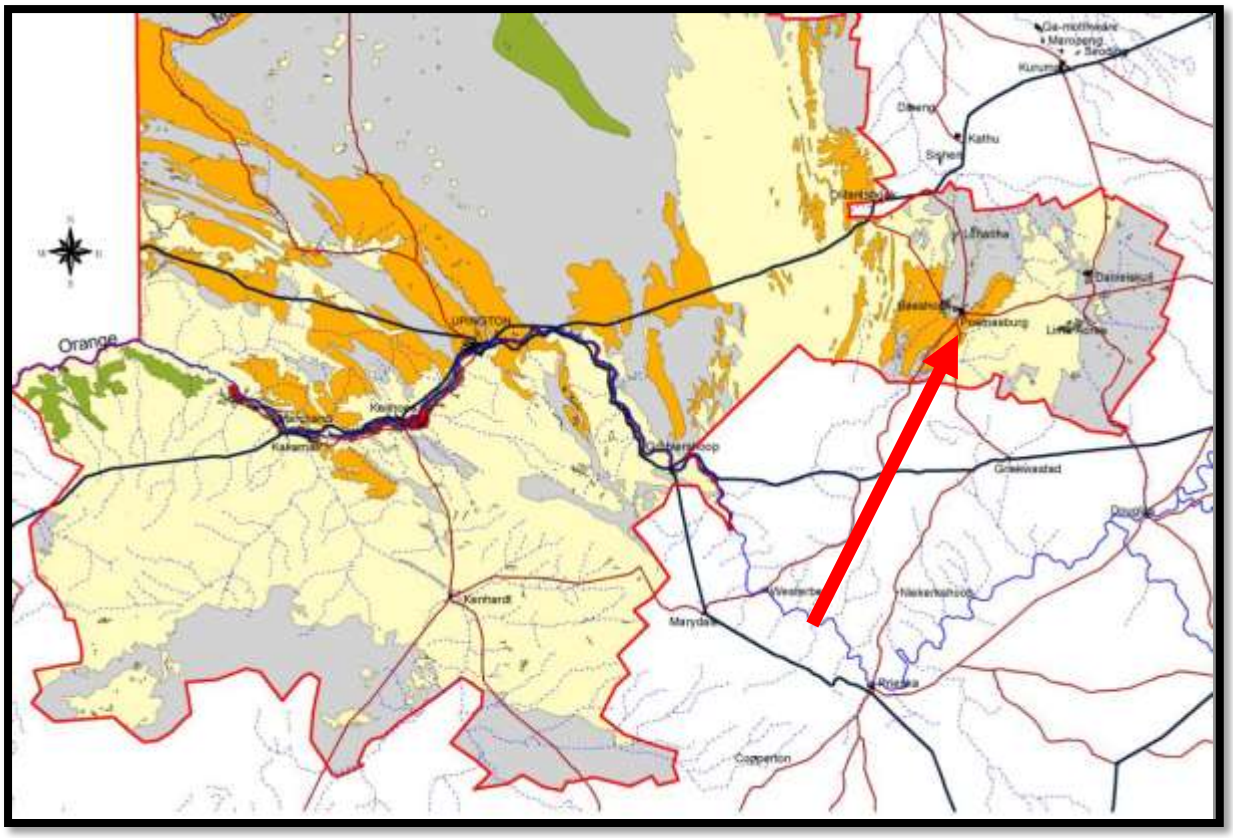

Figure 6: Siyanda Municipal Draft EMF (2008) – Map 12a: Conservation priority areas

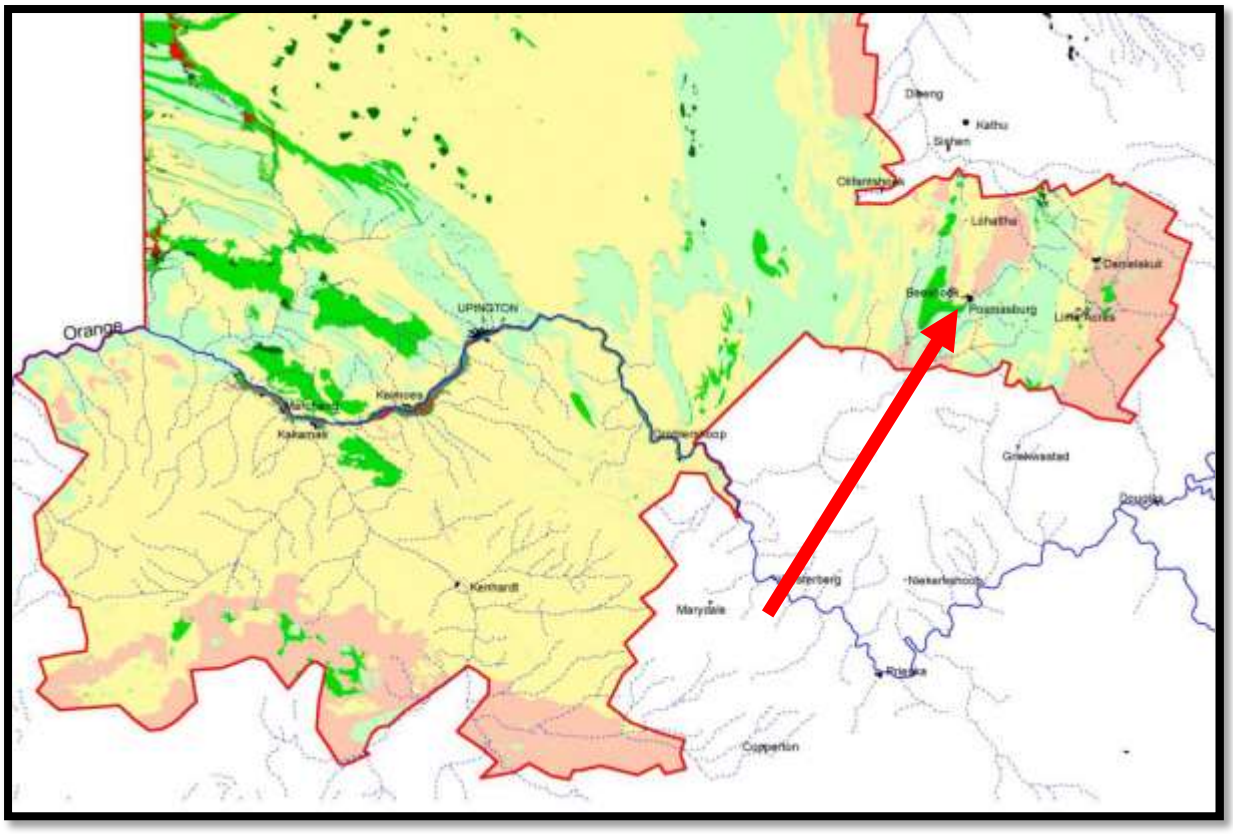

Figure 7: Siyanda Municipal Draft EMF (2008) – Map 14: Environmental Sensitivity Index

5.8 VEGETATION ENCOUNTERED

The description of the vegetation underneath follows the proposed pipeline route from north (pump station) to the south (new WWTW).

5.8.1 Vegetation encountered along the Groenwater Spruit

The riparian vegetation along the Groenwater Spruit from pump station 1 to the proposed new WWTW location can be described as very degraded and impacted as a result of urban creep and agricultural practices (refer to Photo 1 to Photo 4). Apart from a few natural reeds and sedges as well as the occasional *Acacia karroo* and *Searsia lancea* (which were mostly planted as decorative trees), the natural riparian vegetation has been replaced by alien invasive plant species. In the vicinity of pump station 1 and along the town edge the riparian vegetation is characterised by dense stands of trees of which most are alien species like: *Eucalyptus* spp. (Gum tree), *Melia azedarach* (Sering), *Populus canescens* (Match Poplar), *Prosopis glandulosa* (Mesquite) and *Schinus molle* (Pepper tree). Other alien species also commonly encountered were: *Amaranthus hybridus* (Pigweed), *Cirsium vulgare*, *Papaver aculeatum and Pennisetum clandestinum* (Kikuyu grass).

Photo 3: Vegetation encountered along the upper reaches of the Groenwater Spruit (near Pump Station 1)

Further downstream the dense alien tree stands gives way to a more open landscape (mostly cultivated or grazed land). Even though *Prosopis* still dominate in patches, a more natural riparian vegetation was encountered which included while indigenous species like *Acacia karroo* (Soetdoring), *A. mellifera*, (Swarthaak) *A. hebeclada*, *Aloe grandidentata* (on rocky outcrops), *Cynodon dactylon*, *Cyperus marginatus*, *Diospyros lycioides*, *Grewia flava*, *Gymnosporia buxifolia*, *Phragmites australis*, *Pseudoschoenus inanis*, *Searsia burchellii*, *Searsia lancea* and *Ziziphus mucronata* (Blinkblaar wag-'n-bietjie).

Photo 4: Vegetation encountered further along the Groenwater Spruit (intensive agriculture areas)

A number of garden escapees and other alien invasive plants were also encountered just outside the riparian zone namely: *Agave sisalana* (Garingboom), *Echinopsis spachiana*, *Harrisia martini* (Toutjieskaktus), *Opuntia ficus-indica (*Turksvy*)* and the indigenous weed *Gomphocarpus fruticosus*. The main feature of note with regards to biodiversity was the degraded status of the riparian vegetation as well as the number of alien invasive species associated with the river corridor.

