Water Resource Risk Assessment for the proposed Atholl Gardens Emergency Sewer Pipe Replacement

SANDTON, GAUTENG

CLIENT: JOHANNESBURG WATER

This report titled Water Resource Risk Assessment for the proposed Atholl Gardens Emergency Sewer Pipe Replacement was compiled by Ndumiso Dlamini. Ndumiso is registered with the South African Council for Natural Scientific Professions and has completed training in various ecological tools.

Foreword

This document has been prepared to provide a general introduction and overview of the planned replacment of an outfall sewer pipeline and the use, reproduction and/or presentation thereof is subject to the following:

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Prepared For:	**Johannesburg Water**
Prepared By:	Ndumiso Dlamini Ecologist 9ZeroSeven Environmental (Pty) Ltd 21 Rorke Street I Dundee I 3000 Mobile: 071 343 1503 Email: ndumiso@9zeroseven.com

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Declaration

I, Ndumiso Ian Dlamini, as duly authorised representative of 9ZeroSeven Environmental, hereby confirm my independence and declare that I:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Signature of the specialist:	
Designation:	Ecologist (Pr. Sci. Nat.)
Qualifications:	BSc Life and Environmental Sciences (UJ) BSc Hons Botany (UJ)
Experience (years):	Seven (7)
Date:	August 2021

1 Introduction

9ZeroSeven Environmental (907 Environmental or 907) was appointed to undertake a Water Resources Risk Assessment for the proposed Atholl Gardens Sewer Pipeline replacement within the Atholl Gardens area in Sandton within the Johannesburg Metropolitan Municipality within the Gauteng Province.

This report presents the results of a water resources assessment completed for the proposed project. This report should be interpreted after taking into consideration the findings and recommendations provided by the specialist herein. Further, this report should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project.

1.1 Aim and Objectives

As part of this assessment, the following objectives were established:

- The identification of wetland areas through a desktop assessment;
- The identification and delineation of wetland areas within 500m of the proposed project;
- A risk/impact assessment for the proposed development; and
- The prescription of mitigation measures and recommendations for identified impacts / risks.

2 Key Legislative Requirements

The legislation, policies and guidelines listed below are applicable to the current project in terms of biodiversity and ecological support systems. The list below, although extensive, may not be complete and other legislation, policies and guidelines may apply in addition to those listed below.

Explanation of certain documents or organisations is provided where these have a high degree of relevance to the project and/or are referred to in this assessment.

2.1 International Legislation and Policy

- Convention on Biological Diversity (Rio de Janeiro, 1992);
- The Ramsar Convention (on wetlands of international importance);
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival; and
- The IUCN (World Conservation Union). The IUCN's mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable

2.2 National Legislation

- Constitution of the Republic of South Africa (Act 108 of 1996). The Bill of Rights, in the Constitution of South Africa states that everyone has a right to a nonthreatening environment and requires that reasonable measures be applied to protect the environment. This protection encompasses preventing pollution and promoting conservation and environmentally sustainable development;
- The National Environmental Management Act (NEMA) No. 107 of 1198): Ecological Assessment Regulations, 2014. Specifically, the requirements of the specialist report as per the requirements of Appendix 6;
- The National Environmental Management: Biodiversity Act (NEM:BA) No. 10 of 2004: specifically, the management and conservation of biological diversity within the RSA and of the components of such biological diversity;
- National Environmental Management: Biodiversity Act, 2004: Threatened and Protected Species Regulations;
- National Environmental Management: Protected Areas Act, 2003 (Act 57 of 2003);
- National Water Act, 1998 (Act 36 of 1998);
- Environmental Conservation Act, 1989 (ECA), (Act no. 73 of 1989);
- National Forests Act, 1998 (Act 84 of 1998), specifically with reference to Protected Tree species;
- National Heritage Resources Act, 1999 (Act 25 of 1999);
- Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983).

2.3 National Policy and Guidelines

- South Africa's National Biodiversity Strategy and Action Plan (NBSAP);
- National Spatial Ecological Assessment (NSBA); and
- National Freshwater Ecosystem Priority Areas (NFEPA's).

2.4 Provincial and Municipal Level

In addition to national legislation, South Africa's nine provinces have their own provincial biodiversity legislation, as nature conservation is a concurrent function of national and provincial government in terms of the Constitution (Act 108 of 1996).

- The Gauteng Biodiversity Conservation Plan (2017).
- The City of Johannesburg Wetlands Layer.

2.5 Structure of the Report

Aspect	Section
The person who prepared the report; and the expertise of that person to carry out the specialist study or specialised process.	Section 6
A declaration that the person is independent	Page viii
An indication of the scope of, and the purpose for which, the report was prepared	Section 1.1
A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 4
A description of any assumptions made and any uncertainties or gaps in knowledge	Section 5
(f) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 7 and Section 7.3
Recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	Section 7.3 and Section 9
A description of any consultation process that was undertaken during the course of carrying out the study	N/A
A summary and copies of any comments that were received during any consultation process	N/A
Any other information requested by the competent authority.	N/A

3 Description of the Project Area

The project area is located in the Atholl Gardens area within the Sandton area in Gauteng. The project area is situated in a densely populated area that is dominated by built up formal residential areas, business office parks and an extensive road network as presented in Figure 3-1.

The project is situated within the A21C Quaternary Catchment (Figure 3-2) within the Limpopo Water Management area and Highveld Ecoregion. The project area falls within the portion of the WMA that was previously known as the Crocodile (West) and Marico WMA that was amalgamated into the larger Limpopo WMA (NWA, 2016). The portion of the WMA lies adjacent to the Botswana border to the north-west, predominantly within Limpopo. It is situated in a semi-arid part of the country with a mean annual precipitation of 400 to 800 mm. Its main rivers, the Crocodile and Marico Rivers, give rise to the Limpopo River at their confluence. The area is characterised by the urban and industrial complexes of northern Johannesburg and Pretoria and platinum mining north-east of Rustenburg, and activities include extensive irrigation development along the main rivers with grain, livestock and game farming. A substantial portion of the WMA water is transferred from the Vaal River with small transfers out of the WMA to Gaborone in Botswana and to Modimolle in the Limpopo WMA. Increasing quantities of effluent return flow from urban and industrial areas is a major cause of pollution in some rivers (StatsSA, 2010).

The project area is predominantly developed with residential complexes and office parks. Roads and highways are prevalent in the wetland catchment with large scale vegetation modification. Hardened surfaces in the form of parking areas, and reduced vegetation cover in the park areas are a feature in the local landscape.

