Proposed Infrastructure Upgrade and Rehabilitation of the Orlando Dam, Soweto, Gauteng Province

Wetland/Riparian Delineation and Functional Assessment

February 2020

Drafted by
Limosella Consulting Pty Ltd
Reg No: 2014/023293/07
Email: antoinette@limosella.co.za
Cell: +27 83 4545 454
www.limosella.co.za

Prepared for:
Envirolution Consulting
223 Columbine Avenue, Mondeor, 2091
Tel: 0861 44 44 99
Fax: 0861 626 222
Email: info@envirolution.co.za
www.envirolution.co.za

Declaration of Independence

I, **Antoinette Bootsma**, in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member; and
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement.

Antoinette Bootsma (PrSciNat)
Ecologist/Botanist
SACNASP Reg. No. 400222-09

2020.02.13
Date

COMPLIANCE WITH THE APPENDIX 6 OF THE 2017 EIA REGULATIONS

NR.	CONTENT	REFERENCE
a	A specialist report prepared in terms of these Regulations must contain— details of— i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Appendix A
b	A declaration that the specialist is independent in a form as may be specified by the competent authority;	Page 2
c	An indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1
cA	An indication of the quality and age of base data used for the specialist report;	Section 1.1
cB	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 3.1 – 3.4
d	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 1
e	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2
f	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	Section 1.5
g	An identification of any areas to be avoided, including buffers;	Section 2.3 & 3.1.1
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Section 3.1
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.2
j	A description of the findings and potential implications of such findings on the impact of the proposed activity [including identified alternatives on the environment] or activities;	Section 3.1
k	Any mitigation measures for inclusion in the EMPr;	Section 4
l	Any conditions for inclusion in the environmental authorisation;	Section 4
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 4
n	A reasoned opinion— i. [as to] whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Executive Summary
o	A description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
p	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q	Any other information requested by the competent authority.	None

Document and Quality Control:

Report name: Proposed Infrastructure Upgrade and Rehabilitation of the Orlando Dam, Soweto, Gauteng Province			
Nature of Signoff	**Responsible Person**	**Role/Responsibility**	**Qualifications**
Author	Rudi Bezuidenhoudt	Wetland Specialist	BSc Hons, Unisa Pr.Sci.Nat (008867)
Technical Reviewer	Antoinette Bootsma	Senior Wetland Specialist	MSc *Cum Laude,* Unisa, Environmental Science Pr.Sci.Nat (400222/09)
Document number	**Checked by:**	**Electronic Signature:**	**Date**
Technical Review	Antoinette Bootsma	[signature]	2020.02.09
Client review	Jubilee Bubala	[signature]	2020.02.21
Final Report	Antoinette Bootsma	[signature]	2020.02.24

Disclaimer:

The actions and recommendations contained in this report remain the responsibility of the client as the custodian of the property discussed in this report.

Limosella Consulting and the authors of this report are protected from any legal action, possible loss, damage or liability resulting from the content of this report. This report remains confidential until requested by a court of law.

This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge, as well as available information. Information utilised and contained in this report is based on data/information supplied to Limosella Consulting (Pty) Ltd by the client and other external sources (including previous site investigation data and external specialist studies). Limosella Consulting (Pty) Ltd exercises due care and diligence in rendering services and preparing documents, however it has been assumed that the information provided to Limosella Consulting (Pty) Ltd is correct and as such the accuracy of the conclusions made are reliant on the accuracy and completeness of the data supplied. The author reserves the right to modify aspects of the report, including the recommendations, if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

No responsibility is accepted by Limosella Consulting (Pty) Ltd for incomplete or inaccurate data supplied by the client and/or other external sources. Opinions expressed in this report apply to the site conditions and features that existed at the time of the start of the investigations and the production of this document. Limosella Consulting (Pty) Ltd and the authors and directors therefore accept no liability, and the client, by receiving this document, indemnifies Limosella Consulting (Pty) Ltd and the authors and directors against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the author and by the use of this document.

The document may not be altered or added to without the prior written consent of the author. This also refers to electronic copies of the report which are supplied for the purposes of inclusion as part of other reports.

EXECUTIVE SUMMARY

Limosella Consulting was appointed by Envirolution Consulting to undertake a wetland and/or riparian delineation and functional assessment to inform the Environmental Authorization for the proposed upgrade and rehabilitation of infrastructure of the Orlando Dam, Soweto, City of Johannesburg (Henceforth known as the study site). Previous dam safety inspection reports, including the latest one from 2019 recommended that rehabilitation measures be implemented to ensure the continued safe functioning of the dam. The proposed works will essentially be rehabilitation of the existing structures. Reconstruction of the embankment crest might result in a nominal increase in height of the embankment. The existing spillway crest levels will remain as it is currently. The water level in the reservoir will therefore remain unchanged. The upgrades to the spillway will repair the damaged lining but the spillway capacity will remain unchanged. The following measures are proposed:

- Repair/replace and strengthen displaced, damaged and missing interlocking Armorflex blockwork on the training walls of the Auxiliary Spillway.
- Backfilling of the trench along embankment crest. This can be temporary measure until the NOC has been reconstructed to currently accepted engineering standards for embankment dams.
- Rehabilitation and/or total reconstruction of the upstream face of the embankment from a level below where benching has commenced to NOC level and protected with properly designed riprap.
- Rehabilitation and/or total reconstruction of the upper 1.8 m (at least) of the NOC of the embankment.
- Rehabilitation and/or total reconstruction of the downstream face of the embankment with a blanket chimney drain and backfill of imported embankment to reinstate the downstream face of embankment to design slope of 1.0V:2.0H.
- The right-hand training wall of the Auxiliary Spillway should be raised to NOC level and extended in a downstream direction.
- Rehabilitation of the 600 mm diameter outlet pipe and control valve.