5.8.2 Vegetation encountered on the proposed WWTW site

The proposed new WWTW site is located against a rocky slope rising eastwards away from the Groenwater Spruit. The vegetation encountered on site can be described as a low thornveld dominated by *Acacia mellifera* and *Rhigozum trichotomum* (refer to Photo 5). What was interesting was *Rhigozum trichotomum* become more prominent as one moves away from the Groenwater Spruit (higher up the slope, eastwards). The vegetation cover was approximately 70%, reaching approximately 0.6 m in height. Occasionally a small trees or larger shrub layer individuals would rise above the thornveld. The bottom layer consists out of a sparse grassy and shrub layer. Overall the vegetation was very uniform with a low species turnover.

A clump of 4 small (less than 3 m) *Acacia erioloba* trees was encountered to the south west of the proposed site (just outside the riparian zone), while a clump of *Aloe hereroensis* was also located just east of the Camelthorn trees (refer to Figure 8). In addition 2 smallish individuals of *Boscia albitrunca* (both on poor condition as a result of grazing) was also encountered (Figure 8). *Aloe grandidentata* was also very prominent and numerous clumps of this hardy species were encountered on the rocky slopes of the site (actually dominating the ground layer in patches). *Aloe grandidentata* is one of spotted aloes and an especially hardy

species which forms colonies by growing underground stolon's or suckers spreading sideways. Another interesting plant encountered were a single individual of *Pachypodium succulentum* ("Halfmens" family) (Refer to Photo 6). *Pachypodium* (closely related to the genus *Adenium*) falls into a group of the Apocynaceae family notorious for yielding potent poisons which has been used effectively in arrow poisons since ancient times.

Figure 8: Google overview of the approximate location of the proposed new WWTW indicating features of interest encountered

Photo 5: Typical vegetation encountered on the proposed new WWTW site (note the *Aloe grandidentata* in the undergrowth)

Apart from the dominant Swarthaak and Driedoring and species already mentioned above the following plants were also encountered on site: *Acacia hebeclada*, *Asparagus* species, *Diospyros lycioides, Eriocephalus* cf. *ericoides, Grewia flava, Gymnosporia buxifolia, Helichrysum zeyheri, Lycium cinereum, L. hirsutum, Nymania capensis (klapperbos), Olea europaea, Pentzia* species*, Tapinanthus oleifolius (*Mistletoe*), Ziziphus mucronata* ("Wag-'n-bietjie") and *Zygophyllum pubescens.*

Photo 6: *Pachypodium succulentum* (white variant)

The thornveld was in relative good condition, but showed signs of having been subjected to stock grazing over time. Connectivity is still good, even with its proximity to Postmasburg. The main features of biodiversity interested encountered during the site visit are the protected plant species and especially the number of *Aloe grandidentata* patches distributed all over the proposed site and its surroundings.

5.9 FLORA ENCOUNTERED

Please note that this study never intended to be full botanical assessment. However, a scan of significant species was done during the site visit, and even though the author does not claim that all species encountered were identified, all efforts were made to do just that. Table 4 gives a list of the species encountered on the two sites. Appendix 1 gives a list of plant species expected in along the route (SANBI, BGIS data).

Table 4: List of species encountered on the sites (excluding grass species)

SPECIES NAME		OCCURRENCE	FAMILY	SANBI / NCNCA / NFA Status
1.	*Acacia erioloba*	Single individuals just below proposed WWTW	FABACEAE	Protected in terms of the NFA
2.	*Acacia hebeclada*	Occasionally near Groenwater Spruit	FABACEAE	LC
3.	*Acacia karroo*	Along Groenwater Spruit	FABACEAE	LC
4.	*Acacia mellifera*	Common throughout WWTW site	FABACEAE	LC
5.	***Agave sisalana***	Occasionally along the Groenwater Spruit	AGAVACEAE	**Category 2 invader**
6.	*Aloe grandidentata*	Very common on rocky outcrops	ASPODELACEAE	LC; Protected in terms of Schedule 2 of the NCNCA
7.	*Aloe hereroensis*	One patch within the southwest of the new WWTW	ASPODELACEAE	LC; Protected in terms of Schedule 2 of the NCNCA
8.	*Amaranthus hybridus*	Pigweed, occasionally along stream	AMARANTHACEAE	**Alien weed**
9.	***Argemone ochroleuca***	Occasional near watercourses	PAPAVERACEAE	**Category 1 Invader**
10.	*Asparagus* species	Occasionally throughout	ASPARAGACEAE	LC
11.	*Boscia albitrunca*	Regularly encountered	CAPPARACEAE	Protected in terms of the NFA
12.	***Cirsium vulgare***	Occasionally near water course	ASTERACEAE	**Category 1 weed**

SPECIES NAME		OCCURRENCE	FAMILY	SANBI / NCNCA / NFA Status
13.	*Cynodon dactylon*	Common along stream	POACEAE	LC
14.	*Cyperus marginatus*	Patches within the water course	CYPERACEAE	LC
15.	*Diospyros lycioides*	Occasionally near Groenwater Spruit	EBENACEAE	LC
16.	***Echinopsis spachiana***	Occasionally outside the study area	CACTACEAE	**Category 1 Invader**
17.	*Eriocephalus* cf. *ericoides*	Occasionally within WWTW site	ASTERACEAE	LC
18.	***Eucalyptus spp.***		MYRTACEAE	**Category 2 Invader**
19.	*Gomphocarpus fruticosus*	Occasionally near Groenwater Spruit	APOCYANACEAE	**Indigenous Weed**
20.	*Grewia flava*	Occasionally throughout	TILIACEAEA	LC
21.	*Gymnosporia buxifolia*	Occasionally throughout	CELASTRACEAE	LC
22.	***Harrisia martini***	Occasionally	CACTACEAE	**Category 1 weed**
23.	*Lycium cinereum*	Common to karroid	SOLANACEAE	LC
24.	*Lycium hirsutum*	Occasionally in Mekgacha	SOLANACEAE	LC
25.	*Melia azedarach*	Occasionally next to Groenwater Spruit	MELIACEAE	
26.	*Nymania capensis*	Occasionally within WWTW site	MELIACEAE	LC
27.	*Olea europaea*	Single individuals next to stream	OLEACEAE	LC
28.	***Opuntia ficus-indica***	Occasionally throughout	CACTACEAE	**Category 1 invader**
29.	*Pachypodium succulentum*	Only one occurrence within the proposed WWTW site	APOCYNACEAE	LC.
30.	***Papaver aculeatum***	Occasionally near watercourse	PAPAVARACEAE	**Alien weed**
31.	***Pennisetum clandestinum***	Dense patches near watercourse	POACEAE	**Alien weed**
32.	*Pentzia* species	Occasionally within WWTW site	ASTERACEAE	
33.	*Phragmites australis*	Dense stands in Groenwater Spruit	POACEAE	LC; Protected in terms of Schedule 2 of the NCNCA
34.	***Populus canescens***	Along Groenwater Spruit	SALICACEAE	**Category 2 invader**
35.	***Prosopis grandulosa***	Occasionally near water courses	FABACEAE	**Category 2 invader**
36.	*Pseudoschoenus inanis*	Patches within watercourse	CYPERACEAE	LC
37.	*Rhigozum trichotomum*	Common	BIGNONIACEAE	LC
38.	*Schinus molle*	Single individuals next to watercourse	ANACARDIACEAE	**Non-indigenous species**
39.	*Searsia burchellii*	Occasionally throughout	ANACARDIACEAE	LC
40.	*Searsia lancea*	Next to Groenwater Spruit	ANACARDIACEAE	LC
41.	*Tapinanthus oleifolius*	Stem parasite on larger shrub (Mistletoe, lighted matches)	LORANTHACEAE	LC
42.	*Ziziphus mucronata*	Only one observation	RHAMNACEAE	LC
43.	*Zygophyllum pubescens*	Occasionally	ZYGOPHYLLACEAE	LC

5.10 SIGNIFICANT AND/OR PROTECTED PLANT SPECIES

South Africa has become the first country to fully assess the status of its entire flora. The Red List of South African Plants online provides up to date information on the national conservation status of South Africa's indigenous plants (www.redlist.sanbi.org). The table below provides guidelines for specialists on appropriate recommendations for species of conservation concern found on a proposed development site. The recommendations differ depending on both the Red List status of the species, as well as the Red List criteria met.