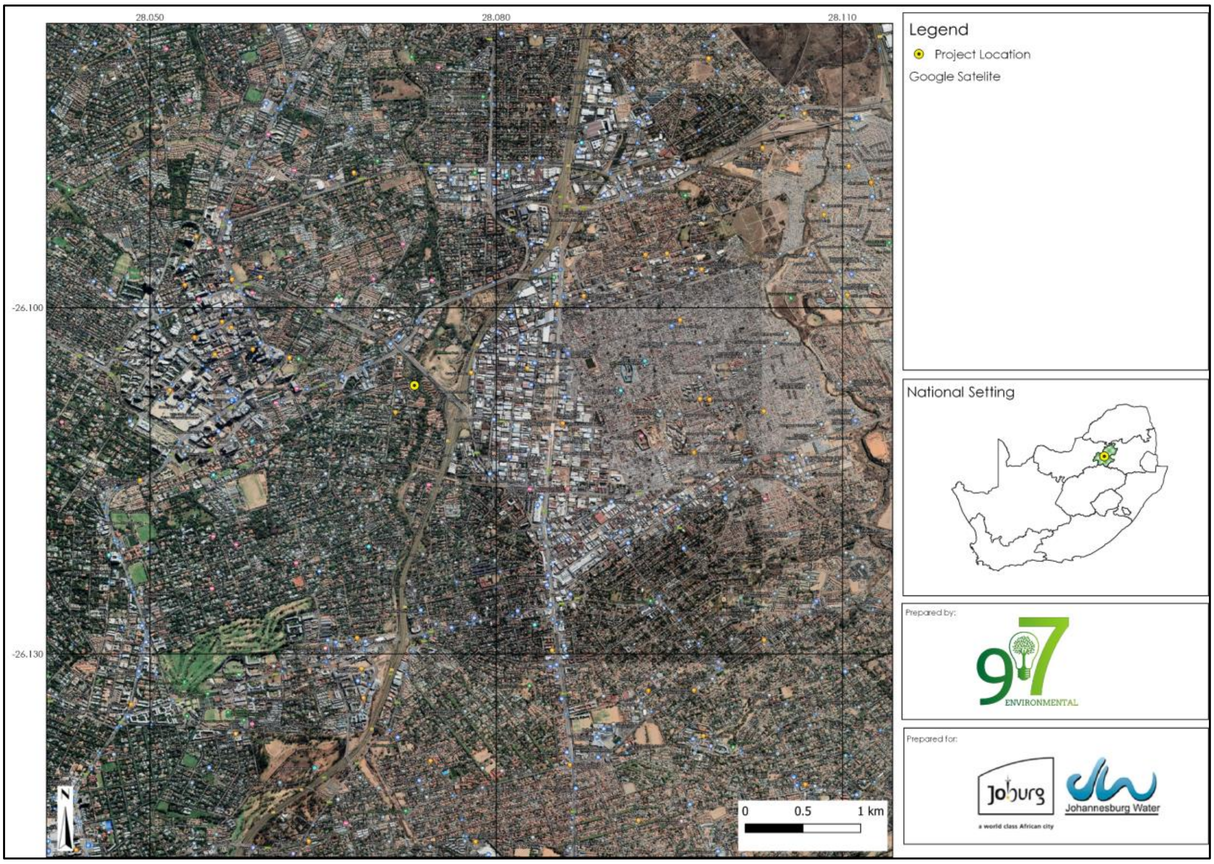


Figure 3-1: Location of the Project Area

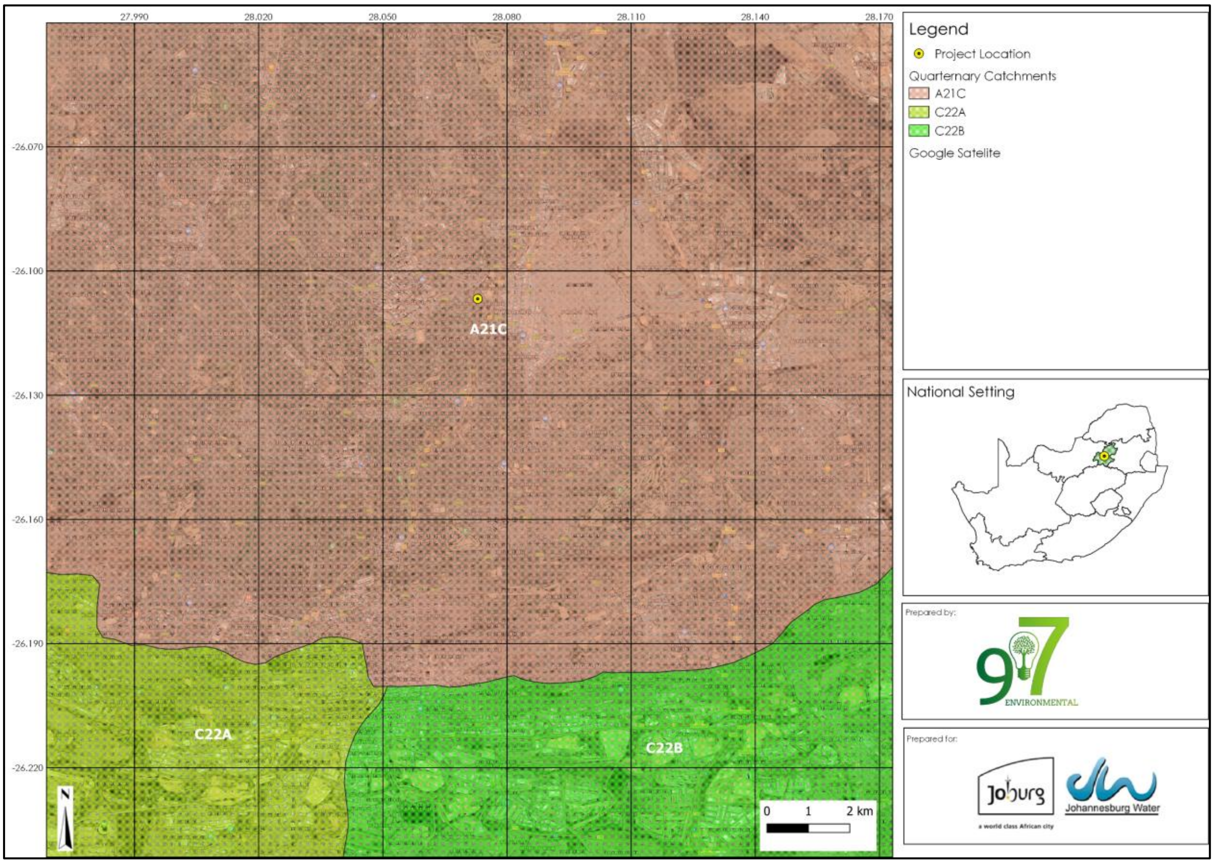
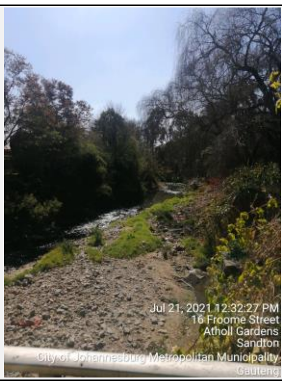


Figure 3-2: Quarternary Catchment of the project area

The upstream and downstream site locations can be seen in Table 3-1.

Table 3-1: Photos, co-ordinates and descriptions for the sites sampled

<table>
<tr><th></th><th>Upstream</th><th>Downstream</th></tr>
<tr><td>Upstream</td><td>
</td><td>
</td></tr>
<tr><td>GPS</td><td colspan="2">26° 6'30.94"S
28° 4'26.11"E</td></tr>
<tr><td>Downstream</td><td>
</td><td></td></tr>
<tr><td>GPS</td><td colspan="2">26° 6'23.42"S
28° 4'22.90"E</td></tr>
</table>

3.1.1 Climate

The project falls within a summer rainfall climate with occasional rainfall in the winter months. The Mean Annual Precipitation (MAP) ranges between 620 – 800mm. Frost is frequent in the area; however, may be found in southern parts more frequently than the northern parts. The maximum temperature for the area is expected to be 36.2 ºC and the minimum temperature is -0.2 ºC with a Mean Annual Temperature (MAT) of 16.0ºC (Mucina and Rutherford, 2006). The climate diagram for the area is presented in Figure 3-3.

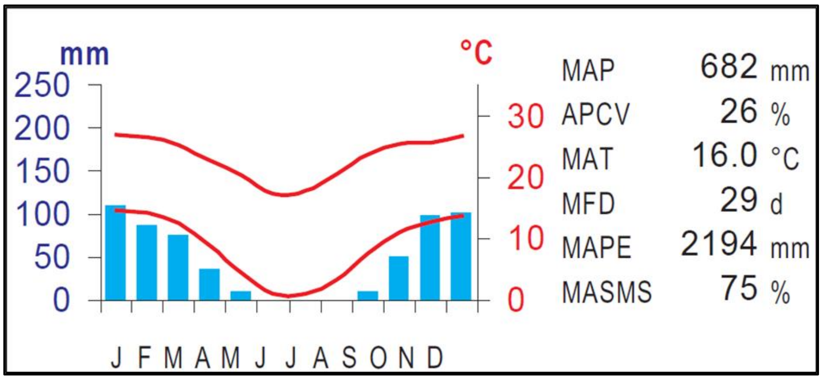


Figure 3-3: Climate diagram (Mucina and Rutherford, 2006)

3.1.2 Landtype Soils

The proposed development is located within the Bb1 land type. (Land Type Survey Staff, 1972 - 2006). The land type characteristics are presented in Table 3-2.The dominant soil forms include Mispah and Glenrosa soils.

Table 3-2: The land type data for the proposed project

Broad Land Type Class	Description
Bb1	Plinthic catena: upland duplex and margalitic soils rare; Dystrophic and/or mesotrophic; red soils not widespread

3.1.3 Regional Vegetation

The project site is located within the Egoli Granite Grassland vegetation unit (Figure 3-4). The vegetation is limited to the Gauteng Province. The vegetation occurs at altitudes between 1280m – 1660m from the Lanseria Airport area towards Centurion in the north and the Muldersdrift area in the west and Tembisa in the east (Mucina and Rutherford, 2006).

The vegetation is characterised by moderately undulating plains and low hills. The tall grass layer is dominated by *Hyparrhenia hirta*. Some woody species may occur, in patches, on the rocky outcrops and ridges.

The vegetation unit is considered Endangered with only 3% of the target 24% conserved. Over 60% of the vegetation unit have been transformed. The transformation of the vegetation unit is through urbanisation, cultivation and the building of roads (Mucina and Rutherford, 2006.

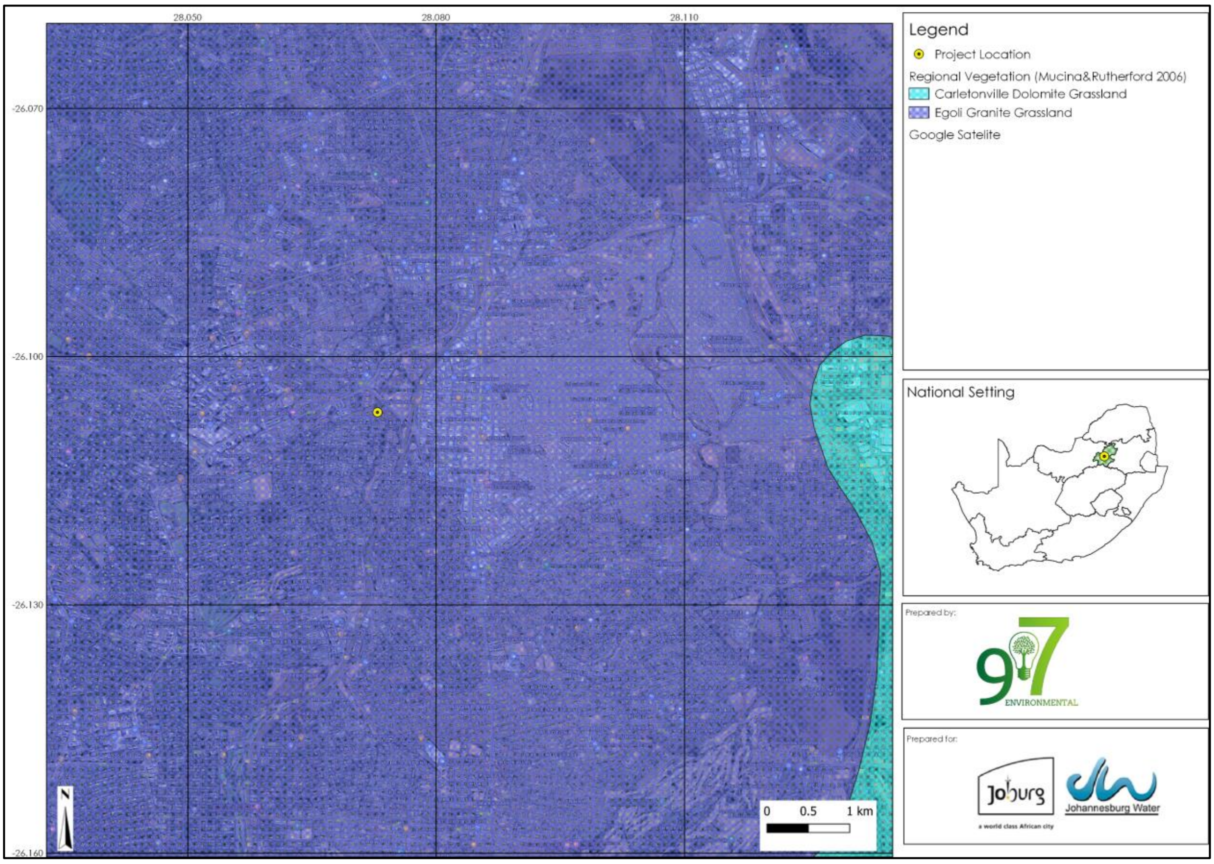


Figure 3-4: The regional vegetation associated with the project area

4 Methodology

4.1 Desktop Assessment

The following information sources were considered for the desktop assessment;

- Aerial imagery (Google Earth Pro);
- Department of Water and Sanitation (DWS, 2019);
- Land Type Data (Land Type Survey Staff 1972 - 2006);
- The National Freshwater Ecosystem Priority Areas (Nel et al., 2011);
- Provincial and municipal spatial datasets; and
- Contour data (5m).

4.2 Field Survey

A survey was conducted in July 2021 by an ecologist where the wetland areas in the project area were delineated and assessed. The survey was conducted during the wet season. The project area was ground-truthed on foot. Photographs were recorded during the site visit.

4.2.1 Wetland Assessment

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) will be considered for this study. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels, and also then includes structural features at the lower levels of classification (Ollis *et al.,* 2013) as presented in Figure 4-1. The methodology to assess wetlands is presented in Table 4-1.