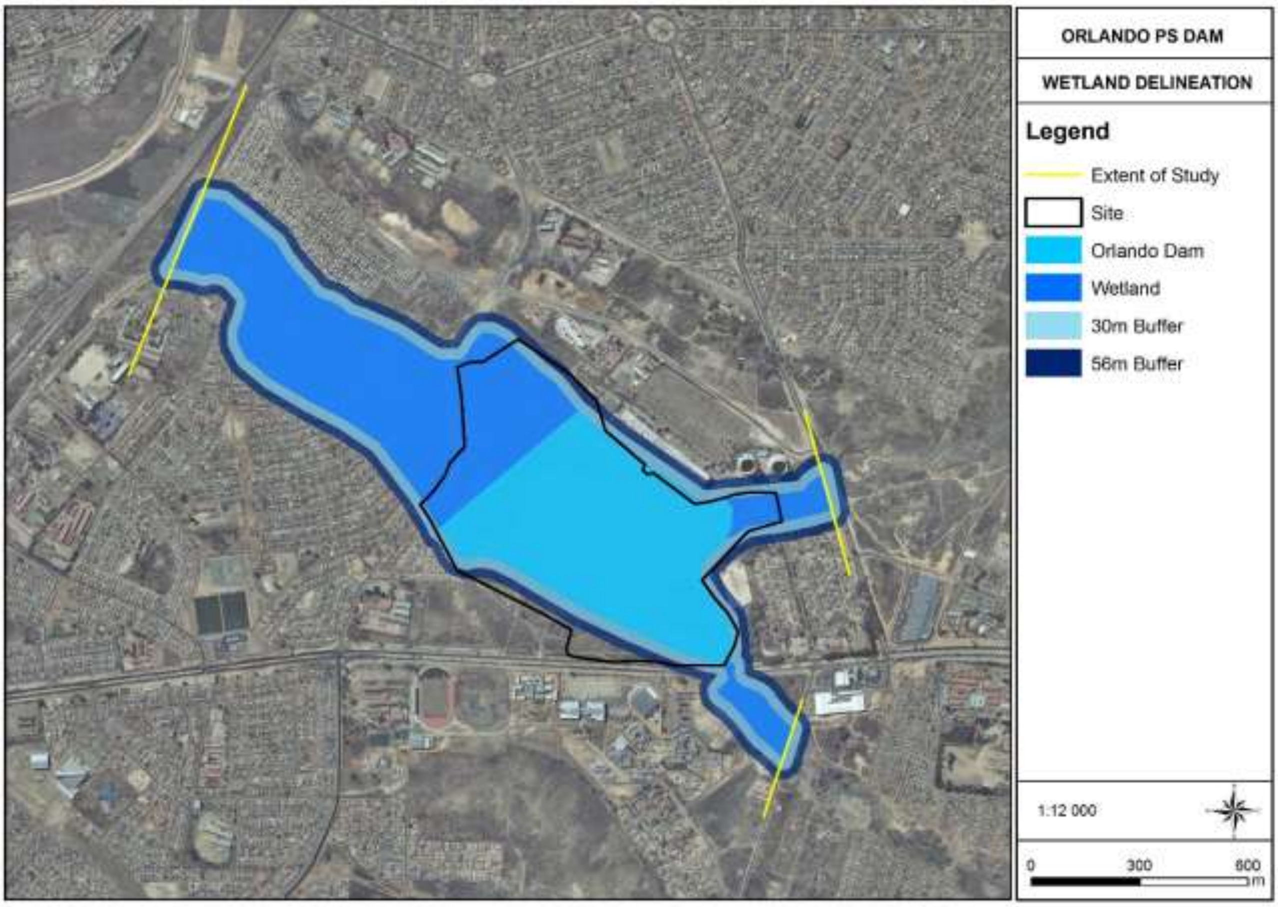
Fieldwork was conducted on the 10th of February 2020.

The terms of reference for the study were as follows:

- Delineate the wetland and riparian areas;
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
- Undertake functional and integrity assessment of wetlands areas within the area assessed as specified in General Notice 267 of 24 March 2017;
- Undertake an impact assessment as specified in the NEMA 2014 regulations (as amended),
- Recommend suitable buffer zones, both generic (as required in GDARD, 2014) and scientific as specified in General Notice 267 of 24 March 2017, following Macfarlane *et al* 2015 ; and
- Discuss appropriate mitigation and management procedures relevant to the conserving wetland areas on the site.

The watercourse discussed in this report is described as a large dam area constructed on the confluence of two small channelled valley bottom wetlands (refer to the figure below). When the water exits the constructed dam it forms an unchannelled valley bottom wetland with elements of floodplain wetland

characteristics. The aforementioned area is thus described as a dam within a wetland system. The construction of the Orlando Power station started in 1939 and the wetland has thus been disturbed for 81 years. Not only does the wetland currently have numerous impoundments, trenches but it also has numerous stormwater drains and canals entering and exiting the wetland. Leaking sewerage is also an issue. The system is subsequently greatly altered from the theoretical natural state. The hydrology, geomorphology and vegetation has changed significantly, however, the wetland and dam provides habitat and breeding ground for a variety of faunal species, especially avifaunal species.