Table 5: Guidelines for specialists on appropriate recommendations for species of conservation concern (www.redlist.sanbi.org)

STATUS	CRITERION	GUIDELINES FOR RECOMMENDATION
Critically Endangered	PE	No further loss of natural habitat should be permitted as the species is on the brink of extinction, and all other known subpopulations have been lost. The subpopulation in question is likely to be newly discovered and the only remaining subpopulation of this species.
Critically Endangered	A,B,C,D	No further loss of natural habitat should be permitted as the species is on the verge of extinction.
Endangered	B,C,D	No further loss of habitat should be permitted as the species is likely to go extinct in the near future if current pressures continue. All remaining subpopulations have to be conserved if this species is to survive in the long term.
Endangered	Listed under A only	If the species has a restricted range (EOO < 2 000 km^2), recommend no further loss of habitat. If range size is larger, the species is possibly long- lived but widespread, and limited habitat loss may be considered under certain circumstances, such as the implementation of an offset whereby another viable, known subpopulation is formally conserved in terms of the National Environmental Management: Protected Areas Act (Act 57 of 2003), and provided that the subpopulation to be destroyed does not occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant spatial biodiversity plan or (iii) on a site associated with additional ecological sensitivities.
Vulnerable	D	This species either constitutes less than 1 000 individuals or is known from a very restricted range. No further loss of habitat should be permitted as the species' status will immediately become either Critically Endangered or Endangered, should habitat be lost.
Vulnerable	B,C	The species is approaching extinction but there are still a number of subpopulations in existence. Recommend no further loss of habitat as this will increase the extinction risk of the species.
Vulnerable	Listed under A only	If the species has a restricted range, EOO < 2 000 km^2, recommend no further loss of habitat. If range size is larger, the species is possibly long-lived but widespread, and limited habitat loss may be considered under certain circumstances, such as the implementation of an offset whereby another viable, known subpopulation is formally conserved in terms of the Protected Areas Act, and provided that the subpopulation to be destroyed does not occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant spatial biodiversity plan or (iii) on a site associated with additional ecological sensitivities.
Data Deficient	D	This species is very poorly known, with insufficient information on its habitat, population status or distribution to assess it. However, it is highly likely to be threatened. If a Data Deficient species will be affected by a proposed activity, the subpopulation should be well surveyed and the data sent to the Threatened Species Programme. The species will be reassessed and the new status of the species, with a recommendation, will be provided within a short timeframe.
Data Deficient	T	There is uncertainty regarding the taxonomic status of this species, but it is likely to be threatened. Contact the taxonomist working on this group to resolve its taxonomic status; the species will then be reassessed by the Threatened Species Programme.
Near Threatened	D	Currently known from fewer than 10 locations, therefore preferably recommend no loss of habitat. Should loss of this species' habitat be considered, then an offset that includes conserving another viable subpopulation (in terms of the Protected Areas Act) should be implemented, provided that the subpopulation to be destroyed does not occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant spatial biodiversity plan or (iii) on a site associated with additional ecological sensitivities.
Near Threatened	B,C	The species is approaching thresholds for listing as threatened but there are still a number of subpopulations in existence and therefore there is need to minimise loss of habitat. Conservation of subpopulations is essential if they occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant spatial biodiversity plan or (iii) on a site associated with additional ecological sensitivities.
Near Threatened	Listed under A only	If the species has a restricted range, EOO < 2 000 km^2, then recommend no further loss of habitat. If range size is larger, the species is possibly long-lived but widespread, and limited habitat loss may be considered. Conservation of subpopulations is essential if they occur (i) within a threatened ecosystem or (ii) within an area required for biodiversity conservation in terms of a relevant biodiversity conservation plan or (iii) on a site associated with additional ecological sensitivities.
Critically Rare		This is a highly range-restricted species, known from a single site, and therefore no loss of habitat should be permitted as it may lead to extinction of the species. The Threatened Species Programme is not aware of any current threats to this species and should be notified without delay.
Rare		The species is likely to have a restricted range, or be highly habitat specific, or have small numbers of individuals, all of which makes it vulnerable to extinction should it lose habitat. Recommend no loss of habitat. The Threatened Species Programme is not aware of any current threats to this species and should be notified without delay.
Declining		The species is declining but the population has not yet reached a threshold of concern; limited loss of habitat may be permitted. Should the species is known to be used for traditional medicine and if individuals will not be conserved in situ, plants should be rescued and used as mother stock for medicinal plant cultivation programmes.

5.10.1 Red List of species for South Africa

No species of conservation concern was recorded in terms of the latest Red List of species for South Africa (Refer to Table 4).

5.10.2 Protected species in terms of the NFA

The National Forests Act (NFA) of 1998 (Act 84 of 1998) provides for the protection of forests as well as specific tree species (GN 71 6 of 7 September 2012).

Two (2) species protected in terms of the NFA were encountered namely:

- ***Acacia erioloba*** **–** One stand of 4 small individuals located just outside of the proposed WWTW footprint (refer to the photo with Par. 5.10.2.1). Should not be impacted.
- ***Boscia albitrunca*** **–** Two individuals in very poor condition (refer to photo with Par. 5.10.2.2) located within the proposed WWTW footprint. Will be impacted.

Table 6: Protected tree species encountered at the proposed reservoir site

WP NO.	SPECIES NAME	HEIGHT	POSITION
1.	***Acacia erioloba***	4 x small individuals (<3 m), grouped together	S28 20 25.1 E23 02 57.8
2.	***Boscia albitrunca***	1 individual tree in poor state (<0.5 m)	S28 20 24.3 E23 03 02.7
3.	***Boscia albitrunca***	1 individual tree in poor state (<0.5 m)	S28 20 22.2 E23 03 07.4

5.10.2.1 Camelthorn

The slow-growing Camelthorn grows well in poor soils and in harsh environmental conditions. However, they will take up to 10 years before starting to flower, and only by age 20, will produce regular large pod crops (Seymour & Milton, 2003). It is this of great important that especially mature seed producing individuals are protected. Most benefits brought by *A. erioloba* are not immediately apparent, and it is only when they are large, years after establishment, that they begin to appreciably affect soil quality, produce large patches of shade, and produce pods, gum, and fuel wood. Large trees also diminish nutrient leaching, increase nutrient levels beneath their canopies (owing to nutrient cycling and concentration of livestock dung), mitigate soil degradation, prevent soil erosion on steep slopes, sequester carbon and replenish organic matter. Pod production is linearly related to tree size, so as trees become older, they become more valuable as a source of seed and forage, as livestock relish eating the pods (Seymour and Milton, 2003). In addition, it is often the only available dense shade tree in the hot arid environment of the south-western regions of its distribution. The Camelthorn tree exhibits distinctive high

quality red heartwood and is a used as a firewood as well as fodder (especially the pods). It holds economic significance in the southern Kalahari region. Camelthorn wood is regarded as the best source of firewood in the region where fuel wood is scarce. As a result this tree has been utilised extensively in the past and are now protected species tree species in South Africa in terms of National Forests Act (GN 716 of 7 September 2012).

5.10.2.2 Sheppard's tree

According to Alias & Milton (2003) *Boscia albitrunca* is a keystone species in arid southern Africa, where it primarily provides browse to livestock and game, shade and food and shelter to other animals including invertebrates and birds. The laws of numerous African traditions strictly prohibit destruction of this tree. The wood is not favoured as a fuel wood and has no commercial value, although it is sometimes used in rural areas for making household items such as tables, chairs, spoons and dishes. This species is under threat, however, owing to intense use of its branches to supplement livestock feed, particularly in times of drought. Its nutritious foliage suggests that this species obtains nutrients from ground water and perhaps also from the concentration of nutrients beneath its canopy because of animal activities. It therefore contributes to nutrient cycling in mainly oligotrophic sands, as well as performing other ecological services such as reducing nutrient leaching, mitigating soil degradation, preventing soil erosion, sequestering carbon and replenishing organic matter. This species is observed to establish beneath other large trees within its environment, primarily *A. erioloba*, which serve as resting and perch sites for animals and birds, making the species dependent on large tree species in arid savannah. Therefore, threats to species that provide these micro-sites also constitute a threat to *B. albitrunca*. Within the arid Kalahari, indiscriminate removal of Camelthorn (*Acacia erioloba*) trees could reduce the availability of suitable germination sites (Alias & Milton, 2003).

5.10.3 Species protected in terms of the NCNCA

The Northern Cape Nature Conservation Act 9 of 2009 (NCNCA) came into effect on the 12th of December 2011, and also provides for the sustainable utilization of wild animals, aquatic biota and plants. Schedule 1 and 2 of the act give extensive lists of specially protected and protected fauna and flora species in accordance with this act.

Three (3) species listed in terms of the NCNCA were encountered along the route, all of which are considered to be of Least Concern in terms of IUCN status (the International Union for the Conservation of Nature). *Aloe*

hereroensis was encountered in one patch to the south west of the proposed site and these individuals should be transplanted or conserved if possible. However, the *Aloe grandidentata* was so numerous that it would not be possible to transplant them all. It is suggested that at least 10% of these plants are transplanted and that local conservation bodies are contacted with regards to possible re-use of the remainder. A single individual of *Pachypodium succulentum* was also encountered and should be transplanted. Please note that a flora permit will have to be applied for in terms of the NCNCA .

5.11 FAUNA AND AVI-FAUNA

Although natural fauna and avi-fauna may still be present, it is expected that it would be limited to avi-fauna, insects and smaller game and reptile species. Because of the proximity of the route and site to Postmasburg it is not expected that game or avi-fauna will be significantly adversely affected, apart from the possible impact which will be left by the removal of larger indigenous trees. In this case care should be taken when working near the riparian zone of the Groenwater Spruit and especially with regards to any remaining large indigenous tree species encountered.