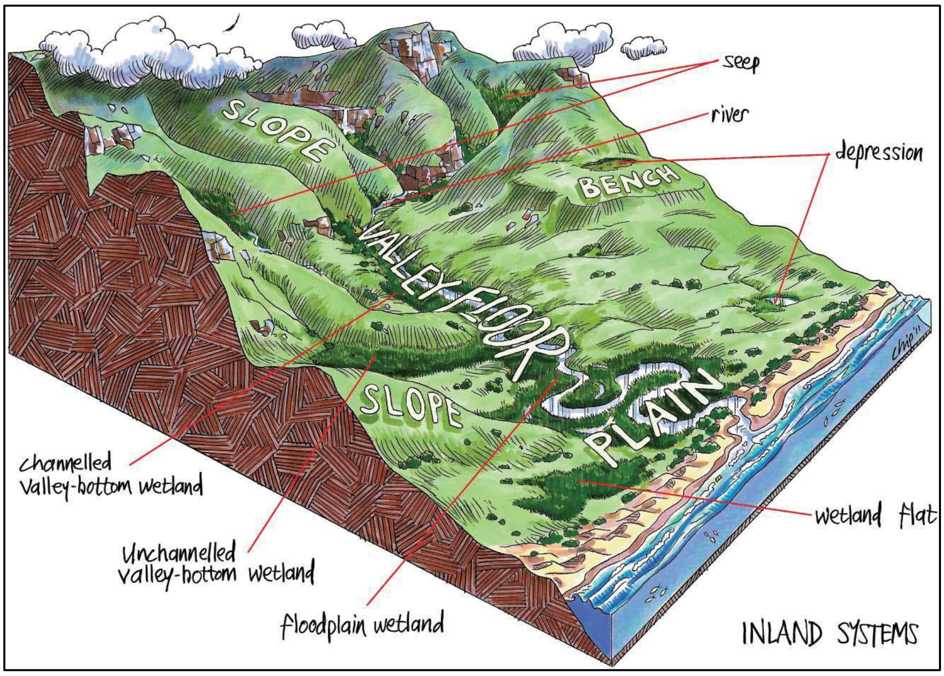
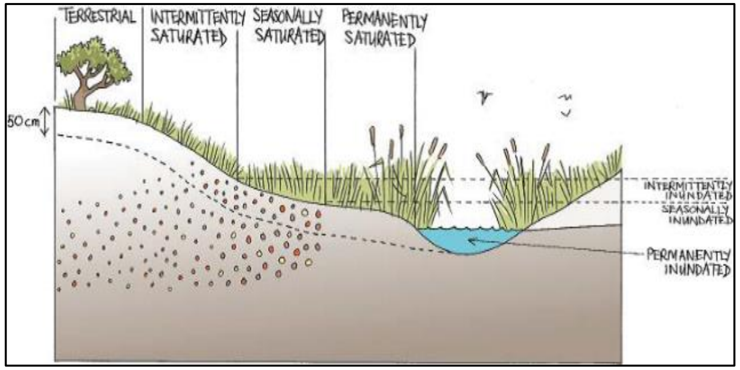


Figure 4-1: Wetland hydrogeomorphic (HGM) units (Ollis et al., 2013)

Table 4-1: Wetland assessment methodolgy

<table>
<tr><th>Assessment Aspect</th><th>Criteria</th><th>Determinant</th></tr>
<tr><td>Delineation</td><td>The Terrain Unit Indicator
The Soil Form Indicator
The Soil Wetness Indicator
The Vegetation Indicator
Vegetation is used as the primary wetland indicator. However, in practise the soil wetness indicator tends to be the most important and reliable, and the other three indicators are used in a confirmatory role</td><td>
</td></tr>
<tr><td>Present Ecological State (PES)/ Wetland Health</td><td>The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact</td><td><table>
<tr><th>Impact Category</th><th>Description</th><th>Impact Score Range</th><th>Present State Category</th></tr>
<tr><td>None</td><td>Unmodified, natural</td><td>0 to 0.9</td><td>A</td></tr>
<tr><td>Small</td><td>Largely Natural</td><td>1.0 to 1.9</td><td>B</td></tr>
<tr><td>Moderate</td><td>Moderately Modified</td><td>2.0 to 3.9</td><td>C</td></tr>
<tr><td>Large</td><td>Largely Modified</td><td>4.0 to 5.9</td><td>D</td></tr>
<tr><td>Serious</td><td>Seriously Modified.</td><td>6.0 to 7.9</td><td>E</td></tr>
<tr><td>Critical</td><td>Critical Modification.</td><td>8.0 to 10</td><td>F</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Assessment Aspect</th><th>Criteria</th><th>Determinant</th></tr>
<tr>
<td>Wetland Functionality/ Ecosystem Services</td>
<td>The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze, et al, 2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided</td>
<td>
<table>
<tr><th>Score</th><th>Rating of functionality</th></tr>
<tr><td>< 0.5</td><td>Low</td></tr>
<tr><td>0.6 - 1.2</td><td>Moderately Low</td></tr>
<tr><td>1.3 - 2.0</td><td>Intermediate</td></tr>
<tr><td>2.1 - 3.0</td><td>Moderately High</td></tr>
<tr><td>> 3.0</td><td>High</td></tr>
</table>
</td>
</tr>
<tr>
<td>Wetland Ecological Importance and Sensitivity (EIS)</td>
<td>The method used for the EIS determination was adapted from the method as provided by DWS (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4.</td>
<td>
<table>
<tr><th>EIS Category</th><th>Range of Mean</th><th>Recommended Ecological Management Class</th></tr>
<tr><td>Very High</td><td>3.1 to 4.0</td><td>A</td></tr>
<tr><td>High</td><td>2.1 to 3.0</td><td>B</td></tr>
<tr><td>Moderate</td><td>1.1 to 2.0</td><td>C</td></tr>
<tr><td>Low Marginal</td><td>< 1.0</td><td>D</td></tr>
</table>
</td>
</tr>
</table>

4.3 Buffer Determination

A buffer zone is defined as "A strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another." (Macfarlane, et al., 2014).

Buffer zones protect water resources in a variety of ways, such as;

- Maintenance of basic aquatic processes;
- The reduction of impacts on water resources from activities and adjoining land uses;
- The provision of habitat for aquatic and semi-aquatic species;
- The provision of habitat for terrestrial species; and
- The provision of societal benefits.

The "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries" (Macfarlane, et al., 2014) was used to determine the appropriate buffer zone for the proposed activity. This guideline was designed to assist in the determination of the appropriate buffer zones for water resources. The assessment procedure can be seen in Figure 4-2.

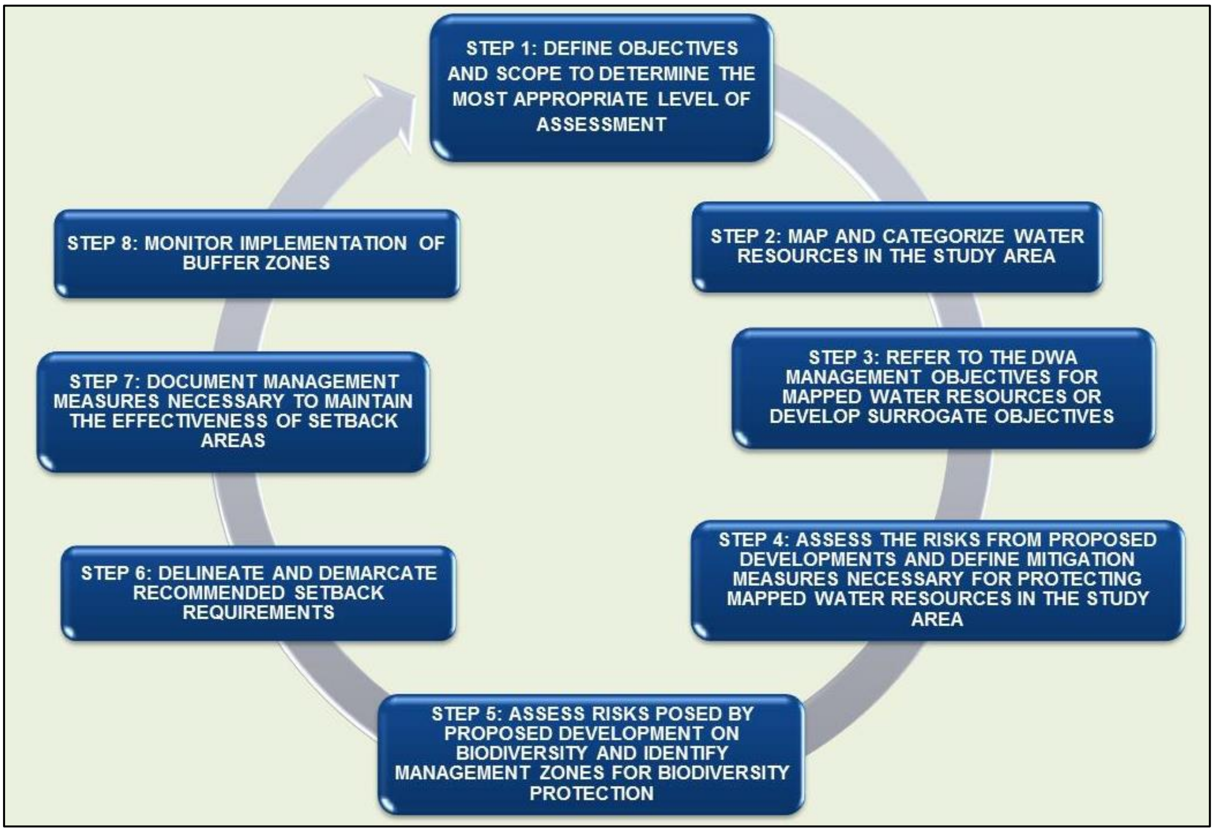


Figure 4-2: The assessment for the determination of the appropriate buffer zone follows this procedure

An Excel tool was developed as part of this project to help assessors identify a suite of alternative mitigation measures and management guidelines that can be used to reduce potential impacts on aquatic ecosystems. The tool is designed to act as a quick reference to a wide range of mitigation measures and guidelines which would otherwise need to be accessed through a plethora of different guidelines. The tool is structured according to nine primary threats which are also assessed as part of the buffer zone determination process. These include:

- Alteration to flow volumes;
- Alteration of patterns of flows (increased flood peaks);
- Increase in sediment inputs & turbidity;
- Increased nutrient inputs;
- Inputs of toxic contaminants (including organics & heavy metals);
- Alteration of acidity (pH);
- Increased inputs of salts (salinization);
- Change (elevation) of water temperature; and
- Pathogen inputs (i.e. disease-causing organisms).

4.4 Water Quality

Water quality was measured in situ using a handheld calibrated Extech DO700 multi-meter. The constituents considered that were measured included: pH, conductivity (µS/cm), water temperature (°C) and Dissolved Oxygen (DO) in mg/l.