The important factors relevant to the project are summarised in the table below:

	Quaternary Catchment and WMA areas	**Important Rivers possibly affected**	
	C22A – 5th WMA Vaal	Tributary of the Klip River	
Integrity and functional assessment	Present Ecological Status (PES): 7.1 (**E – Low)**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable. The status of this wetlands is likely to remain stable over the next 5 years.		
	Ecological Importance and Sensitivity (EIS): 1.4 (**C - Moderate**). Wetlands in this category are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers		
	Recommended Ecological Category (REC): **D**		
	WetEcoServices: Phosphate trapping - 2.9 Toxicant removal - 3.0 Threats - 3.0		
Buffer zones	Generic (GDARD, 2014; CoJ, 2010): **30m**		
	Calculated (Macfarlane *et al*, 2015): **23 m Operational & 56 Construction**		
NEMA 2014 Impact Assessment	The impact scores for the following aspects are relevant:	Without Mitigation	With Mitigation
	Changes to flow dynamics	M	L
	Sedimentation	M	L
	Establishment of alien plants	M	L
	Pollution of watercourses	M	L
	Loss of fringe vegetation and habitat	M	L
DWS 2016 Risk Assessment	The proposed upgrade and rehabilitation of the Orlando dam are likely to have minimal additional impact and construction and operational phase fall in the **Low** risk category.		
Does the specialist support the development?	Yes. Given that the mitigation measures are adhered to.		
Recommendations	In particular, the following mitigation measures should be awarded a high priority: • Particular attention should be given to the protection of downstream areas during the construction phase, particularly erosion and sedimentation. • Rigorous monitoring should determine if design and rehabilitation targets are being met, and should aim to highlight any unintended negative impacts downstream resulting from changed hydrology, for example bank instability or erosion where water flowpaths have been altered • Sediment control should be audited on a weekly during construction to demonstrate compliance with upstream conditions. • Where necessary, corrective action should be determined by a team of specialists including engineers, hydrologists and ecologists		

Table of Contents

Figures

Tables

1 INTRODUCTION

Limosella Consulting was appointed by Envirolution Consulting to undertake a wetland and/or riparian delineation and functional assessment to inform the Environmental Authorization for the proposed upgrade and rehabilitation of infrastructure of the Orlando Dam, Soweto, City of Johannesburg (Henceforth known as the study site). Previous dam safety inspection reports, including the latest one from 2019 recommended that rehabilitation measures be implemented to ensure the continued safe functioning of the dam. The proposed works will essentially be rehabilitation of the existing structures. Reconstruction of the embankment crest might result in a nominal increase in height of the embankment. The existing spillway crest levels will remain as it is currently. The water level in the reservoir will therefore remain unchanged. The upgrades to the spillway will repair the damaged lining but the spillway capacity will remain unchanged. The following measures are proposed:

- Repair/replace and strengthen displaced, damaged and missing interlocking Armorflex blockwork on the training walls of the Auxiliary Spillway.
- Backfilling of the trench along embankment crest. This can be temporary measure until the NOC has been reconstructed to currently accepted engineering standards for embankment dams.
- Rehabilitation and/or total reconstruction of the upstream face of the embankment from a level below where benching has commenced to NOC level and protected with properly designed riprap.
- Rehabilitation and/or total reconstruction of the upper 1.8 m (at least) of the NOC of the embankment.
- Rehabilitation and/or total reconstruction of the downstream face of the embankment with a blanket chimney drain and backfill of imported embankment to reinstate the downstream face of embankment to design slope of 1.0V:2.0H.
- The right-hand training wall of the Auxiliary Spillway should be raised to NOC level and extended in a downstream direction.
- Rehabilitation of the 600 mm diameter outlet pipe and control valve.

Fieldwork was conducted on the 10th of February 2019.

1.1 Terms of Reference

The terms of reference for the study were as follows:

- Delineate the wetland and riparian areas;
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
- Undertake functional and integrity assessment of wetlands areas within the area assessed as specified in General Notice 267 of 24 March 2017;
- Undertake an impact assessment as specified in the NEMA 2014 regulations (as amended),
- Undertake a risk assessment as specified in General Notice 509 in published in the Government Gazette 40713 of 24 March 2017,
- Recommend suitable buffer zones as specified in General Notice 267 of 24 March 2017, following Macfarlane *et al* 2015 ; and

- Discuss appropriate mitigation and management procedures relevant to the conserving wetland areas on the site and downstream of the site.

1.2 Assumptions and Limitations

- The information provided by the client forms the basis of the planning and layouts discussed.
- All wetlands within 500 m of any developmental activities should be identified as per the DWS Water Use Licence application regulations. Wetlands within the study sites were delineated on a fine scale based on detailed soil and vegetation sampling. Wetlands that fall outside of the site, but that fall within 500 m of the proposed activities were delineated based on desktop analysis of vegetation gradients visible from aerial imagery.
- The detailed field study was conducted from a once off field trip and thus would not depict any seasonal variation in the wetland plant species composition and richness.
- Description of the depth of the regional water table and geohydrological and hydropedological processes falls outside the scope of the current assessment
- Floodline calculations fall outside the scope of the current assessment
- A Red Data scan, fauna and flora, and aquatic assessments were not included in the current study
- Some wetland areas are located in gated communities, housing complexes, fenced areas and other inaccessible areas.
- The recreation grade GPS used for wetland and riparian delineations is accurate to within five meters.
- Wetland delineation plotted digitally may be offset by at least five meters to either side. Furthermore, it is important to note that, during the course of converting spatial data to final drawings, several steps in the process may affect the accuracy of areas delineated in the current report. It is therefore suggested that the no-go areas identified in the current report be pegged in the field in collaboration with the surveyor for precise boundaries. The scale at which maps and drawings are presented in the current report may become distorted should they be reproduced by for example photocopying and printing.

1.3 Definitions and Legal Framework

This section outlines the definitions, key legislative requirements and guiding principles of the wetland study and the Water Use Authorisation process.

The National Water Act, 1998 (Act No. 36 of 1998) [NWA] provides for Constitutional water demands including pollution prevention, ecological and resource conservation and sustainable utilisation. In terms of this Act, all water resources are the property of the State and are regulated by the Department of Human Settlements, Water and Sanitation (DHWS). The NWA sets out a range of water use related principles that are to be applied by DWS when taking decisions that significantly affect a water resource. The NWA defines a water resource as including a watercourse, surface water, estuary or aquifer. A watercourse includes a river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake, pan or dam, into which or from which water flows; any collection of water that the Minister may declare to be a watercourse; and were relevant its beds and banks.