Mammals: The site falls within the distribution range of approximately 50 mammal species indicating moderate diversity. Human activity in the area is medium-high and it is highly unlikely that a fair representation of these mammals will be found along the route. It is considered highly unlikely that it will pose a significant impact on mammal species and as a result the impact is deemed negligible.

Reptiles: The site falls within the distribution range of approximately 30 reptile species, indicating low diversity. Although the substrate is rocky it does not offer much habitat protection such as rocky outcrops would, and it likely to be dominated by species which inhabit open areas, such as snakes, lizards and geckos. Human activity in the area is medium-high and it is highly unlikely that large numbers of these species will be present on site. As such, the impact on reptiles should be negligible.

Amphibians: The site falls within the distribution range of approximately 10 amphibian species. Suitable breeding places will be present along the Groenwater Spruit, but since the Spruit has been subjected to significant disturbance it is unlikely that a fair representation will be present in the proposed study area. The impact on amphibian species is considered low and temporary.

Avi-fauna: The site falls within the distribution range of approximately 200 bird species known from the broad area and a number of species had been observed along the Groenwater Spruit. Apart from the possible impact on mature trees (mentioned above) the proposed activity is not expected to have a significant impact on avi-fauna. However, it remains important that all larger indigenous trees must be protected wherever possible in order to minimise the possible impact (although localised) on bird species.

5.12 RIVERS AND WETLANDS

Rivers maintain unique biotic resources and provide critical water supplies to people. South Africa's limited supplies of fresh water and irreplaceable biodiversity are very vulnerable to human mismanagement. Multiple environmental stressors, such as agricultural runoff, pollution and invasive species, threaten rivers that serve the world's population. River corridors are important channels for plant and animal species movement, because they link different valleys and mountain ranges. They are also important as a source of water for human use. Vegetation on riverbanks needs to be maintained in order for rivers themselves to remain healthy, thus the focus is not just on rivers themselves but on riverine corridors.

The proposed pipeline route will follow the non-perennial Groenwater Spruit for approximately 1.3 km. Please note that the Groenwater Spruit is supposed to be seasonal stream, but that it now supports a constant stream of water in the vicinity of Postmasburg as a result of water being released into the stream. However, this stream is only supported for small distance downstream after which it probably siphons into the ground. During the site visit the smell and colour of the water indicate water of very poor quality (Refer to the photo underneath).

During the 2004 National Spatial Biodiversity Assessment, the Groenwater Spruit system has been classified as largely natural and not threatened, which places a special emphasis on the management and protection of this river system. Although this might hold true for most of the river system, the portion of the Spruit near Postmasburg is certainly in a poor ecological state and impacted by the urban edge effect, agriculture and alien infestation and is certainly not pristine anymore.

5.12.1 *Loss of riparian habitat and bed/bank modification:*

The preparation and installation of the pipeline has the potential to impact on the riparian zone of the Groenwater Spruit, during construction. The disturbance of habitat during and after the construction activities also provides an opportunity for further invasive alien plants to establish in the area and might leave erosion potential. However, it should be taken into account that the placement of the pipeline along the Groenwater Spruit will be temporary of nature and with good control should not add to further degradation of its ecological status. Even so, it is recommended that the proposed pipeline is placed away from the riparian zone wherever possible and that efforts are made to remove alien tree species along the proposed route (taking special care with the method used to remove *Prosopis* in order not to aggravate the current infestation densities). During the construction phase the impact on any riparian zone should be kept to a minimum. After the construction phase, the riparian area should be rehabilitated. Follow up work should be carried out after rehabilitation to control invasive alien infestation within the riparian zone.

Figure 9: Google image showing the proposed construction layout next to the Groenwater Spruit as well as agricultural practices

In the long run the new WWTW might benefit the water course and especially underground water resources in the sense that better control over treated effluent quality and disposal will minimise raw sewerage spillages through the town and into the Groenwater Spruit (thus improving water quality. This alone is probably the most significant potential positive of this project, since Postmasburg is dependent on underground water for their daily use the protection of this resource is of great importance. The physical impact on the Groenwater Spruit is considered short term and unlikely to further degrade the already poor ecological status. However, improve water quality from the treatment works and the possible prevention of further uncontrolled sewerage spills into the Spruit and to underground water resources might have a significant long positive results.

5.13 INVASIVE ALIEN INFESTATION

Quite a number of alien species and especially invasive alien species had been encountered during the site visit. Of these the most concerning are probably the presence of the *Prosopis* trees along the Groenwater Spruit and the Cactaceae species encountered with in the WWTW site and adjacent to the water course. In total a 13 potentially invasive species were encountered, of which five (5) were category 1 weeds in terms of CARA, another 4 were category 2 invader species in terms of CARA, and 4 were considered weeds (not listed in terms of CARA), one being the indigenous species *Gomphocarpus fruticosus*. In addition the alien tree *Schinus molle* (not listed) was also encountered. According to regulation 15 and 16 of CARA all listed alien invader plants and weeds must be removed/controlled.

In this case all category 1 and 2 listed alien invader species encountered should be removed from at least construction footprint and its immediate vicinity. However, it is important that the correct method is used as species such as *Prosopis* may quickly become much larger problems if incorrect or mechanical means alone are used for their removal.

6. VELD FIRE RISK

The revised veldfire risk classification (Forsyth, 2010) in terms of the National Veld and Forest Fire Act 101 of 1998 was promulgated in March 2010. The purpose of the revised fire risk classification is to serve as a national framework for implementing the National Veld and Forest Fire Act, and to provide a basis for setting priorities for veldfire management interventions such as the promotion of and support to Fire Protection Associations. In the fire-ecology types and municipalities with High to Extreme fire risk, comprehensive risk management strategies are needed.

The proposed Postmasburg WWTW is located in an area supporting low shrubland for the majority of the route which has been classified with a **high fire risk classification** (Refer to Figure 10). It is thus important that during construction and operation the site must adhere to all the requirements of the local Fire Protection Association (FPA) if applicable, or must adhere to responsible fire prevention and control measures.

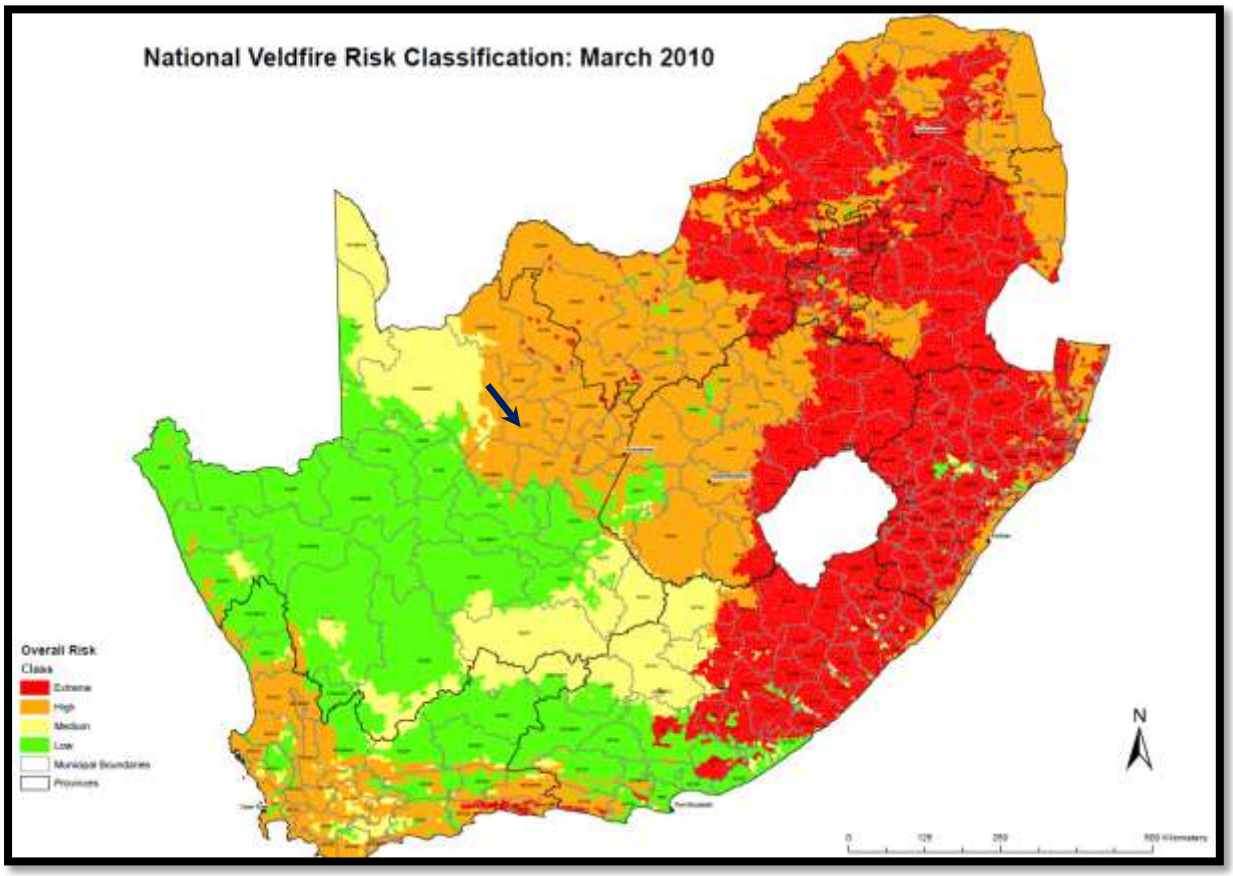

Figure 10: South African National Veldfire Risk Classification (March 2010)