4.5 Aquatic Habitat Integrity

The Intermediate Habitat Assessment Index (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), 1999 were used to define the ecological status of the river reach.

The area covered in this assessment included the assessed Klip River tributary. This habitat assessment model compares current conditions with reference conditions that are expected to have been present.

The IHIA model was used to assess the integrity of the habitats from a riparian and instream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996). The criteria and ratings utilised in the assessment of habitat integrity in the current study are presented in Table 4-2 and Table 4-3 respectively.

Table 4-2: Criteria used in the assessment of habitat integrity (Kleynhans, 1998)

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.

Criterion	Relevance
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or alternatively agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments.
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also, a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the riverbank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 4-3: Descriptions used for the ratings of the various habitat criteria

Impact Category	Description	Score
None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

4.6 Aquatic Macroinvertebrate Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al.,* 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al.,* 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

4.6.1 Invertebrate Habitat Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al.,* 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al.,* 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

4.6.2 South African Scoring System

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).

Sampled invertebrates were identified using the "Aquatic Invertebrates of South African Rivers" Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion *et al.,* 1995; Dickens and Graham, 2002; Gerber and Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the Highveld - lower ecoregion (Figure 3). This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database.

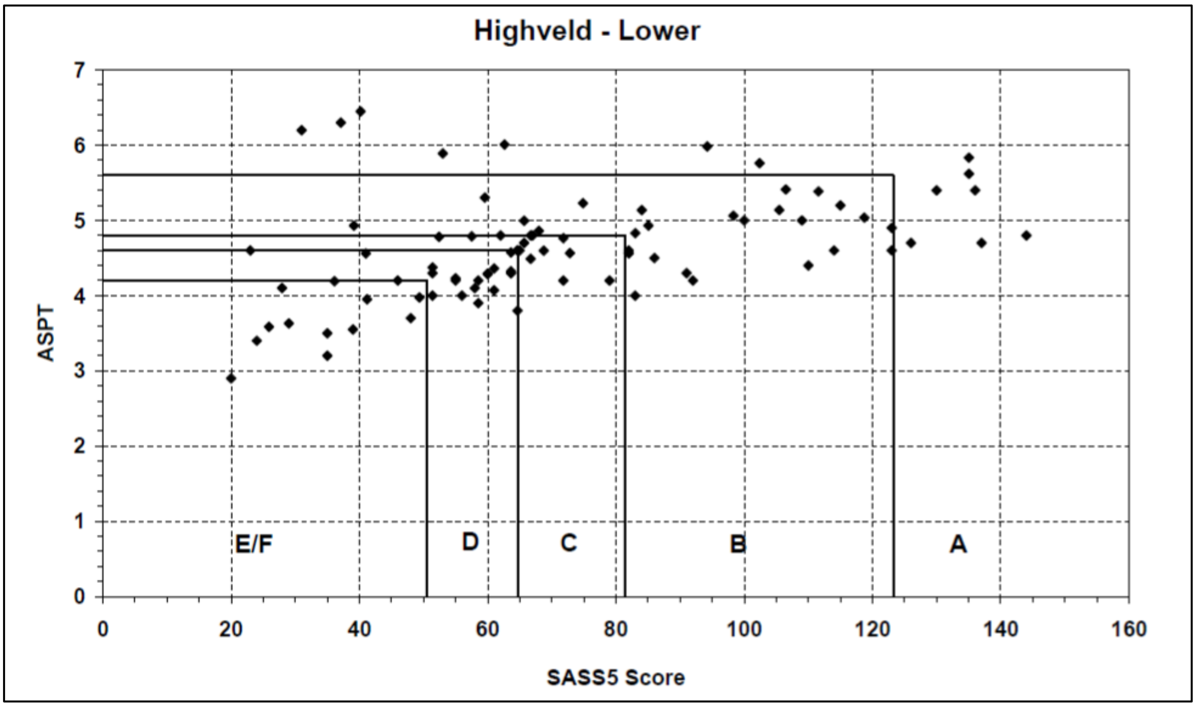


Figure 4-3: Biological Bands for the Highveld - Lower Ecoregion, calculated using percentiles

4.7 Risk Assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines. The significance of the impact is calculated according to Table 4-4.

Table 4-4: Significance ratings matrix

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

5 Limitations and Assumptions

The following assumptions and limitations are applicable to this report:

- The wetland assessment is confined to the proposed project area, and does not include the neighbouring and adjacent areas project site; these were however considered as part of the desktop assessment;
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked. It is, however, expected that most

floral and faunal communities have been accurately assessed and considered;

- The data presented in this report is based on a single site visit, undertaken in July 2021 by the author and an assistant. This survey consititutes a dry season survey. A more accurate assessment would require that assessments take place in all seasons of the year.
- It is assumed that the proposed project will be for the replacement of a section of the pipeline that was washed away not the entire pipeline; and
- No activities list has been provided and as such the risk assessment will be conducted based on the proposed works outlined in the technical documents.

6 Expertise of the Specialists

Ndumiso Dlamini obtained his BSc Hons degree in Botany in 2011 at the University of Johannesburg and is a registered Pr. Sci. Nat with SACNASP (116579) in Botanical Science and Ecological Science. Ndumiso has been conducting biodiversity, ecological and water resources assessments as an Environmental Consultant for over 7 years. He has performed numerous ecological impact assessments for various projects which include mining, housing developments, roads and infrastructure and rehabilitation. A detailed CV can be made available on request.

7 Findings

7.1 Desktop Assessment

7.1.1 National Freshwater Ecosystem Priority Areas (NFEPA) Wetlands

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of NWA (Act 36 of 1998). This directly applies to the National Water Act, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al.*, 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al.*, 2011).

One NFEPA wetland was identified within 500m of the proposed project area. The wetland was classified as a natural Unchannelled Valley Bottom system. The wetland is a Rank 6 in a severely modified (Z1) state. The wetland classification of the wetlands can be seen in Table 7-1. The identified wetlands area presented in Figure 7-1.

Table 7-1: The wetland classification of the FEPA wetlands

FEPA Wetland	Classification Levels				Wetland Veg Class	Nat / Art	Cond.	Rank
	L1 (System)	L2 (Ecoregion)	L3 Landscape Position	L4 HGM Class				
Unchannelled Valley Bottom	Inland System	Highveld	Valley bottom	Unchannelled	Mesic Highveld Grassland	Natural	Z1	6

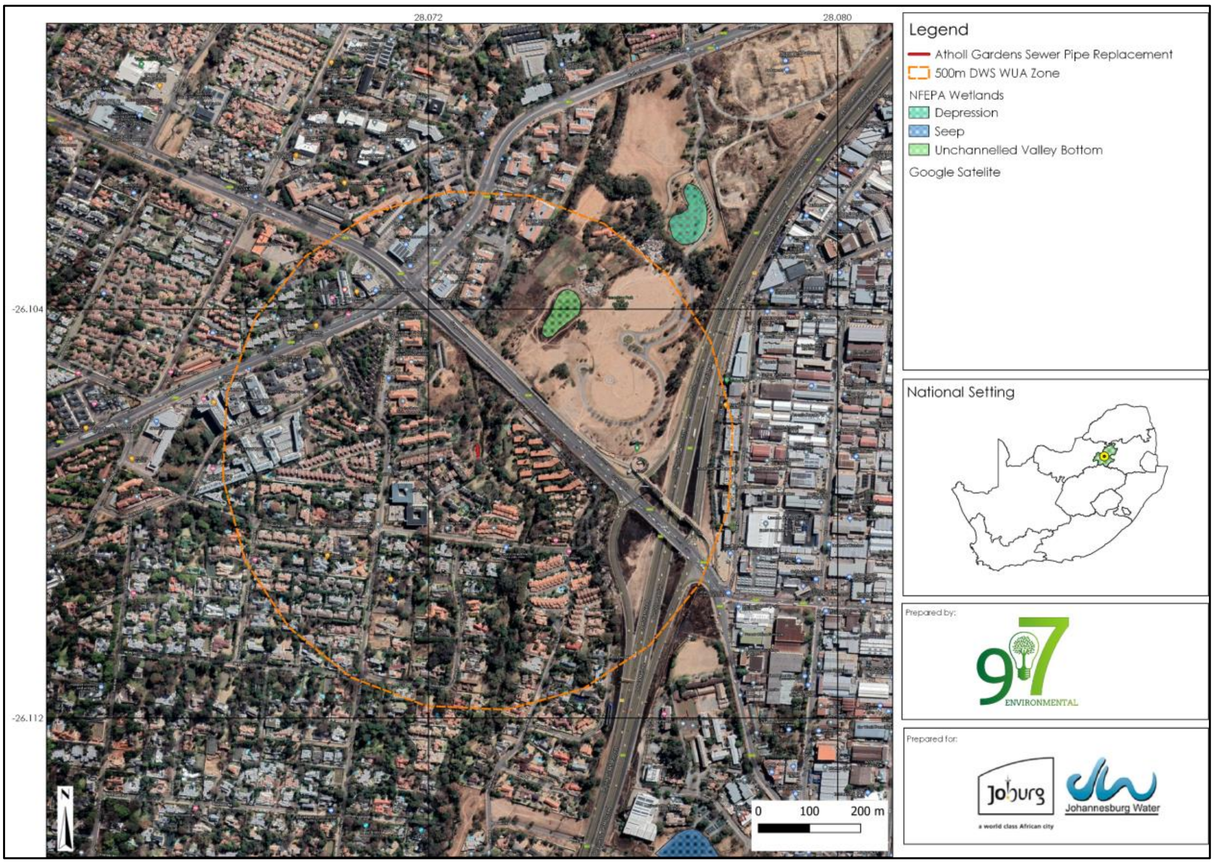


Figure 7-1: NFEPA Wetlands associated with the project area

7.1.2 City of Johannesburg Wetlands

The proposed pipeline will traverse an identified City of Johannesburg (CoJ) wetland (Figure 7-2), the wetland is classified as a channelled valley bottom wetland. No health status is available for the wetland.