The NWA defines a wetland as “land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.” In addition to water at or near the surface, other distinguishing indicators of wetlands include hydromorphic soils and vegetation adapted to or tolerant of saturated soils (DWA, 2005).

Riparian habitat often times perform the important ecological and hydrological functions, some similar to those performed by wetlands (DWA, 2005). Riparian habitat is also the accepted indicator used to delineate the extent of a river’s footprint (DWAF, 2005). It is defined by the NWA as follows: “Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse, which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas”.

Water uses for which authorisation must be obtained from DHWS are indicated in Section 21 of the NWA. Section 21 (c) and (i) is applicable to any activity related to a watercourse:
Section 21(c): Impeding or diverting the flow of water in a watercourse; and
Section 21(i): Altering the bed, banks, course or characteristics of a watercourse.

Authorisations related to wetlands are regulated by Government Notice 509 of 2016 regarding Section 21(c) and (i). This notice grants General Authorisation (GA) for the above water uses on certain conditions. This regulation also stipulates that water uses must the registered with the responsible authority. Any activity that is not related to the rehabilitation of a wetland and which takes place within 500 m of a wetland are excluded from a GA under either of these regulations, unless the impacts score as low in the requires risk assessment matrix (DWS, 2016) Such an activity requires a Water Use Licence (WUL) from the relevant authority.

Conditions for impeding or diverting the flow of water or altering the bed, banks, course or characteristics of a watercourse (Section 21(c) and (i) activities) include:
9. (3) (b). The water user must ensure that the selection of a site for establishing any impeding or diverting the flow or altering the bed, banks, course or characteristics of a watercourse works:
(i) is not located on a bend in the watercourse;
(ii) avoid high gradient areas, unstable slopes, actively eroding banks, interflow zones, springs, and seeps;.

In addition to the above, the proponent must also comply with the provisions of the following relevant national legislation, conventions and regulations applicable to wetlands and riparian zones:

- Convention on Wetlands of International Importance - the Ramsar Convention and the South African Wetlands Conservation Programme (SAWCP).
- National Environmental Management Act, 1998 (Act No. 107 of 1998) [NEMA].
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).
- National Environment Management Protected Areas Act, 2003 (Act No. 57 of 2003).
- Regulations GN R.982, R.983, R. 984 and R.985 of 2014, promulgated under NEMA.
- Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983).
- Regulations and Guidelines on Water Use under the NWA.

- South African Water Quality Guidelines under the NWA.
- Mineral and Petroleum Resources Development Act, 2002 (Act No. 287 of 2002).
- GN 267 (Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals)

1.4 Locality of the study site

The study site is located in the suburb of Orlando East in Soweto, City of Johannesburg, Gauteng Province (Figure 1). The dam located south of the Orlando Power Station and the Soweto Towers. It is bordered in the south by the M68 road. The approximate coordinates of the study area are 26°15'16.88"S and 27°55'9.76"E (Figure 1).