7. BIODIVERSITY ASSESSMENT

Biological diversity, or biodiversity, refers to the variety of life on Earth. As defined by the United Nations Convention on Biological Diversity, it includes diversity of ecosystems, species and genes, and the ecological processes that support them. Natural diversity in ecosystems provides essential economic benefits and services to human society—such as food, clothing, shelter, fuel and medicines—as well as ecological, recreational, cultural and aesthetic values, and thus plays an important role in sustainable development. Biodiversity is under threat in many areas of the world. Concern about global biodiversity loss has emerged as a prominent and widespread public issue. The objective of this study was to evaluate the biological diversity associated with the study area in order to identify significant environmental features which should be avoided during development activities and or to evaluate short and long term impact and possible mitigation actions in context of the proposed development.

As such the report aim to evaluate the biological diversity of the area using the Ecosystem Guidelines for Environmental Assessment (De Villiers *et. al*., 2005), with emphasis on:

- Significant ecosystems
    - Threatened or protected ecosystems
    - Special habitats
    - Corridors and or conservancy networks
- Significant species
    - Threatened or endangered species
    - Protected species

7.1 DISCUSSION OF POTENTIAL IMPACTS

The Postmasburg WWTW and connection pipeline entails the construction of a new pipeline of approximately 1.3 km along the Groenwater Spruit and the construction of a new WWTW (to replace the existing works) adjacent to the Groenwater Spruit. The placement of the proposed pipeline is likely to impact on the riparian vegetation along the Groenwater Spruit, especially along the first portion of the pipe where it will runs next to existing housing of Postmasburg as a result of limited space. Physical barriers like rocky outcrops will also prevent the pipeline being removed totally from the riparian zone at some points. Still it should aim at minimising the impact on the riparian zone wherever possible. However, along most of the pipeline route the riparian zone can be described as degraded and in a poor ecological state. Alien infestation coupled with agricultural practices (intensive agriculture within the alluvial valley bottom) and the urban edge effect has transformed the river status in large sections within the proposed construction site. BUT it must also be noted that with good alien management and better environmental practices being implemented along this watercourse the natural riparian vegetation should be easily re-established. Pollution from the town and its associated activities (including the sewerage works) as well as nearby industries has also recently resulted in significant impacts on the water quality of the Groenwater Spruit. It is very likely that the current water quality poses significant health risks if consumed or used for recreation.

Direct impacts will be associated with the pipeline will be relative short construction period (months) and are considered temporary, since the pipeline will be located underground. However, even though the impact will be localised and temporary in nature it will have a direct impact on the riparian zone of the Groenwater Spruit (no matter in what poor condition it currently is). In addition the potential to aggravate infestation ratios of specifically *Prosopis* trees are high if not managed correctly. The direct impact on the proposed WWTW will be permanent of nature. The vegetation types encountered are all considered Least Threatened (thus not under any immediate threat in terms of extinction) but both are currently poorly protected and will require further conservation efforts. It is important to understand that these vegetation types are not particularly rich in plant species and does not contain any centre of endemism. Unlike some biomes of South Africa, local endemism is also very low. **Meaning that the vegetation type is fairly similar over extended areas and it would be unlikely that small localised impacts will have any significant impact on any specific species or the vegetation type as a whole.** The vegetation is also not fragmented in any way with extended areas of excellent connectivity remaining throughout.

Two (2) protected species in terms of the NFA were encountered on or near the proposed new WWTW site. The *Acacia erioloba* individuals are located just to the southwest of the proposed site and with environmental control there should be no reason that these trees are impacted. Two individuals (both in poor state) of the Sheppard's tree (*Boscia albitrunca*) was encountered within the proposed new WWTW site and will be impacted. In addition two *Aloe* species and one *Pachypodium* individual, protected in terms of the NCNCA was encountered, along the pipeline route as well as within the proposed WWTW site. Please note that both are classified as of Least Concern according to the latest IUCN status (International Union for the Conservation of Nature). Only a limited patch of *Aloe hereroensis* was encountered and even though they will be impacted it will be possible to transplant them in the immediate surrounding area. However, the hardy *Aloe grandidentata* was encountered in great numbers spread all over the proposed WWTW site and its immediate surroundings. It will not be practical to replant all of these species, but the project should aim at transplanting at least 10% of these plants to the adjacent natural areas. Furthermore, conservation bodies should be contacted with regards to possible re-use of the remainder before construction began. Even though quite a few *Aloe grandidentata* individuals will thus be lost as a result of the proposed new WWTW locations it is highly unlikely that **the construction activities will have any significant impact on local or regional populations** of any of the protected species.

Of greater concern is the possible impact of the pipeline on the riparian vegetation of the Groenwater Spruit. The disturbance of habitat during and after the construction activities also provides an opportunity for further invasive alien plants to establish in the area and might leave erosion potential. However, it should be taken into account that the construction will be temporary of nature and with good control should not add to further degradation of its ecological status. But it will be important that the alien control methods are used as species such as *Prosopis* will become much larger problems if incorrect or mechanical means alone are used for their removal.

7.2 EVALUATION OF POTENTIAL ENVIRONMENTAL SIGNIFICANCE

The table underneath gives a summary of biodiversity features encountered during the site visit and a short discussion of their possible significance in terms of regional biodiversity targets.

BIODIVERSITY ASPECT	SHORT DESCRIPTION	SIGNIFICANCE RATING	
Potential impacts on biophysical environment			
Geology & soils	Geology & soils vary only slightly in the larger study area.	No special features have been encountered (e.g. true quartz patches or broken veld) and the impact on geology and soils is expected to be very localised and low. Mitigation will entail minimising footprint.	
		Without mitigation: Low	**With mitigation: Low**
Land use and cover	The proposed route will have a permanent impact on approximately 10 ha of grazing area.	The grazing potential of the land is low and the impact is considered localised. Mitigation will minimising disturbance footprint associated with the pipeline construction.	
		Without mitigation: Low	**With mitigation: Low**
Potential impacts on threatened or protected ecosystems			
Vegetation type(s)	Two vegetation types were encountered (Refer to Table 2):	Both vegetation types are classified as "Least threatened" but poorly protected. According to the Draft Siyanda EMF, both vegetation types have a high conservation priority (being poorly protected) but a low/medium sensitivity index (more than 98% remaining and low species turnover). It is thus highly unlikely that small localised impacts will have any significant impact on any specific species, local and regional conservation targets or threatened ecosystems. Mitigation will entail minimising footprint where possible.	
		Without mitigation: Low	**With mitigation: Low**
Corridors and conservation priority areas/networks.	Draft Environmental Management Framework (EMF) for the Siyanda District Municipality.	According to the Draft Siyanda EMF, both vegetation types have a high conservation priority (being poorly protected) but a low/medium sensitivity index (more than 98% remaining and low species turnover). It is thus highly unlikely that small localised impacts will have any significant impact on any specific species, local and regional conservation targets or threatened ecosystems. The impact on river corridors will be short term and temporary of nature, but is likely to impact on the riparian vegetation. Mitigation will entail minimising the impact on riparian vegetation and to ensure erosion control through good rehabilitation. Correct alien eradication will also be important.	
		Without mitigation: Medium/Low	**With mitigation: Low**
Protected plant species	No SA red list species was observed. Two tree NFA protected tree species were encountered and 3 NCNCA protected plant species were observed.	No *Acacia erioloba* individual should be impacted, but two *Boscia albitrunca* shrubs in poor condition will be impacted. In addition a number of *Aloe* individuals and one *Pachypodium* will be impacted. Mitigation will entail excellent environmental control and application for permits in terms of the NFA and the NCNCA.	
		Without mitigation: Medium/Low	**With mitigation: Low**
Fauna & Avi-fauna	The proposed route will follow existing road reserves and with low impact on habitat.	Because of the temporary and localised nature of the activity it is considered highly unlikely that it will have any significant impact on fauna or avi-fauna. Mitigation will entail staying within the road reserve and minimising footprint and the impact on mature indigenous tree species.	
		Without mitigation: Low	**With mitigation: Insignificant**
Rivers & wetlands	The proposed route will follow the Groenwater Spruit and are likely to impact on riparian vegetation.	Even though the riparian vegetation is in poor state and the impact will be localised and short term, uncontrolled excavation can have serious additional impacts on the riparian zone especially with regards to infestation escalation (specifically *Prosopis* infestation). Mitigation will entail excellent environmental control in order to minimise the impact on riparian zones, to ensure good rehabilitation and to reduce the	