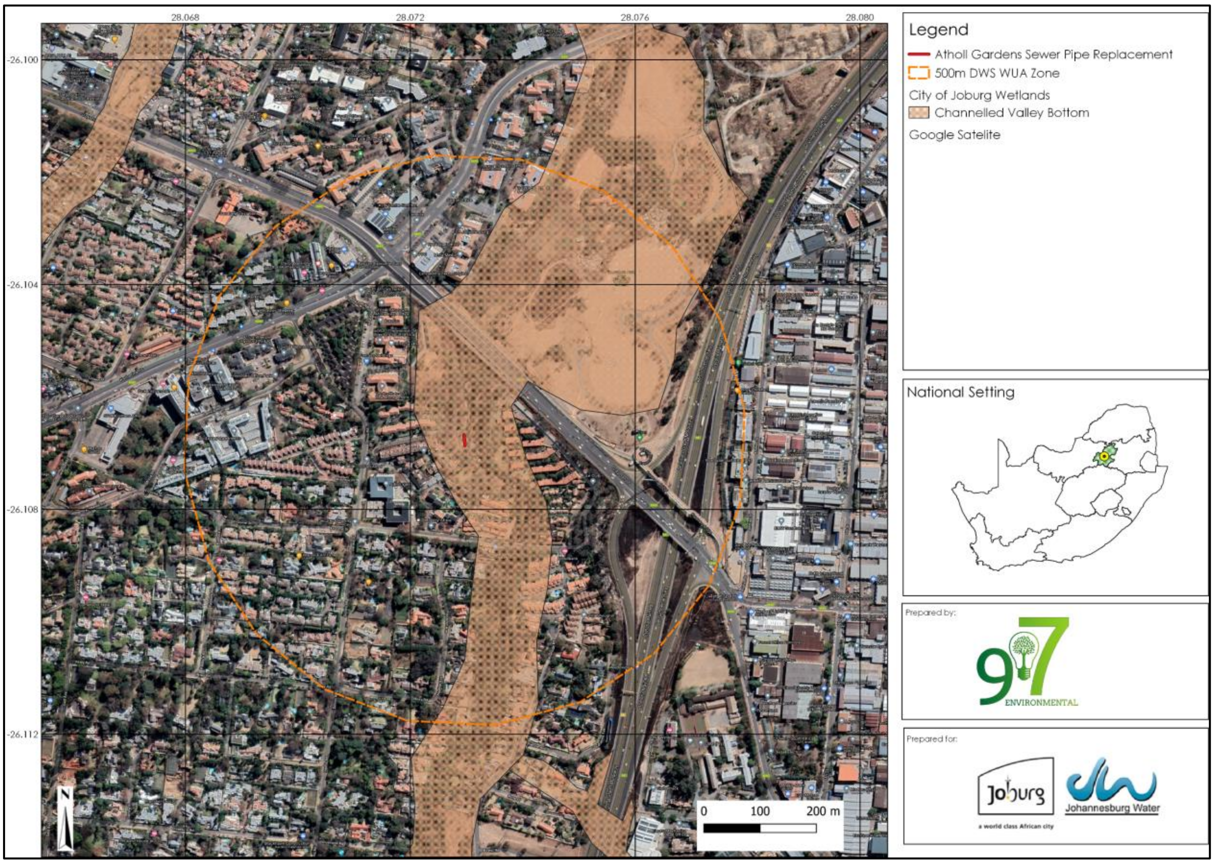


Figure 7-2: The City of Johannesburg wetlands associated with the proposed project

7.2 Wetland Ecological Assessment

7.2.1 Wetland Delineation

7.2.1.1 Terrain Unit

The project area is characterised by a modified topography with hardened surfaces in the form of buildings and highways. The wetland within 500m of the project area was determined to be a valley bottom. The terrain setting observed in the project area was a channelled valley bottom as presented in Figure 7-3.

Figure 7-3: Observed terrain unit setting of a channelled valley bottom

7.2.1.2 Wetland Soils

The observed soils within the wetland areas were disturbed as a result of the surrounding landuses and onset of erosion from the recent flood events. The soil forms expected are Katspruit and Rensburg soils. Sedimentation within the channel was oobserved.

7.2.1.3 Vegetation

Wetland plants are classified as hydrophytic which refers to their adaptation to survive in highly saturated soils. The wetland assessment was conducted during the dry season and vegetation identification was a challenge. The slopes and adjacent areas of the channel were dominated by *Imperata cylindrica*. The in-channel wetland vegetation was dominated by *Typha capensia, Juncus effusus* and *Salix babylonica*. The wetland delineation is presented in Figure 7-4. One Hydrogeomorphic (HGM) type was delineated within 500m of the project area namely a channelled valley bottom wetland.

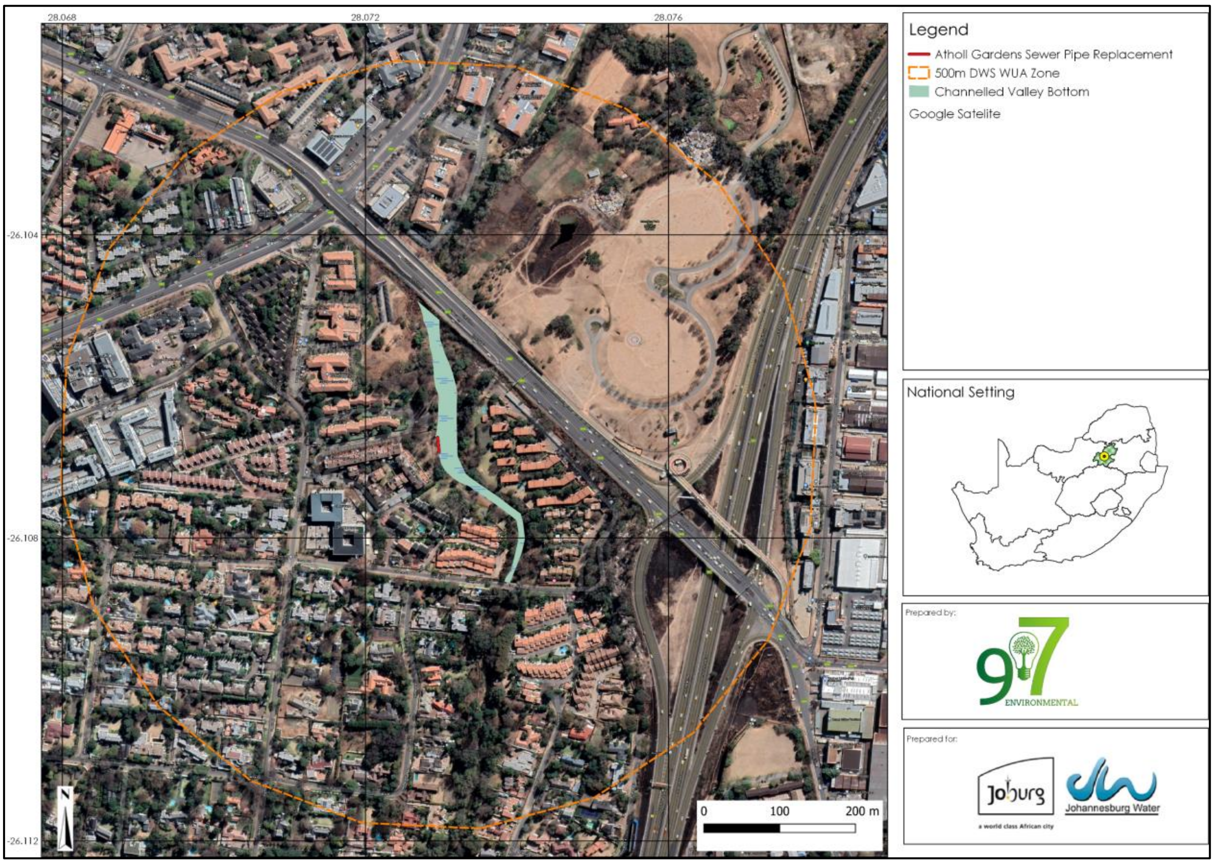


Figure 7-4: The identified wetland associated with the project area

7.2.1.4 Hydrogeomorphic Units

The wetland was classified according to its terrain unit setting. One HGM unit was classified for the project. The HGM was:

- HGM 1 – Channelled Valley Bottom

The classification of the HGM unit is presented in Table 7-2..

Table 7-2: Wetland classification as per SANBI guideline (Ollis et al., 2013)

Wetland Name	Level 1	Level 2		Level 3		Level 4	
	System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	4A (HGM)	4B	4C
HGM 1	Inland	Highveld	Mesic Highveld Grassland	Valley Floor	Channelled Valley Bottom	N/A	N/A

7.2.2 Present Ecological State

The PES for the assessed wetland is presented in Table 7-3. The overall wetland health for wetland was determined to be Severely Modified, PES or class E.

Table 7-3: Summary of the wetland PES

Wetland	Area (ha)	Hydrology		Geomorphology		Vegetation	
		Rating	Score	Rating	Score	Rating	Score
HGM	4,19	F: Critically Modified	9,5	D: Largely Modified	4,2	D: Largely Modified	4,2
Overall PES Score		6,5		Overall PES Class		E: Severely Modified	

A summary for the respective modules is as follows:

- The hydrological component for the HGM has been modified largely by the development and spread of the residential dwellings and office parks in the wetland catchment. These developments have increased hardened surface within the area which have altered the flow paths into the wetland. Furthermore, areas of low vegetation cover are prevalent in the wetland area which further alters the flows of water in the wetland leaving the wetland susceptible to erosion. The spread of invasive species and large trees in the wetland areas have resulted in the reduction of water available for the wetland and wetland plants. The development of roads and related stormwater management systems has largely contributed to the disturbance of the wetland and altered flood peaks and flows. The impacts to the wetland hydrology can be seen in Figure 7-5.

Figure 7-5: Impacts to the hydrology – Increased hardened surfaces as a result of the spread of residential dwellings and office parks

- The geomorphology component for the HGM was impacted largely by the altered hydrology of the wetland which resulted in intensified flows in the wetland. The wetland has become susceptible to erosion as a result of the intensified flows. Impacts to the soils within the wetland are presented in Figure 7-6. The wetlands area has been impacted by previous landuses which include agriculture, trenches and gravel roads.

Figure 7-6: Impacts to the geomorphology – erosion and incision as a result of the stormwater runoff intensities

- The vegetation component for HGM 1 was largely impacted as a result of the decreased vegetation cover on the wetland catchment and the banks, and the prevalence of large woody trees in the area. The vegetation has been altered as a result of soil destabilisation and erosion within the wetland. The vegetation has been altered due to physical disturbance and dumping within the wetland area. *Acacia mearnsii* was identified within the wetland area which indicated alien invasion within the wetland area as presented in Figure 7-7.

Figure 7-7: Impacts to wetland vegetation.

7.2.3 Ecosystem Services Assessment

The ecosystem services provided by the wetland identified within proximity to the proposed development were assessed and rated using the WET-EcoServices method (Kotze, *et al*. 2009). The summarised results for the wetland are shown in Table 7-4 and Figure 7-8.

The wetland showed an overall moderate level of service with flood attenuation and toxicant assimilation showing moderately high levels of service for the HGM. The wetland showed none to minimal direct benefits in the local landscape. The provision of ecosystem services has been hampered by the impacts to the wetland health.