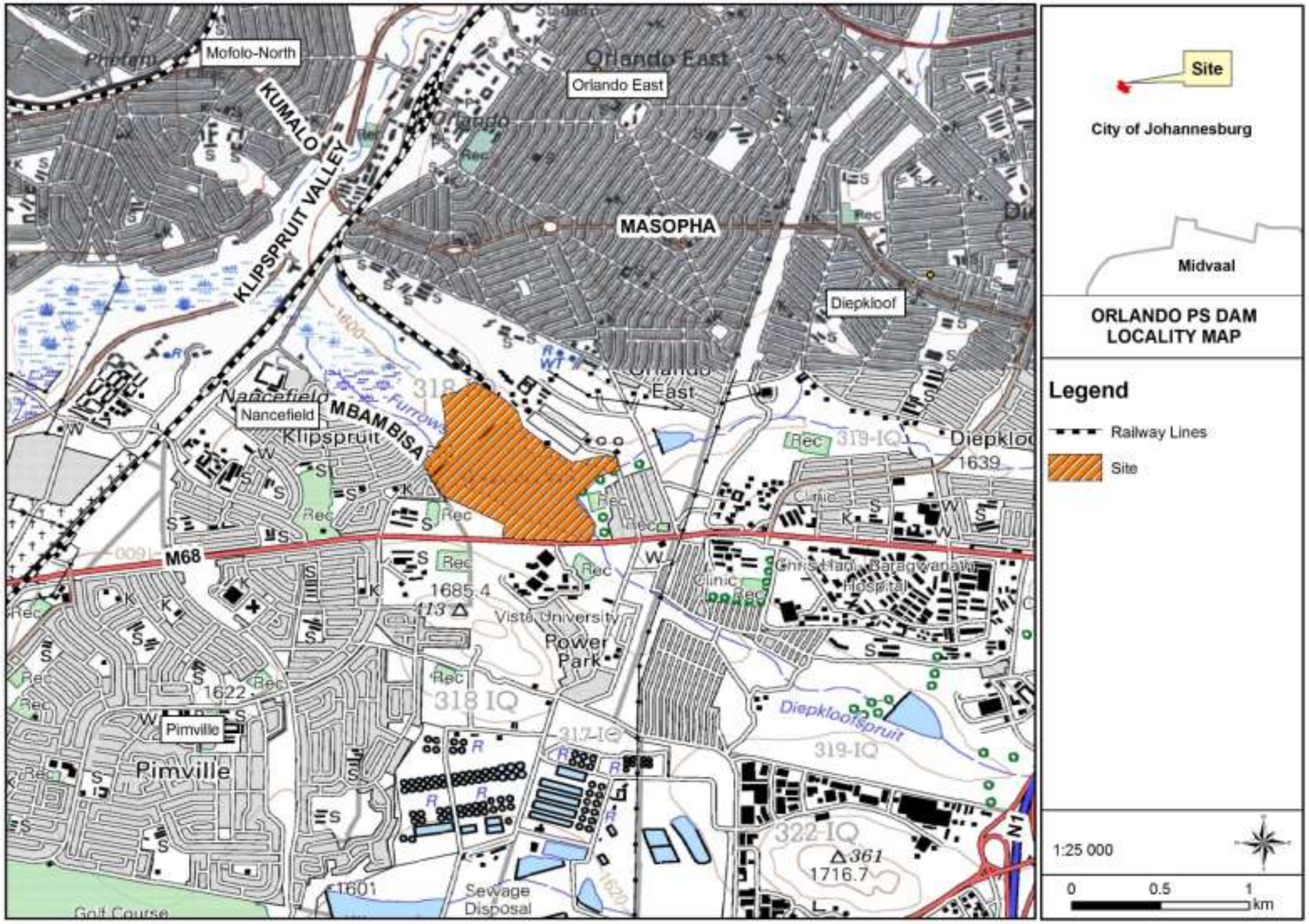


Figure 1: Locality Map

1.5 Description of the Receiving Environment

A review of available literature and spatial data formed the basis of a characterisation of the biophysical environment in its theoretically undisturbed state and consequently an analysis of the degree of impact to the ecology of the study site in its current state.

Quaternary Catchments and Water Management Area (WMA):

As per Macfarlane *et al*, (2009) one of the most important aspects of climate affecting a wetland's vulnerability to altered water inputs is the ratio of Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) (i.e. the average rainfall compared to the water lost due to the evapotranspiration that would potentially take place if sufficient water was available). The site is situated in Quaternary Catchment C22A. In this catchment, the precipitation rate is considerably lower than the evaporation rate with a Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) of 0.32. Consequently, wetlands in this area are sensitive to changes in regional hydrology, particularly where their catchment becomes transformed and the water available to sustain them becomes redirected.

Nine Water Management Areas (WMA) were established by, and their boundaries defined in Government Gazette Nr. 40279, dated 16 September 2016. The Quaternary Catchment C22A fall within the fifth WMA, the Vaal Major. The major rivers that are located within this WMA include the Wilge-, Liebenbergsvlei-, Mooi-, Renoster-, Vals-, Sand-, Vet-, Harts-, Molopo and Vaal River. The wetland and associated dam flows south into the Klip River, which eventually drains into the Vaal River.

Hydrology:

Surface water spatial layers such as the National Freshwater Ecosystems Priority Areas (NFEPA) Wetland Types for South Africa (SANBI, 2010) and Gauteng Department of Agriculture and Rural Development (GDARD) were consulted for the presence of wetlands and rivers. This layer reflects one watercourses that runs through the study area (Figure 2). The wetland vegetation group of the study area is Mesic Highveld Grassland Group 3.

The wetland on the study site forms one of the tributaries of the Klip River. This river eventually confluences with the Vaal River. This river of strategic importance is the third largest river in South Africa after the Orange River (2200 km long) and the Limpopo River (1750 km long) and was established as the main source of water for the great Witswatersrand area after the gold rush during the 19th Century (http://www.randwater.co.za).

Regional Vegetation:

According to the Vegetation Map of South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006), the study site is located on an area classified as Soweto Highveld Grassland. Soweto Highveld Grassland is associated with the gently to moderately undulating landscape of the Highveld Plateau supporting short to medium-high, dense, tufted grassland, dominated by a variety of grasses. In undisturbed areas grassland is interrupted by small wetlands and narrow stream alluvia and occasional ridges or rocky outcrops. Soweto Highveld Grassland is considered Endangered as only a handful of patches are statutorily, or privately, conserved (Mucina and Rutherford, 2006).

Geology and soils:

The entire site is underlain by Klipriviersberg and Turffontein geological units (GDACE, 2002) (Figure 3). The regional soil description for the area is summarised in the table and figures below (Table 1 & Figure 3)

Table 1: Soil of the study site.

Soil Name	Description	Relation to wetlands according to Fey (2005)
U – Entire study area	Unconsolidated/Urban Soil Usually considered a disturbed soil which no longer retains recognizable profiles following anthropogenic disturbance.	None

Gauteng Conservation Plan

The Gauteng Conservation Plan (Version 3.3) (GDARD, 2011) classified areas within the province on the basis of its contribution to reach the conservation targets within the province. Critical Biodiversity Areas (CBAs) contain irreplaceable, important and protected areas (terms used in C-Plan 2) and are areas needed to reach the conservation targets of the Province. In addition, 'Ecological Support Areas' (ESAs), mainly around riparian areas and other movement corridors were also classified to ensure sustainability in the long term. Landscape features associated with ESAs is essential for the maintenance and generation of biodiversity in sensitive areas and requires sensitive management where incorporated into C-Plan 3. The area associated with the watercourse and dam is classified as Important and Ecological Support Areas (Figure 4).