BIODIVERSITY ASPECT	SHORT DESCRIPTION	SIGNIFICANCE RATING	
		risk of erosion.	
		Without mitigation: Medium	**With mitigation: Medium/Low**
Invasive alien infestation	A total of 14 alien species or indigenous weeds were observed of which the most concerning are the presence of *Prosopis* along the Groenwater Spruit and the Cactaceae species.	All listed invasive alien species must be removed during the construction. However, incorrect alien control methods used for especially *Prosopis* species may aggravate the situation and result in spreading in place of control of these species. Mitigation will entail correct alien control methods coupled with follow up work after rehabilitation.	
		Without mitigation: Medium/Low	**With mitigation: Positive**
Potential direct impacts			
Direct impacts	Refers to those impacts with a direct impact on biodiversity features.	The proposed activity will have a direct impact on natural vegetation, which is likely to include protected plant species in terms of the NFA and NCNCA, riparian vegetation of the Groenwater Spruit and vegetation with a potential high conservation value. The impact on soil, landuse, fauna and avi-fauna and veld fire is considered to be low. However, it is unlikely that the proposed project will have significant impact on local or regional conservation targets. Mitigation will include all the mitigation aspects discussed above.	
		Without mitigation: Medium/Low	**With mitigation: Low**
Potential indirect impacts			
Indirect impacts	Refers to impacts that are not a direct result of the main activity, but are impacts associated or resulting from the main activity.	It is very likely that the proposed project will have indirect impacts like the establishment of temporary lay-down areas, temporary construction sites and concrete mixing areas. However, with good environmental control it will be possible to minimise the impact of such indirect impacts. Mitigation will entail excellent environmental control, placement of temporary lay-down areas or construction sites within areas that are not environmentally sensitive and will not impact on protected plant species. It will also entail good waste and wastewater control.	
		Without mitigation: Medium/Low	**With mitigation: Low**
Potential cumulative impacts			
Cumulative impacts	Refers to the cumulative loss of ecological function and other biodiversity features on a regional basis.	The proposed project will have a localised impact, which should not result in significant additional permanent impacts. Overall it is not considered likely that the cumulative impact will result in any significant additional impact on regional biodiversity targets. Mitigation will entail excellent environmental control and all of the mitigation measures addressed above	
		Without mitigation: Medium	**With mitigation: Medium/Low**

BIODIVERSITY ASPECT	SHORT DESCRIPTION	SIGNIFICANCE RATING
The No-Go Option		
The No-Go Option	The "No-Go alternative" does not signify significant biodiversity gain or loss especially on a regional basis. However, it will ensure that none of the potential impacts above occur.	The existing Waste Water Treatment Works operate at over maximum capacity which had led to numerous uncontrolled discharges through town and into the Groenwater Spruit, which resulted in significant environmental and public health risks. To accommodate the growing population of Postmasburg and the growing costs of operating the existing waste water treatment works must be upgraded or replaced. At present treated effluent at the existing WWTW, is discharged into two freestanding maturation ponds while a portion is used for irrigation. The remainder of the effluent is either evaporated or overflows to adjacent shallow pans. During years of high rainfall the storm water run-off flows into the maturation/evaporation ponds located on the high ground south east of Postmasburg. This high influx of storm water causes the treated effluent to overflow from the maturation ponds which then discharges down the hill in a north-westerly direction through the new Airfield residential development and the Postmasburg CBD where it eventually ends up in the Groenwater Spruit. This discharge is uncontrolled and poses a significant environmental and public health risk. Because of the location of the existing works (the highest point of the town property) there is a continual pumping cost in order to pump raw effluent from the main collection sump (Pump Station 1) at the lowest point in town (next to the Groenwater Spruit) to the treatment works (which involves more than one pump station). Pumping costs and continual maintenance of the system places a huge demand on the town's resources. Studies indicate that there will be significant long term benefits if the treatment works can be re-positioned on a lower-lying area. Pumping costs will be significantly reduced and maintenance will be easier and the existing pollution and especially health issues will be addressed (redirected away from the town). The No-Go option will result in continual pollution and health risks, coupled with huge maintenance costs. In addition the current WWTW will still have to be upgraded in order to handle the current and projected sewerage volumes expected. The location of the current works will remain problematic (uncontrolled discharge of raw effluent) and very expensive to operate (pumping costs).

8. SUMMARY

Having evaluated the biodiversity aspects and associated impacts pertaining to the proposed development, the author is of the opinion that the proposed project will have a significant impact on cutting operational costs, pollution prevention and health risks. The improved treatment method should enable easy expansion without major footprint enlargements (or further work within the riparian zone). From a biodiversity perspective it will have very little impact on local or regional conservation targets, but will have a slight impact on protected species and a temporary impact on the Groenwater Spruit riparian vegetation. But the impact will be localised and with good environmental control and mitigation should not have any significant impact on conservation targets.

The evaluation of the potential environmental impacts indicates the most significant potential impacts identified where:

- The potential impact on two NFA *Boscia albitrunca* individuals;
- The impact on a number of species protected in terms of the NCNCA;
- The potential impact on vegetation with a high conservation priority as a result of its current poor conservation status (fortunately more than 98% of both these vegetation types remains);
- The potential impact on the riparian vegetation associated with the Groenwater Spruit.

With mitigation it is considered highly unlikely that the proposed project will contribute significantly to any of the following:

- Significant loss of vegetation type and associated habitat.
- Loss of ecological processes (e.g. migration patterns, pollinators, river function etc.) due to development and operational activities.
- Loss of local biodiversity and threatened plant species.
- Loss of ecosystem connectivity

Lastly it is felt that good environmental planning and control during development, the appointment of a suitably qualified ECO and the implementation of an approved EMP could significantly reduce environmental impact.

With the available information to the author's disposal it is recommended that project be approved, provided that mitigation is adequately addresses.

9. MITIGATION RECOMMENDATIONS

9.1 GENERAL

- All construction must be done in accordance with an approved construction and operational phase Environmental Management Plan (EMP), which must be developed by a suitably experienced Environmental Assessment Practitioner.
- A suitably qualified Environmental Control Officer must be appointed to monitor the construction phase in terms of the EMP and the Biodiversity study recommendations as well as any other conditions pertaining to other specialist studies and requirements of the DENC or DAFF.
- The pipeline route and WWTW site must be demarcated (aiming at the smallest footprint).
- Before any excavation is allowed all significant plant species identified during the botanical scan must be rescued in a search and rescue operation supervised by a suitably qualified botanist.
- Only existing access routes should be used wherever possible.

9.2 OTHER LEGISLATION

- An **application must be made for a permit in terms of the NFA** with regards to the potential impact on the two protected tree species.
- An **application must be made for a flora permit in terms of the NCNCA** with regards to the impact on listed species identified in terms of Schedule 1 and 2 of the act.
- An application for a Department of Water Affairs authorization might be applicable with regards to the location of the new WWTW and the pipeline as well as end use (irrigation) in terms of the NWA.

9.3 SITE SPECIFIC RECOMMENDATION

- When working within or near water courses the impact on riparian vegetation must be minimised through excellent environmental control with the aim of minimising the impact on riparian zones; ensuring good rehabilitation and re-vegetation with suitable indigenous vegetation to reduce the risk of erosion in the stream channels.
- The final pipeline route must be adjusted on site via ECO approval, with the aim of minimising impact on mature indigenous tree species (especially protected tree species), through slight route alterations.
- If required, river crossing should only be done when they are not in flow (dry season) and wherever possible, the crossings should be diagonally to the river banks (the shortest route possible).
- Where possible work in the vicinity of the Groenwater Spruit should aim at utilising already disturbed areas (e.g. road verges) thus minimising any additional footprint within the river corridor.
- The integrity of the Groenwater Spruit system must be protected throughout the construction and operation phase of the pipeline.

- Adequate measures must be implemented to ensure against erosion.
- Additional lay-down areas or construction sites must be located within already disturbed areas or areas of low ecological value and must be pre-approved by the ECO.
- Indiscriminate clearing of areas must be avoided.
- At the WWTW location, topsoil (the top 10-20 cm layer of soil), which will contain 80-90% of the seed bearing material and bulbs, must be protected throughout the project (removal and separately storage).
- The topsoil and vegetation must be replaced over the disturbed soil to provide a source of seed and a seed bed to encourage re-growth of plant species (topsoil from the new WWTW location can be re-used for pipeline rehabilitation outside of the riparian zone).

9.4 ALIEN VEGETATION MANAGEMENT

- All alien vegetation must be removed from within the construction footprint (the road reserve) and immediate surroundings (especially river corridors).
- It is imperative that the correct alien eradication methods are employed (especially with regards to *Prosopis* control) as incorrect methods **WILL** aggravate the infestation.
- Follow up work must be carried out after rehabilitation to ensure that no invasive alien plant re-establishes itself.

9.5 WASTE MANAGEMENT

- An integrated waste management approach must be implemented during construction.
- Construction related general and hazardous waste may only be disposed of at Municipal approved waste disposal sites.
- Spoil from excavation work should be used as fill where possible.