Table 7-4: The EcoServices offered by the identified wetlands

Wetland Unit					HGM 1
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		2,3
			Streamflow regulation		2,0
			Water Quality enhancement benefits	Sediment trapping	1,8
				Phosphate assimilation	1,6
				Nitrate assimilation	1,7
				Toxicant assimilation	2,1
				Erosion control	1,8
			Carbon storage		1,3
	Direct Benefits	**Biodiversity maintenance**			1,6
		Provisioning benefits	Provisioning of water for human use		0,8
			Provisioning of harvestable resources		0,4
			Provisioning of cultivated foods		0,0
		Cultural benefits	Cultural heritage		0,0
			Tourism and recreation		0,7
			Education and research		0,8
Overall					18,9
Average					1,3

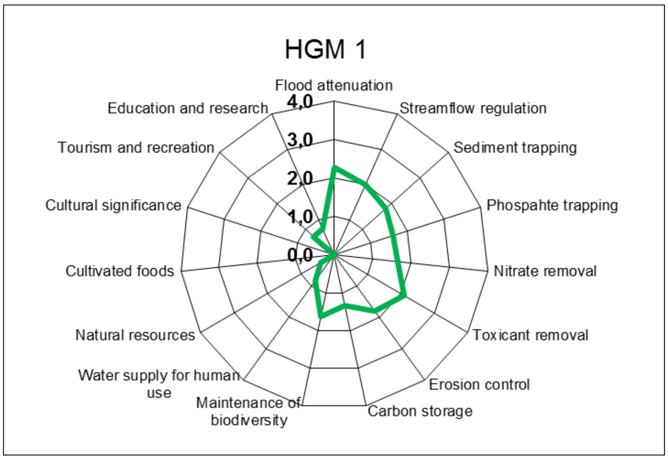


Figure 7-8: The spider diagram for the HGM

7.2.4 Ecological Importance & Sensitivity (EIS)

The EIS assessment was applied to HGM in order to assess the levels of sensitivity and ecological importance of the wetland. The results of the assessment are shown in Table 7-5.

The EIS and Hydrological Functionality were calculated to have a Moderate (class C) level of importance for the assessed wetland. The EIS was determined to be moderate as there were no signs of ecologically important taxa within the wetlands and none had been recorded within the area. Furthermore, no wetlands of importance (NFEPA) occur within the area and within 500m of the project site. The wetlands did provide habitat in the area and this is important especially as the extent of residential areas increases. The wetland provides minimal services and likely serves as an ecological refuge for the bird communities. The hydrology of the wetland serves to protect the residential areas from flood.

The Direct Human Benefits were calculated to have a Low (class D) level of importance as there was no evidence of any direct human interaction with the wetlands assessed and no direct services provided by the wetland.

Table 7-5: The EIS results for the identified wetland

WETLAND IMPORTANCE AND SENSITIVITY	
HGM	
	Importance
ECOLOGICAL IMPORTANCE & SENSITIVITY	**2,0**
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**1,8**
DIRECT HUMAN BENEFITS	**0,4**

7.2.5 Buffer Zone Determination

The wetland buffer zone tool was used to calculate the appropriate buffer required for the upgrade of the Outfall Sewer. The model shows that the largest risks (Moderate) posed by the project during the construction phase is that of "increased sediment inputs and turbidity" and "inputs of metal contaminants". During the operational phase, the High risks identified for the project included "Increase in sediment inputs and turbidity", "altered patterns of flows", "inputs of toxic organic contaminants" and the "input of metal contaminants" (Table 7-8). These risks are calculated with no prescribed mitigation and the calculated buffer requirement is presented in Table 7-6.

Table 7-6: Pre-mitigation buffer requirement

Required Buffer before mitigation measures have been applied	
Construction Phase	31m
Operational Phase	16m

According to the buffer guideline (Macfarlane, et al. 2014) a high-risk activity would require a buffer that is 95% effective to reduce the risk of the impact to a low level threat.

The risks were then reduced to Low with the prescribed mitigation measures and therefore the recommended buffer was calculated to be 15m (Table 7-7) for the construction and operational phases.

Table 7-7: Post-mitigation buffer requirement

Required Buffer after mitigation measures have been applied	
Construction Phase	15 m
Operational Phase	15 m

A conservative buffer zone was suggested of 15 m for the construction and operation phases respectively, this buffer is calculated assuming mitigation measures are applied.

The buffer zone will not be applicable for areas of the project that traverse wetland areas, however, for all secondary activities such as lay down yards, storage areas and camp sites, the buffer zone must be implemented.

Table 7-8: The risk results from the wetland buffer model for the proposed project

Phase	Threat Posed by the proposed land use / activity	Specialist Threat Rating	Threat Rating after Mitigation	Recommended Mitigation
Construction Phase	1. Alteration to flow volumes	Very Low	Very Low	
	2. Alteration of patterns of flows (increased flood peaks)	Low	Low	
	3. Increase in sediment inputs & turbidity	Very High	Medium	The project is for the replacement of a pipeline over the wetland areas and the proposed project will not introduce a new impact. Dry season construction, silt traps, managed stockpiles, storm water management will reduce the risk of sedimentation during the construction.
	4. Increased nutrient inputs	Low	Low	
	5. Inputs of toxic organic contaminants	Medium	Very Low	
	6. Inputs of toxic heavy metal contaminants	Medium	Low	Off-site equipment vehicle fuelling and maintenance, storage in bunded area, no on-site fabrication, oil spill kits, equipment & vehicle inspections.
	7. Alteration of acidity (pH)	Low	Low	
	8. Increased inputs of salts (salinization)	N/A	N/A	
	9. Change (elevation) of water temperature	Very Low	Very Low	
	10. Pathogen inputs (i.e. disease-causing organisms)	Very Low	Very Low	
Operational Phase	1. Alteration to flow volumes	Medium	Low	An infrastructure monitoring plan will be devised to regularly check for leaks and remedy these. Furthermore, the project is for existing infrastructure upgrade and will minimse the current impacts.
	2. Alteration of patterns of flows (increased flood peaks)	High	Low	
	3. Increase in sediment inputs & turbidity	High	Low	
	4. Increased nutrient inputs	High	Low	
	5. Inputs of toxic organic contaminants	High	Medium	
	6. Inputs of toxic heavy metal contaminants	High	Low	
	7. Alteration of acidity (pH)	High	Low	
	8. Increased inputs of salts (salinization)	High	Low	
	9. Change (elevation) of water temperature	Medium	Low	
	10. Pathogen inputs (i.e. disease-causing organisms)	High	Medium	

It is recommended that the operational phase buffer zone of 15m be applied throughout all phases of the project (Figure 7-9)

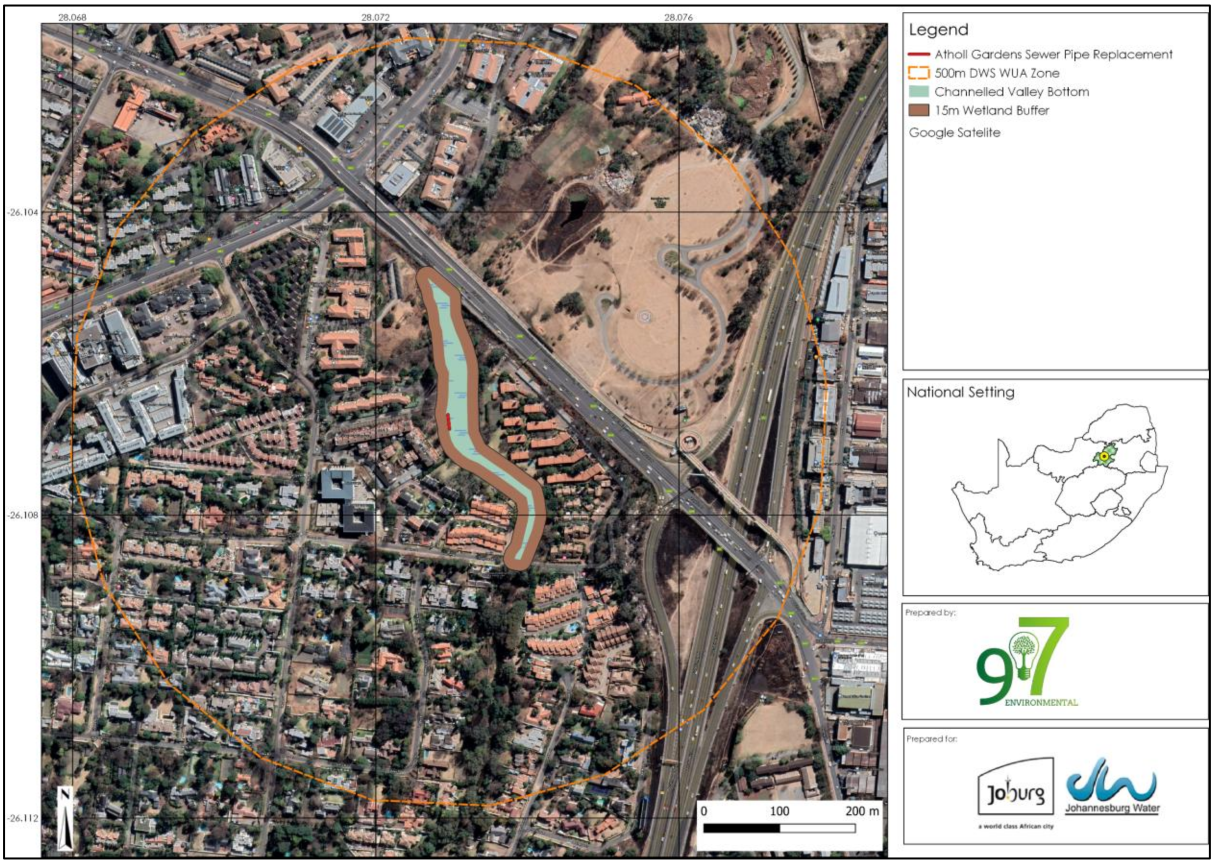


Figure 7-9: 15m Wetland Buffer Zone for the delineated wetland areas

7.3 Aquatic Assessment

7.3.1 *In situ* Water Quality

In situ water quality analysis was conducted during the study. Results have been compared to limits stipulated in the Target Water Quality Range (TWQR) for aquatic ecosystems (DWS, 1996a). The results of the assessment are presented in Table 7-9.

Table 7-9: In situ surface water quality results

Site	pH	Conductivity (µS/cm)	Dissolved Oxygen (mg/l)	Temperature (°C)
TWQR*	6.5-9*	-	>5.00*	5-30*
Upstream	7.52	529	2.8	12.5
Downstream	7.38	528	2.4	12.1

*TWQR – Target Water Quality Range; Levels exceeding guideline levels are indicated in red

In situ water quality for the watercourse indicates modified conditions. Although the pH, Electrical Conductivity (EC) and temperature were compliant with target Water Quality Ranges (TWQR), the dissolved oxygen (DO) was found to be below the TWQR. Raw sewage was observed flowing into the system and is corroborated by the DO values. Sewage contains high levels of organics which have a high oxygen demand to break down. This creates highly anoxic conditions within the system. While not a tested parameter the sewage also produced an awful odour which residents have complained about. The drop in pH between the sites is also attributed to the sewage inlet at the pipe doscharge although it remains neutral (pH = 7).