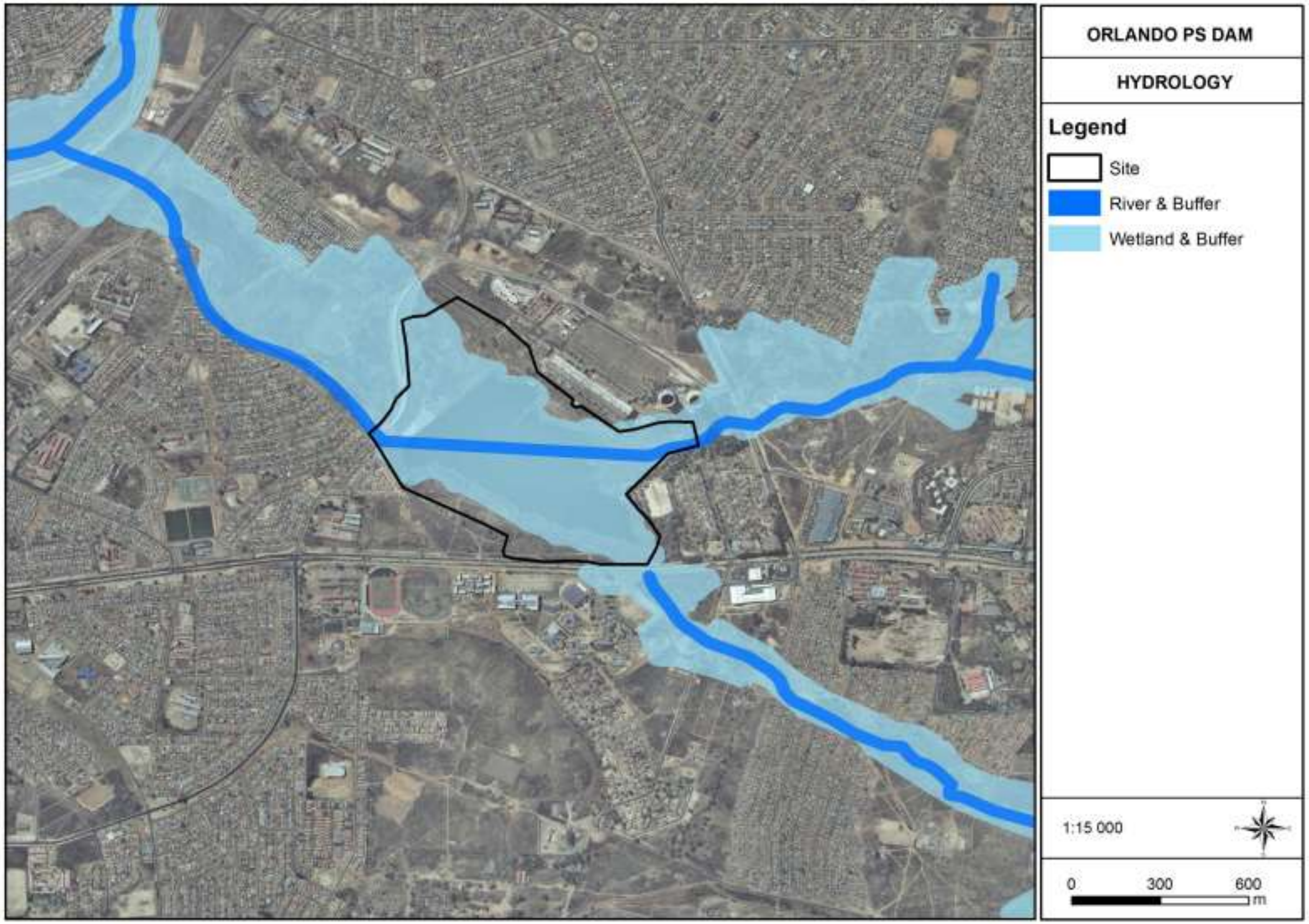


Figure 2: Regional hydrology

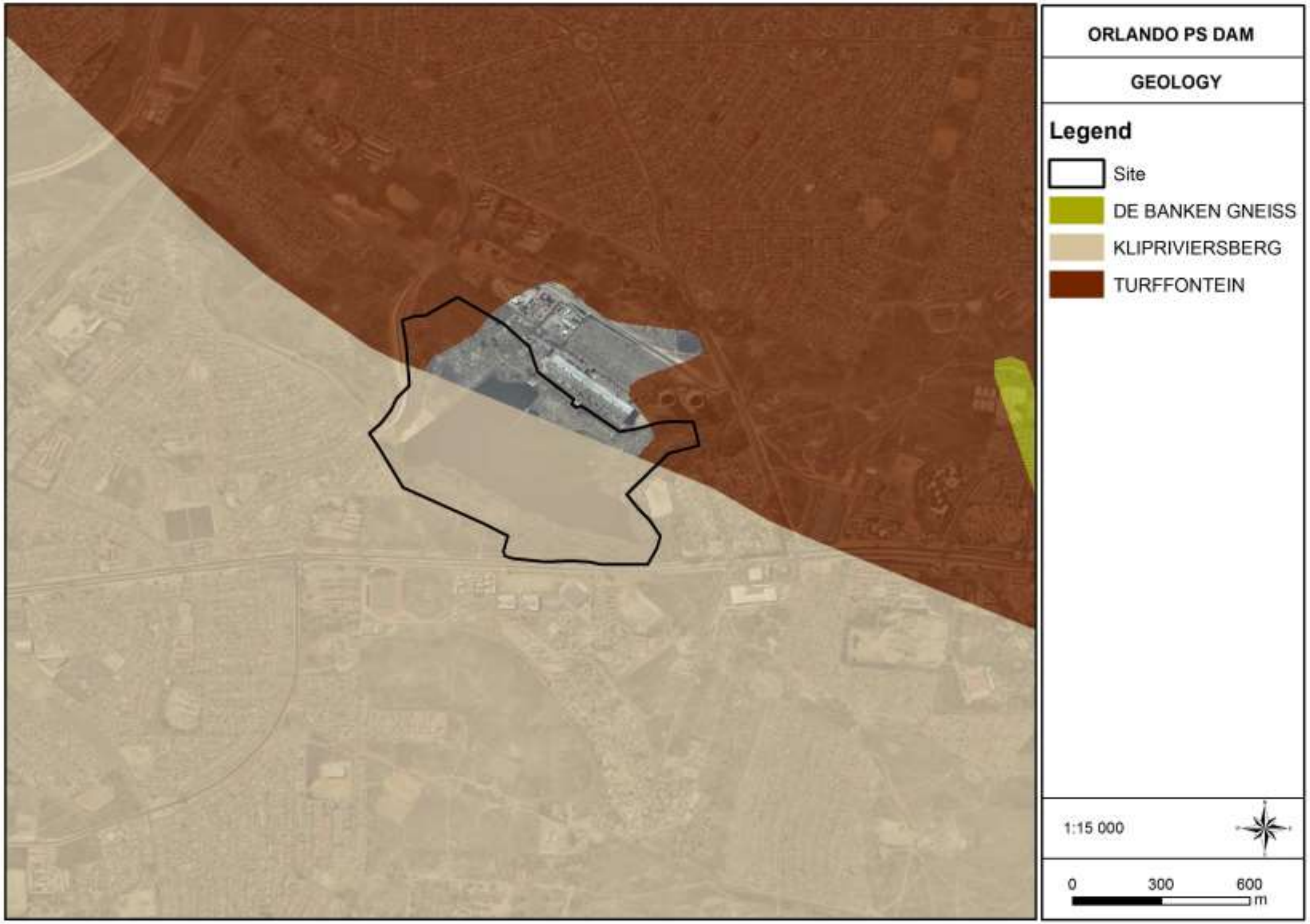


Figure 3: Geology of the study area and surroundings.

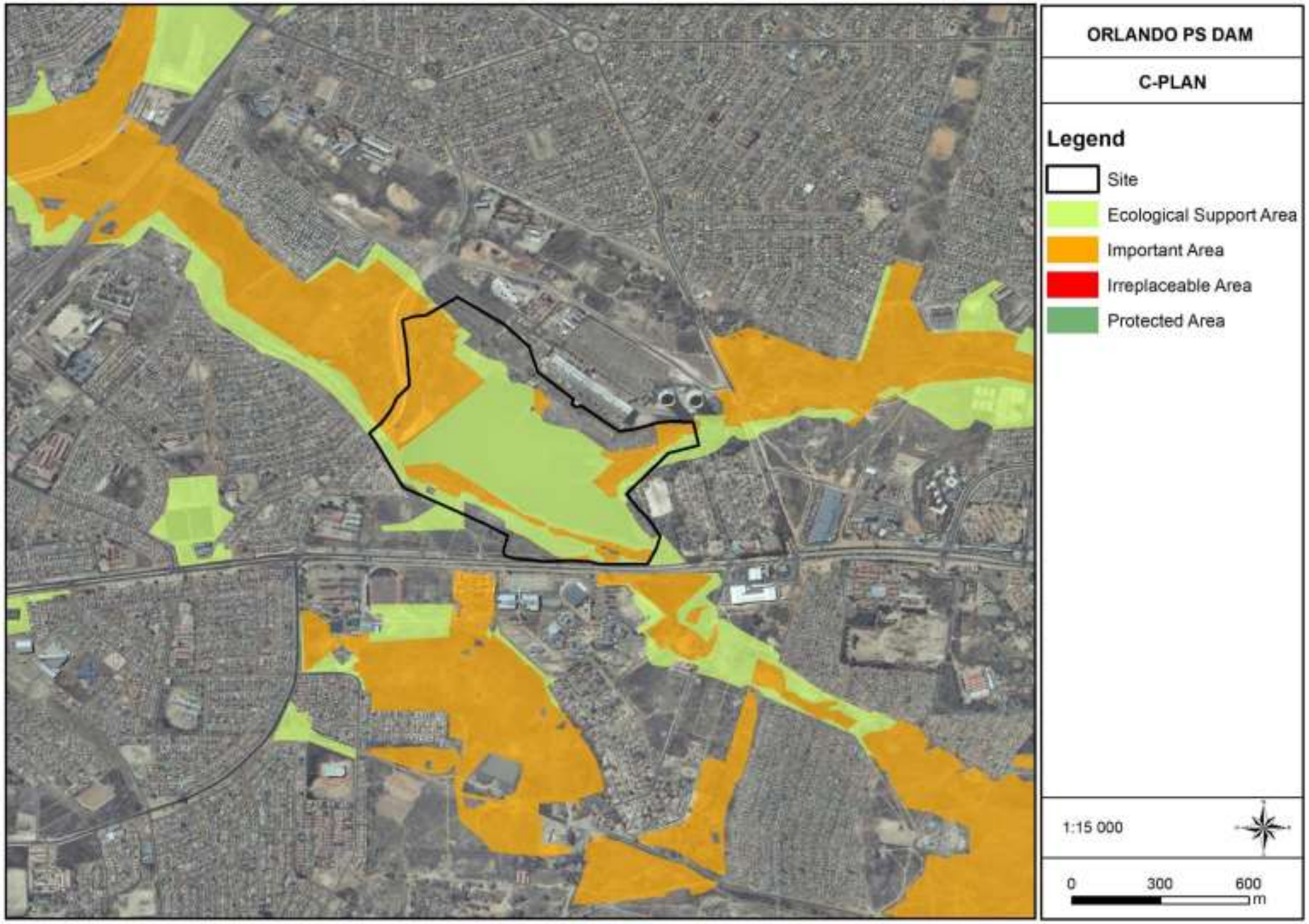


Figure 4: Gauteng Conservation Areas associated with the study site.

1.6 Buffer Zones

A buffer zone is defined as a strip of land surrounding a wetland or riparian area in which activities are controlled or restricted (DWAF, 2005). A development has several impacts on the surrounding environment and on a wetland. The development changes habitats, the ecological environment, infiltration rate, amount of runoff and runoff intensity of the site, and therefore the water regime of the entire site. An increased volume of stormwater runoff, peak discharges, and frequency and severity of flooding is therefore often characteristic of transformed catchments. The buffer zone identified in this report serves to highlight an ecologically sensitive area in which activities should be conducted with this sensitivity in mind.

Buffer zones have been shown to perform a wide range of functions and have therefore been widely proposed as a standard measure to protect water resources and their associated biodiversity. These include (i) maintaining basic hydrological processes; (ii) reducing impacts on water resources from upstream activities and adjoining landuses; (iii) providing habitat for various aspects of biodiversity. A brief description of each of the functions and associated services is outlined in Table 2 below.