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APPENDIX 1: BGIS SPECIES EXPECTED ALONG THE ROUTE (FLORA & FAUNA)

FAMILY	SPECIES NAME	CATEGORY
MALVACEAE	*Abutilon austro-africanum*	Plants
FABACEAE	*Acacia mellifera* subsp*. detinens*	Plants
CUCURBITACEAE	*Acanthosicyos naudinianus*	Plants
PASSIFLORACEAE	*Adenia repanda*	Plants
AMARANTHACEAE	*Aerva leucura*	Plants
AIZOACEAE	*Aizoon asbestinum*	Plants
HYACINTHACEAE	*Albuca* sp.	Plants
ASPHODELACEAE	*Aloe dichotoma*	Plants
ASPHODELACEAE	*Aloe hereroensis* var*. hereroensis*	Plants
BORAGINACEAE	*Anchusa riparia*	Plants
POACEAE	*Anthephora pubescens*	Plants
SCROPHULARIACEAE	*Aptosimum indivisum*	Plants
SCROPHULARIACEAE	*Aptosimum marlothii*	Plants
ASTERACEAE	*Arctotis acaulis*	Plants
ASTERACEAE	*Arctotis venusta*	Plants
FABACEAE	*Argyrolobium argenteum*	Plants
POACEAE	*Aristida adscensionis*	Plants
POACEAE	*Aristida congesta* subsp*. barbicollis*	Plants
POACEAE	*Aristida congesta* subsp*. congesta*	Plants
POACEAE	*Aristida diffusa* subsp*. burkei*	Plants
POACEAE	*Aristida stipitata* subsp*. graciliflora*	Plants
POACEAE	*Aristida vestita*	Plants
ASPARAGACEAE	*Asparagus exuvialis* forma *exuvialis*	Plants
ASPARAGACEAE	*Asparagus nelsii*	Plants
ASPARAGACEAE	*Asparagus suaveolens*	Plants
CHENOPODIACEAE	*Atriplex suberecta*	Plants
PORTULACACEAE	*Avonia albissima*	Plants
IRIDACEAE	*Babiana bainesii*	Plants
IRIDACEAE	*Babiana hypogaea*	Plants
ACANTHACEAE	*Barleria bechuanensis*	Plants
ACANTHACEAE	*Barleria lichtensteiniana*	Plants
ACANTHACEAE	*Barleria rigida*	Plants
ASTERACEAE	*Berkheya pinnatifida* subsp*. pinnatifida*	Plants
ACANTHACEAE	*Blepharis integrifolia* var*. clarkei*	Plants
CAPPARACEAE	*Boscia albitrunca*	Plants
POACEAE	*Brachiaria brizantha*	Plants
POACEAE	*Brachiaria marlothii*	Plants
APOCYNACEAE	*Brachystelma circinatum*	Plants
ASPHODELACEAE	*Bulbine abyssinica*	Plants
SCROPHULARIACEAE	*Chaenostoma halimifolium*	Plants
FABACEAE	*Chamaecrista biensis*	Plants
VERBENACEAE	*Chascanum pinnatifidum* var*. pinnatifidum*	Plants
MESEMBRYANTHEMACEAE	*Chasmatophyllum musculinum*	Plants

FAMILY	SPECIES NAME	CATEGORY
PTERIDACEAE	*Cheilanthes dolomiticola*	Plants
PTERIDACEAE	*Cheilanthes eckloniana*	Plants
POACEAE	*Chloris virgata*	Plants
ASTERACEAE	*Chrysocoma ciliata*	Plants
ASTERACEAE	*Chrysocoma obtusata*	Plants
COLCHICACEAE	*Colchicum melanthoides* subsp. *melanthoides*	Plants
COMMELINACEAE	*Commelina africana* var. *africana*	Plants
CRASSULACEAE	*Crassula muscosa* var. *muscosa*	Plants
FABACEAE	*Crotalaria griquensis*	Plants
FABACEAE	*Crotalaria virgultalis*	Plants
EUPHORBIACEAE	*Croton gratissimus* var. *gratissimus*	Plants
CUCURBITACEAE	*Cucumis kalahariensis*	Plants
POACEAE	*Cymbopogon pospischilii*	Plants
APOCYNACEAE	*Cynanchum orangeanum*	Plants
CYPERACEAE	*Cyperus margaritaceus* var. *margaritaceus*	Plants
CARYOPHYLLACEAE	*Dianthus micropetalus*	Plants
ASTERACEAE	*Dicoma capensis*	Plants
POACEAE	*Digitaria eriantha*	Plants
POACEAE	*Digitaria polyphylla*	Plants
ASTERACEAE	*Dimorphotheca cuneata*	Plants
ASTERACEAE	*Dimorphotheca polyptera*	Plants
HYACINTHACEAE	*Drimia macrantha*	Plants
HYACINTHACEAE	*Drimia sanguinea*	Plants
IRIDACEAE	*Duthieastrum linifolium*	Plants
MESEMBRYANTHEMACEAE	*Ebracteola wilmaniae*	Plants
BORAGINACEAE	*Ehretia rigida* subsp. *rigida*	Plants
POACEAE	*Enneapogon scoparius*	Plants
POACEAE	*Eragrostis bicolor*	Plants
POACEAE	*Eragrostis chloromelas*	Plants
POACEAE	*Eragrostis curvula*	Plants
POACEAE	*Eragrostis lehmanniana* var. *chaunantha*	Plants
POACEAE	*Eragrostis lehmanniana* var. *lehmanniana*	Plants
POACEAE	*Eragrostis nindensis*	Plants
POACEAE	*Eragrostis obtusa*	Plants
POACEAE	*Eragrostis rotifer*	Plants
POACEAE	*Eragrostis* sp.	Plants
ASTERACEAE	*Eriocephalus ericoides* subsp. *ericoides*	Plants
ASTERACEAE	*Eriocephalus ericoides* subsp. *griquensis*	Plants
ASTERACEAE	*Eriocephalus karooicus*	Plants
ERIOSPERMACEAE	*Eriospermum porphyrium*	Plants
EBENACEAE	*Euclea undulata*	Plants
HYACINTHACEAE	*Eucomis autumnalis* subsp. *amaryllidifolia*	Plants
EUPHORBIACEAE	*Euphorbia bergii*	Plants

FAMILY	SPECIES NAME	CATEGORY
EUPHORBIACEAE	*Euphorbia duseimata*	Plants
EUPHORBIACEAE	*Euphorbia gariepina* subsp. *gariepina*	Plants
EUPHORBIACEAE	*Euphorbia wilmaniae*	Plants
ASTERACEAE	*Euryops multifidus*	Plants
ASTERACEAE	*Euryops subcarnosus* subsp. *vulgaris*	Plants
POACEAE	*Eustachys paspaloides*	Plants
CONVOLVULACEAE	*Evolvulus alsinoides*	Plants
ASTERACEAE	*Felicia filifolia* subsp. *filifolia*	Plants
ASTERACEAE	*Felicia muricata* subsp. *cinerascens*	Plants
ASTERACEAE	*Felicia muricata* subsp. *muricata*	Plants
ASTERACEAE	*Felicia namaquana*	Plants
ASTERACEAE	*Felicia* sp.	Plants
POACEAE	*Fingerhuthia africana*	Plants
APOCYNACEAE	*Fockea angustifolia*	Plants
IRIDACEAE	*Freesia andersoniae*	Plants
ASTERACEAE	*Gazania krebsiana* subsp. *arctotoides*	Plants
ASTERACEAE	*Geigeria ornativa* subsp. *ornativa*	Plants
IRIDACEAE	*Gladiolus orchidiflorus*	Plants
ACANTHACEAE	*Glossochilus burchellii*	Plants
THYMELAEACEAE	*Gnidia burchellii*	Plants
THYMELAEACEAE	*Gnidia polycephala*	Plants
APOCYNACEAE	*Gomphocarpus tomentosus* subsp. *tomentosus*	Plants
AMARANTHACEAE	*Gomphrena globosa*	Plants
NEURADACEAE	*Grielum humifusum* var. *humifusum*	Plants
NEURADACEAE	*Grielum sinuatum*	Plants
ASTERACEAE	*Helichrysum arenicola*	Plants
ASTERACEAE	*Helichrysum cerastioides* var. *cerastioides*	Plants
ASTERACEAE	*Helichrysum lucilioides*	Plants
ASTERACEAE	*Helichrysum zeyheri*	Plants
BRASSICACEAE	*Heliophila minima*	Plants
BRASSICACEAE	*Heliophila trifurca*	Plants
BORAGINACEAE	*Heliotropium strigosum*	Plants
MALVACEAE	*Hermannia abrotanoides*	Plants
MALVACEAE	*Hermannia bryoniifolia*	Plants
MALVACEAE	*Hermannia burkei*	Plants
MALVACEAE	*Hermannia comosa*	Plants
MALVACEAE	*Hermannia sp.*	Plants
MALVACEAE	*Hermannia tomentosa*	Plants
POACEAE	*Heteropogon contortus*	Plants
MALVACEAE	*Hibiscus marlothianus*	Plants
MALVACEAE	*Hibiscus micranthus* var. *micranthus*	Plants
MALVACEAE	*Hibiscus schinzii*	Plants
ASTERACEAE	*Ifloga glomerata*	Plants