In situ water quality results indicate a deterioration in water quality between the upstream and downstream sites (pH) although it remains neutral. Water quality within the reach is considered a limiting factor to local aquatic biota.

7.3.2 Habitat Integrity Assessment

The IHIA was completed for the associated watercourse as described in the IHIA methodology component of this study. The special framework of which constitutes a 5km reach above and below the proposed project location. The results thereof are shown in Table 7-10.

Table 7-10: Intermediate Habitat Integrity Assessment for the associated Klip River tributary

Criterion	Impact Score	Weighted Score
Instream		
Water abstraction	6	3.4
Flow modification	15	7.8
Bed modification	13	6.8
Channel modification	16	8.3
Water quality	25	14
Inundation	9	3.6
Exotic macrophytes	5	1.8
Exotic fauna	2	0.6
Solid waste disposal	21	5.0
Total Instream Score		**48.68**
Instream Category		**Class D**
Riparian		
Indigenous vegetation removal	**13**	**6.8**
Exotic vegetation encroachment	**11**	**5.3**
Bank erosion	**15**	**8.4**
Channel modification	**20**	**9.6**
Water abstraction	**7**	**3.6**
Inundation	**11**	**4.8**
Flow modification	**22**	**10.6**
Water quality	**23**	**12.0**
Total Riparian Score		**38.96**
Riparian Category		**Class E**

The results of the instream and riparian habitat assessment in the associated watercourse indicates a seriously modified state (class E) in the riparian habitat and largely modified (class D) in the instream habitat. Instream condition indicate large losses to natural habitat, biota and basic ecosystem functions have occurred. The largest contributors to this state were in the form of waste, where solid waste was found to line the river bed as well as raw sewage flowing into the reach as seen in Figure 7-10. There is clear evidence of channel modification in the form of gabion baskets limiting the natural meandering nature of the river as seen in Figure 7-11. The seriously modified state of the riparian habitat indicates extensive losses of natural habitat, biota and basic ecosystem functions. The major contributors were water quality, flow modification and channel modification. Water quality was influenced by multiple factors in the riparian area such as waste dumping. Flow modification occurs through the form of inlets of sewage flowing into the reach. Increased amounts of water increase the flow rates which cause increased erosion.

Figure 7-10: Raw sewage and solid waste flowing within the watercourse.

Figure 7-11: Gabion baskets used for bank stabilisation causing channel modification

7.3.3 Aquatic Macroinvertebrate Assessment

7.3.3.1 Invertebrate Habitat Assessment

An indication of the available instream biotopes (habitat) sampled are presented in Table 7-11. Biological assessments were completed at representative site in the considered river reach. The invertebrate habitat at the site was assessed using the South African Scoring System version 5 (SASS5) biotope rating assessment as applied in Tate and Husted (2015). A rating system of 0 to 5 was applied, 0 being not available. The weightings for upper foothills rivers (slope class D) are suggested by DWS (2019), however these biotopes are based off of average gradient and don't consider on site habitat. Therefore, the site was classified as a source zone (slope class A) due to the characteristics the site exhibited and was used to categorize biotope ratings (Rowntree *et al.* 2000; Rowntree and Ziervogel, 1999).

Table 7-11: Biotope availability at the sites (Rating 0-5)

Biotope	Weighting (Upper Foothills)	Upstream	Downstream
Stones in current	20	2	1
Stones out of current	10	0	0
Bedrock	5	0	0

Biotope	Weighting (Upper Foothills)	Upstream	Downstream
Aquatic Vegetation	0.5	0	0
Marginal Vegetation In Current	2	2	2
Marginal Vegetation Out Of Current	2	1.5	1
Gravel	3.5	2	1
Sand	1	2.5	2
Mud	0.5	2	2
Biotope Score		12	9
Weighted Biotope Score (%)		16	10
Biotope Category (Tate and Husted, 2015)		**F**	**F**

Low habitat availability was observed in the reach associated with the project area during the survey. This was due to the lack of diversity and of presence stones in and out of current, as well as the absence of aquatic vegetation. Most stones were found to be bricks and are not favoured by macroinvertebrates, as macroinvertebrates aren't found to colonize anthropogenic habitats. The poor habitat availability within the reach was categorized as class F (Tate and Husted, 2015). The biotope results within the reach indicate that the habitat availability would be a limiting factor for the macroinvertebrate communities.

7.3.3.2 South African Scoring System

The aquatic macroinvertebrate results for the survey are presented in Table 7-12.

Table 7-12: Macroinvertebrate assessment results recorded during the survey

Site	SASS Score	No. of Taxa	ASPT*	Category (Dallas, 2007)**
Upstream	3	2	1.5	**E/F**
Downstream	2	1	2	**E/F**

*ASPT: Average score per taxon; **Highveld - Lower ecoregion

The SASS5 assessment results generated SASS5 scores that are categorised as a class E/F (Dallas, 2007) which indicates critically modified conditions within the reach. The low number of taxa sampled during the survey are a clear indication of the effects of sewage on a system as a maximum of 2 taxa were found within the system. The average score per taxon (ASPT) indicated that only tolerant macroinvertebrates were collected during this survey. These include Oligochaeta (earthworms) and Chironomidae (Blood worms). Only one individual from the genus Oligochaeta was found, while a C (100-1000) abundance of Chironomidae was observed. Many species of Chironomidae larvae are specialists in poorly oxygenated environments such as sewage due to their haemoglobin and specialised breathing tubes (Pinder, 1986). Terrestrial maggots were also sampled which colonize faecal matter within the system but are not considered part of SASS5 While there was limiting habitat within the reach, the low ASPT is not attributed to this. There are key species which would still have been present but were absent which provides evidence for water quality deterioration within the reach.

8 Risk Assessment

The project is for the replacement of the proposed sewer pipeline, that will directly impact watercourses in proximity to the project area. As this project is for the replacement of an existing pipeline, impacts associated with the area are potentially moderate to low. Modifications to wetlands are likely to occur during construction. The project will entail the clearing of moderate amounts of vegetation and levelling of areas for the construction activities. This has the potential to increase erosion and sedimentation of downstream habitats due to surface runoff during the wet season. Furthermore, due to the proximity of the construction to the water resources, direct impacts to the wetland zones are likely. Some of the more notable impacts identified during the site visit and that will be considered for the risk assessment include the following:

- Portions of the pipeline within wetland areas
- Potential for inadequate measures to dissipate flows and prevent erosion resulting in the sedimentation of the receiving systems.

8.1 Identification of Risk

Risks posed by the proposed project can be seen in Table 8-1. The findings of the risk assessment will determine the level and enable the opportunity to address some of the identified impacts. Findings from the DWS aspect and risk assessment are provided in Table 8-2.

Table 8-1: Risks identified for the proposed project

NDUMISO DLAMINI	PR. SCI. NAT.	116579
ACTIVITY	**Aspect**	**Impacts to watercourse**
CONSTRUCTION AND INSTALLATION OF PIPELINE AND CROSSINGS	Site clearing and preparation	❖ Alteration to flow volumes ❖ Alteration of patterns of flows (increased flood peaks) ❖ Increase in sediment inputs & turbidity ❖ Inputs of toxic organic contaminants
	Excavation of pipeline trenches	
	Soil stockpiles and management	
	Operation of machinery and vehicles within watercourse area	
	Operation of machinery and vehicles in adjacent areas	
	Waste and ablutions facilities	
	Pipeline trench back-filling and surface levelling	
	Final landscaping and shaping	

	Post-construction rehabilitation	
OPERATION OF PIPELINE AND CROSSINGS	Possible leaks (underground and above surface)	❖ Alteration to flow volumes ❖ Alteration of patterns of flows (increased flood peaks) ❖ Increase in sediment inputs & turbidity ❖ Inputs of toxic organic contaminants
	Increased water runoff (manhole overflows)	
	Routine monitoring and maintenance work (vehicular movement)	
	Establishment of alien plants and erosion from disturbed areas	

Table 8-2: DWS Risk Impact Matrix for the proposed project

NAME and REGISTRATION No of SACNASP Professional member: **Ndumiso Dlamini** **Reg no.: 116579**

Phase	Aspect	Severity																	
		Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Without Mitigation	Confidence	With Mitigation	PES/EIS of Watercourse
Construction	Site clearing and preparation	2	2	2	1	1,75	2	2	5,75	1	2	1	3	7	**40,25**	**Low**	80	**Low**	E
	Excavation of pipeline trenches	2	1	2	2	1,75	2	2	5,75	1	3	5	2	11	**63,25***	**Moderate**	80	**Low**	E
	Soil stockpiles and management	1	2	1	2	1,5	2	2	5,5	1	3	1	2	7	**38,5**	**Low**	80	**Low**	E
	Operation of machinery and vehicles within watercourse area	2	2	2	2	2	2	2	6	1	3	5	3	12	**72***	**Moderate**	80	**Low**	E
	Operation of machinery and vehicles in adjacent areas	1	2	1	1	1,25	2	2	5,25	1	2	1	1	5	**26,25**	**Low**	80	**Low**	E
	Waste and ablutions facilities	1	3	1	3	2	1	2	5	1	2	1	2	6	**34,5**	**Low**	80	**Low**	E
	Pipeline trench back-filling and surface levelling	2	2	1	1	1,5	2	2	5,5	1	3	5	2	11	**63,25***	**Moderate**	80	**Low**	E
	Final landscaping and shaping	1	1	2	1	1,25	2	2	5,25	1	1	1	3	6	**33**	**Low**	80	**Low**	E
	Post-construction rehabilitation	1	1	2	1	1,25	2	2	5,25	1	1	1	3	6	**36**	**Low**	80	**Low**	E
Operational	Possible leaks	2	3	2	3	2,5	2	4	8,5	2	3	5	1	11	**93,5**	**Moderate**	80	**Moderate**	E
	Increased water runoff (manhole overflows)	2	1	2	1	1,5	2	4	7,5	2	2	1	1	6	**45**	**Low**	80	**Low**	E
	Routine monitoring and maintenance work (vehicular movement)	1	1	1	1	1	1	4	6	2	1	1	1	5	**30**	**Low**	80	**Low**	E
	Establishment of alien plants and erosion from disturbed areas	1	1	2	1	1,25	1	4	6,25	2	2	1	2	7	**43,75**	**Low**	80	**Low**	E

(*) denotes - In accordance with General Notice 509 "Risk is determined after considering all listed control / mitigation measures. Borderline Low / Moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures detailed below.

8.2 Unplanned Events

The planned activities will have known impacts as discussed above; however, unplanned events may occur on any project and may have potential impacts which will need mitigation and management. Table 8-3 is a summary of the findings from a wetland ecological perspective.

Please note not all potential unplanned events may be captured herein and this must therefore be managed throughout all phases.

Table 8-3: Unplanned Events, Low Risks and their Management Measures

Unplanned Event	Potential Impact	Mitigation
Hydrocarbon spill on natural areas	Contamination of sediments and wetland areas associated with the spillage.	A spill response kit must be available at all times. All incidents must be reported on and if necessary, a wetland specialist must investigate the extent of the impact and provide remedial actions.
Uncontrolled erosion	Degradation of grassland habitat and wetland areas	Erosion control measures

8.3 Cumulative Impacts

It is necessary to consider the impacts that the development will have from a broad area perspective, by considering land-use and transformation of natural habitat in areas surrounding the site. Cumulative impacts are assessed by considering past, present and anticipated changes to biodiversity.

Even with extensive mitigation, significant latent impacts on the receiving terrestrial ecological environment are deemed likely. The following points highlight the key latent impacts that have been identified:

- Destruction of wetland habitat structures;
- Permanent loss of and altered wetland species diversity;
- Alien floral invasion; and
- Disturbed areas are highly unlikely to be rehabilitated to pre-development conditions of ecological functioning and a loss of ecoservices.

8.4 Mitigation Measures

The mitigation measures are prescribed to address the risks that may arise from the proposed activities and can be seen in Table 8-4.:

Table 8-4: Mitigation Measures and Actions

Impact/Risk Aspect	Mitigation Measure	Responsible Person
Site Establishment	❖ The footprint area of the working area should be kept a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas; ❖ All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good "housekeeping"; ❖ Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation); ❖ Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems;	Environmental Control Officer & Site Foreman
Excavation, construction and pipeline construction	❖ The recommended buffer zones must be strictly adhered to during the construction phase of the project, with exception of the activities and structures required to traverse a watercourse. Any supporting aspects and activities not required to be within the buffer area must adhere to the buffer zone; ❖ All construction activities and access must make use of the existing road and any access to be established must be beyond the wetland area; ❖ A suitable storm water management plan must be compiled for the construction phase. This plan must attempt to displace and divert storm water and discharge the water into adjacent areas without eroding the receiving areas. It is preferable that run-off velocities be reduced with energy dissipaters and flows discharged into the local watercourses; ❖ Laydown yards, camps and storage areas must be beyond the aquatic areas. Where possible, the construction of the crossings must take place from the existing road and not from within the watercourse and associated buffer; ❖ The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;	Environmental Control Officer & Site Foreman

Impact/Risk Aspect	Mitigation Measure	Responsible Person
	❖ It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces; ❖ Prevent uncontrolled access of vehicles through the water resources system that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas; ❖ All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site; ❖ Temporary storm water channels should be filled with aggregate and/or logs (branches included) to dissipate flows. ❖ The pipeline must be aligned as close to the road as possible; ❖ Pipeline trenches and sandy bedding material may produce preferential flow paths for water across the project area perpendicular to the general direction of flow instead of angle. This risk can be reduced by installing clay plugs at intervals down the length of the trench to force water out of the trench and down the natural topographical gradient; ❖ Contamination of aquatic systems with unset cement or cement powder should be negated as it is detrimental to aquatic biota. Pre-cast structures should be made use of (where possible) to avoid the mixing of these materials on site, reducing the likelihood of cement in the river system.	
Operational Phase, Maintenance and Monitoring	❖ Residents should be educated and informed of how to dispose of waste including hydrocarbon waste; and ❖ Stormwater infrastructure should be maintained regularly; ❖ No sewer connections over watercourse areas, the sewer line must be connected to the existing outfall sewer manholes.	Environmental Control Officer & Site Foreman

9 Recommendation/Opinion of the Specialist

An impact statement is required as per the NEMA regulations with regards to the proposed development.

The impacts as described, rated and mitigated in this report pose a risk to the wetland area. With firm adherence to the mitigation measures prescribed in this report, the risks have been rated as low and it is the opinion of the specialist the proposed Atholl Gardens Sewer Pipeline Replacement project may proceed, following authorisations with the following conditions:

- An infrastructure monitoring and service plan must be compiled and implemented during the operational phase.
- An Environmental Control Officer (ECO) must oversee the construction phase of the project, with wetland areas as a priority.
- Based on the wetland assessment there is no envisaged alternative route, especially since the project is for the upgrade of existing infrastructure.
- The project must be expedited to alleviate the water contamination of the watercourse.

10 Conclusion

A channelled valley bottom wetland was identified within 500m of the project area. The wetland was determined to be in a severely modified state; however, the wetland contributed to the ecological integrity and biodiversity within the area.

Instream and riparian habitat modifications were attributed to extensive solid waste disposal, water quality modification, channel and flow modification within the river system. According to in situ water quality analysis, the system was found to be modified due to dissolved oxygen levels being critically low and below the established with Target Water Quality Range (TWQR's). The poor water quality was attributed to sewage discharge into the watercourse.

The condition of the local aquatic macroinvertebrates within the system was rated as seriously/critically modified according to the biological bands. The low ASPT scores within the reach were not found to be a result of poor habitat due to the absence of key species and abundance of Chironomidae (low dissolved oxygen specialists), but rather a result of poor water quality

The risk posed during the construction phase of the project were determined to be predominantly moderate prior to the application of mitigation measures. All risks were determined to be low following the application of mitigation measures, with the exception of the risk of sewerage discharge into the watecourse.

It is the opinion of the specialists that the project be considered and allow for the proposed pipeline replacement to proceed, should all prescribed mitigation measures and recommendations be implemented. As far as possible the project must be expedited to alleviate the flow of sewage into the system.

11 References

Barbour, M.T., Gerritsen, J. & White, J.S. 1996. Development of a stream condition index (SCI) for Florida. Prepared for Florida Department of Environmental Protection: Tallahassee, Florida.

Dallas, H.F. 1997. A preliminary evaluation of aspects of SASS (South African Scoring System) or the rapid bioassessment of water in rivers with particular reference to the incorporation of SASS in a national biomonitoring programme. South African Journal of Aquatic Science, 23: 79-94.

Dallas, H.F. 2007. River Health Programme: South African Scoring System (SASS) Data Interpretation Guidelines. Report produced for the Department of Water Affairs and Forestry (Resource Quality Services) and the Institute of Natural Resources.

Department of Water Affairs and Forestry (DWS). (2005). A practical field procedure for identification and delineation of wetlands and riparian areas. Pretoria: Department of Water Affairs and Forestry.

Department of Water and Sanitation (DWS). 1996. South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems. Department of Water Affairs and Forestry, Pretoria.

Department of Water and Sanitation (DWS). 2005. River Ecoclassification: Manual for Ecostatus Determination. First Draft for Training Purposes. Department of Water Affairs and Forestry.

Department of Water and Sanitation (DWS). 2019. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Draft. Compiled by RQS-RDM.

Dickens, C. W. S. and Graham, P.M. 2002. The South African Scoring System (SASS) Version 5: Rapid bioassessment method for rivers. African Journal of Aquatic Science. 27 (1): 1 -10.

DWA (Department of Water Affairs) 2013. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Draft. Compiled by RQS-RDM.

Gerber, A. & Gabriel, M.J.M. 2002. Aquatic Invertebrates of South African Rivers Field Guide. Institute for Water Quality Studies. Department of Water Affairs and Forestry. 150pp

Hellawell, J.M. 1977. Biological Surveillance and Water Quality Monitoring. In: JS Alabaster (Ed). Biological monitoring of inland fisheries. Applied Science, London. Pp 69-88.

International Union for Conservation of Nature and Natural Resources (IUCN). 2015.3. Red list of threatened species. www.iucnredlist.org.

Kleynhans, CJ. 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo System, South Africa) Journal of Aquatic Ecosystem Health 5:41-54.

Kotze, D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.C., and Collins, N.B. 2009. A Technique for rapidly assessing ecosystem services supplied by wetlands. Mondi Wetland Project.

Land Type Survey Staff. (1972 - 2006). Land Types of South Africa: Digital Map (1:250 000 Scale) and Soil Inventory Databases. Pretoria: ARC-Institute for Soil, Climate, and Water.

Macfarlane, D.M., Bredin, I.P., Adams, J.B., Zungu, M.M., Bate, G.C. and Dickens, C.W.S. 2014. Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries. Final Consolidated Report. WRC Report No TT 610/14, Water Research Commission, Pretoria.

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. and Goge, C. 2007. A technique for rapidly assessing wetland health: WET-Health. WRC Report TT 340/08.

McMillan, P.H. 1998. An Invertebrate Habitat Assessment System (IHASv2), for the Rapid Biological Assessment of Rivers and Streams. A CSIR research project, number ENV – P-I 98132 for the Water Resource Management Program, CSIR. Ii + 44p.

Mucina, L., & Rutherford, M. C. (2006). *The Vegetation of South Africa, Lesotho, and Swaziland. Strelitzia 19.* Pretoria: National Biodiversity Institute.

Nel JL, Murray KM, Maherry AM, Petersen CP, Roux DJ, Driver A, Hill L, Van Deventer H, Funke N, Swartz ER, Smith-Adao LB, Mbona N, Downsborough L and Nienaber S. 2011. Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

Ollis DJ, Snaddon CD, Job NM, and Mbona N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. South African Biodiversity Institute, Pretoria.

Pinder, L.C.V., 1986. Biology of freshwater Chironomidae. Annual review of entomology, 31(1), pp.1-23.

Plafkin, J.L., Barbour, M.T., Porter, K.D., Gross S.K., Hughes, R.M., 1989. Rapid Bio-assessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. U.S. Environmental Protection Agency.

Rountree KM, Wadeson RA and O'Keeffe J. 2000. The Development of a Geomorphological Classification System for the Longitudinal Zonation of South African Rivers. South African Geographical Journal 82 (3): 163-172.

Rountree MW, Malan H and Weston B (editors). 2012. Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0). Joint Department of Water Affairs/Water Research Commission Study. Report No XXXXXXXXX. Water Research Commission, Pretoria

Rowntree, K.M. and Ziervogel, G., 1999. Development of an index of stream geomorphology for the assessment of river health. National Aquatic Ecosystem.

Skelton, P.H. 2001. A complete guide to the freshwater fishes of southern Africa. Struik Publishers, South Africa.

South African National Biodiversity Institute (SANBI). 2009. Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

Statistics South Africa (StatsSA). 2010. Water Management Areas in South Africa. http://www.statssa.gov.za/publications/d04058/d04058.pdf.

Thirion, C.A., Mocke, A. & Woest, R. 1995. Biological monitoring of streams and rivers using SASS4. A User's Manual. Internal Report No. N 000/00REQ/1195. Institute for Water Quality Studies. Department of Water Affairs and Forestry. 46