FAMILY	SPECIES NAME	CATEGORY
FABACEAE	*Indigofera charlieriana* var. *charlieriana*	Plants
FABACEAE	*Indigofera heterotricha*	Plants
FABACEAE	*Indigofera sessilifolia*	Plants
CONVOLVULACEAE	*Ipomoea bolusiana*	Plants
CONVOLVULACEAE	*Ipomoea suffruticosa*	Plants
SCROPHULARIACEAE	*Jamesbrittenia integerrima*	Plants
CRASSULACEAE	*Kalanchoe rotundifolia*	Plants
CUCURBITACEAE	*Kedrostis foetidissima*	Plants
CUCURBITACEAE	*Kedrostis hirtella*	Plants
ASTERACEAE	*Kleinia longiflora*	Plants
RUBIACEAE	*Kohautia caespitosa* subsp. *brachyloba*	Plants
FABACEAE	*Lebeckia macrantha*	Plants
BRASSICACEAE	*Lepidium africanum* subsp. *divaricatum*	Plants
POACEAE	*Leptochloa appletonii*	Plants
FABACEAE	*Lessertia macrostachya* var. *macrostachya*	Plants
LAMIACEAE	*Leucas capensis*	Plants
ASTERACEAE	*Leysera tenella*	Plants
MOLLUGINACEAE	*Limeum aethiopicum subsp. aethiopicum var. aethiopicum*	Plants
MOLLUGINACEAE	*Limeum arenicolum*	Plants
MOLLUGINACEAE	*Limeum sulcatum* var. *sulcatum*	Plants
MESEMBRYANTHEMACEAE	*Lithops aucampiae* var. *euniceae*	Plants
SOLANACEAE	*Lycium cinereum*	Plants
SCROPHULARIACEAE	*Manulea burchellii*	Plants
MARSILEACEAE	*Marsilea burchellii*	Plants
MALVACEAE	*Melhania prostrata*	Plants
MALVACEAE	*Melhania rehmannii*	Plants
MALVACEAE	*Melhania virescens*	Plants
POACEAE	*Melinis repens* subsp. *grandiflora*	Plants
FABACEAE	*Melolobium microphyllum*	Plants
MESEMBRYANTHEMACEAE	*Mestoklema tuberosum*	Plants
POACEAE	*Microchloa caffra*	Plants
APOCYNACEAE	*Microloma armatum* var. *armatum*	Plants
ACANTHACEAE	*Monechma divaricatum*	Plants
ACANTHACEAE	*Monechma genistifolium* subsp. *australe*	Plants
ACANTHACEAE	*Monechma incanum*	Plants
IRIDACEAE	*Moraea polystachya*	Plants
MESEMBRYANTHEMACEAE	*Nananthus aloides*	Plants
MESEMBRYANTHEMACEAE	*Nananthus* sp.	Plants
MESEMBRYANTHEMACEAE	*Nananthus vittatus*	Plants
MELIACEAE	*Nymania capensis*	Plants
OLEACEAE	*Olea europaea subsp. africana*	Plants
COLCHICACEAE	*Ornithoglossum vulgare*	Plants
ASTERACEAE	*Osteospermum microphyllum*	Plants

FAMILY	SPECIES NAME	CATEGORY
ASTERACEAE	*Osteospermum spinescens*	Plants
OXALIDACEAE	*Oxalis lawsonii*	Plants
OXALIDACEAE	*Oxalis* sp.	Plants
APOCYNACEAE	*Pachypodium succulentum*	Plants
POACEAE	*Panicum maximum*	Plants
FABACEAE	*Parkinsonia africana*	Plants
ASTERACEAE	*Pegolettia retrofracta*	Plants
SCROPHULARIACEAE	*Peliostomum leucorrhizum*	Plants
ASTERACEAE	*Pentzia globosa*	Plants
NYCTAGINACEAE	*Phaeoptilum spinosum*	Plants
MOLLUGINACEAE	*Pharnaceum brevicaule*	Plants
PHYLLANTHACEAE	*Phyllanthus maderaspatensis*	Plants
ASTERACEAE	*Phymaspermum parvifolium*	Plants
SOLANACEAE	*Physalis peruviana*	Plants
AIZOACEAE	*Plinthus cryptocarpus*	Plants
POACEAE	*Pogonarthria squarrosa*	Plants
POLYGALACEAE	*Polygala seminuda*	Plants
PORTULACACEAE	*Portulaca quadrifida*	Plants
MESEMBRYANTHEMACEAE	*Prepodesma orpenii*	Plants
ASTERACEAE	*Pseudognaphalium luteo-album*	Plants
ASTERACEAE	*Psiadia punctulata*	Plants
ASTERACEAE	*Pteronia glauca*	Plants
ASTERACEAE	*Pteronia mucronata*	Plants
ASTERACEAE	*Pteronia sordida*	Plants
FABACEAE	*Ptycholobium biflorum* subsp. *angolensis*	Plants
CELASTRACEAE	*Putterlickia pyracantha*	Plants
ICACINACEAE	*Pyrenacantha scandens*	Plants
BIGNONIACEAE	*Rhigozum obovatum*	Plants
BIGNONIACEAE	*Rhigozum trichotomum*	Plants
ANACARDIACEAE	*Rhus dregeana*	Plants
FABACEAE	*Rhynchosia* sp.	Plants
RICCIACEAE	*Riccia albolimbata*	Plants
RICCIACEAE	*Riccia crinita*	Plants
RICCIACEAE	*Riccia okahandjana*	Plants
ASTERACEAE	*Rosenia humilis*	Plants
MESEMBRYANTHEMACEAE	*Ruschia* sp.	Plants
CHENOPODIACEAE	*Salsola kali*	Plants
LAMIACEAE	*Salvia namaensis*	Plants
LAMIACEAE	*Salvia stenophylla*	Plants
DRACAENACEAE	*Sansevieria aethiopica*	Plants
APOCYNACEAE	*Sarcostemma viminale* subsp. *viminale*	Plants
HYACINTHACEAE	*Schizocarphus nervosus*	Plants
POACEAE	*Schmidtia kalahariensis*	Plants

FAMILY	SPECIES NAME	CATEGORY
POACEAE	*Schmidtia pappophoroides*	Plants
ANACARDIACEAE	*Searsia burchellii*	Plants
ANACARDIACEAE	*Searsia ciliata*	Plants
SCROPHULARIACEAE	*Selago acocksii*	Plants
SCROPHULARIACEAE	*Selago* sp.	Plants
ASTERACEAE	*Senecio consanguineus*	Plants
ASTERACEAE	*Senecio reptans*	Plants
MALVACEAE	*Sida chrysantha*	Plants
MALVACEAE	*Sida cordifolia* subsp. *cordifolia*	Plants
MALVACEAE	*Sida dregei*	Plants
SOLANACEAE	*Solanum nigrum*	Plants
SOLANACEAE	*Solanum retroflexum*	Plants
SOLANACEAE	*Solanum supinum* var. *supinum*	Plants
POACEAE	*Sporobolus fimbriatus*	Plants
LAMIACEAE	*Stachys burchelliana*	Plants
POACEAE	*Stipagrostis uniplumis* var. *neesii*	Plants
SCROPHULARIACEAE	*Sutera griquensis*	Plants
FABACEAE	*Sutherlandia frutescens*	Plants
PORTULACACEAE	*Talinum arnotii*	Plants
ASTERACEAE	*Tarchonanthus camphoratus*	Plants
ASTERACEAE	*Tarchonanthus obovatus*	Plants
AIZOACEAE	*Tetragonia arbuscula*	Plants
POACEAE	*Themeda triandra*	Plants
SANTALACEAE	*Thesium hystrix*	Plants
MESEMBRYANTHEMACEAE	*Titanopsis calcarea*	Plants
MESEMBRYANTHEMACEAE	*Titanopsis* sp.	Plants
ASPHODELACEAE	*Trachyandra saltii* var. *saltii*	Plants
POACEAE	*Tragus berteronianus*	Plants
POACEAE	*Tragus koelerioides*	Plants
ASTERACEAE	*Troglophyton capillaceum* subsp. *capillaceum*	Plants
ASTERACEAE	*Ursinia nana* subsp. *nana*	Plants
RUBIACEAE	*Vangueria infausta* subsp. *infausta*	Plants
ASTERACEAE	*Verbesina encelioides* var. *encelioides*	Plants
RHAMNACEAE	*Ziziphus mucronata* subsp. *mucronata*	Plants
ZYGOPHYLLACEAE	*Zygophyllum gilfillanii*	Plants
ZYGOPHYLLACEAE	*Zygophyllum lichtensteinianum*	Plants
ZYGOPHYLLACEAE	*Zygophyllum microcarpum*	Plants
ZYGOPHYLLACEAE	*Zygophyllum pubescens*	Plants
MUTILLIDAE	*Odontomutilla ovata*	Animals
STAPHYLINIDAE	*Hasumius zambesi*	Animals
TENEBRIONIDAE	*Stenodesia gibbipennis*	Animals
CLUBIONIDAE	*Clubiona sp.*	Animals