Table 2: Generic functions of buffer zones relevant to the study site (adapted from Macfarlane *et al*, 2010)

Primary Role	Buffer Functions
Maintaining basic aquatic processes, services and values.	• Groundwater recharge: Seasonal flooding into wetland areas allows infiltration to the water table and replenishment of groundwater. This groundwater will often discharge during the dry season providing the base flow for streams, rivers, and wetlands.
Reducing impacts from upstream activities and adjoining land uses	• Sediment removal: Surface roughness provided by vegetation, or litter, reduces the velocity of overland flow, enhancing settling of particles. Buffer zones can therefore act as effective sediment traps, removing sediment from runoff water from adjoining lands thus reducing the sediment load of surface waters. • Removal of toxics: Buffer zones can remove toxic pollutants, such hydrocarbons that would otherwise affect the quality of water resources and thus their suitability for aquatic biota and for human use. • Nutrient removal: Wetland vegetation and vegetation in terrestrial buffer zones may significantly reduce the amount of nutrients (N & P), entering a water body reducing the potential for excessive outbreaks of microalgae that can have an adverse effect on both freshwater and estuarine environments. • Removal of pathogens: By slowing water contaminated with faecal material, buffer zones encourage deposition of pathogens, which soon die when exposed to the elements.

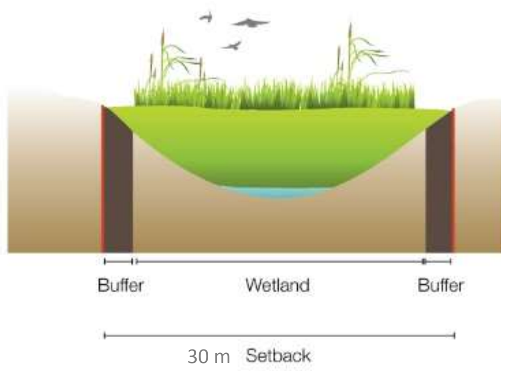
Despite limitations, buffer zones are well suited to perform functions such as sediment trapping, erosion control and nutrient retention which can significantly reduce the impact of activities taking place adjacent to water resources. Buffer zones are therefore proposed as a standard mitigation measure to reduce impacts of land uses / activities planned adjacent to water resources. These must however be considered in conjunction with other mitigation measures.

Buffer calculation tools were developed and are published as "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries. Consolidated Report" by the WRC (Macfarlane *et al* 2015). This new buffer tools aims to calculate the best suited buffer for each wetland or section of a wetland based on numerous on-site observations. The resulting buffer area can thus have large differences depending on the current state of the wetland as well as the nature of the proposed development. Developments with a high risk factor such as mining are likely to have a larger buffer area compared to a residential development with a lower risk factor. The minimum accepted buffer for low risk developments are however 15 meters from the edge of the wetland (Macfarlane, *et al* 2015) as opposed to the generic recommendation of 30 m for wetlands inside the urban edge and 50 m outside the urban edge (GDARD, 2014). This is also reflected in the Johannesburg Catchment Management Policy (2010).

The generic recommended buffer zone applicable to the proposed project following (GDARD, 2014) are 30m from the delineated edge of the wetland. The calculated buffer zone following Macfarlane et al (2015) is 23m (operational phase) and 56m (construction phase). However

It should be noted that the buffer calculation tool does not take into account the effects of climate change or cumulative impacts to floodflows resulting from transformed catchments. Therefore, a conservative approach to the application of buffer zones is encouraged. Furthermore, the buffer recommended in this report should be reviewed to include possible sensitive fauna species.

Figure 5 images represent the buffer zone setback for the wetlands discussed in this report.



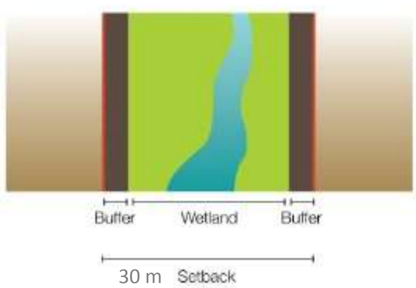


Figure 5: A representation of the buffer zone setback for the wetland types discussed in this report

2 RESULTS

2.1 Land Use, Cover and Ecological State

The study area contributes to an urban built up environment. The watercourses flowing into the dam are used in large for subsistence farming. The study site is further located south of the Johannesburg mining belt area. This area has been extensively mined for the better part of a century and wetlands and rivers flowing through the area are subject to significant pollution. The area is also disturbed by various anthropogenic activities such as dumping and littering and infrastructure encroachment onto specialised habitats. The vegetation composition is mainly exotic with only a few pioneer species colonising the area. Furthermore, informal settlements have encroached into the wetland in some areas further degrading the wetland system (Figure 6).

Figure 6: Aerial imagery showing the increase in informal settlement encroachment into the wetland from 2000 (Top) to 2019 (Bottom).

3 Wetland Classification and Delineation

The watercourse recorded on the site was classified as a large dam area constructed on the confluence of two small channelled valley bottom wetlands (Figure 7). When the water exits the constructed dam it forms an unchannelled valley bottom wetland with elements of floodplain wetland characteristics. The aforementioned area is thus described as a dam within a wetland system. The construction of the Orlando Power station started in 1939 and the wetland has thus been impacted on for 81 years or longer. Not only does the wetland have numerous impoundments, trenches but it also has numerous stormwater drains and canals entering and exiting the wetland. Leaking sewerage is also an issue. The system is subsequently greatly altered from the theoretical natural state. The hydrology, geomorphology and vegetation has changed significantly, however, the wetland and dam provide habitat and breeding ground for a variety of faunal species, especially avifaunal species.

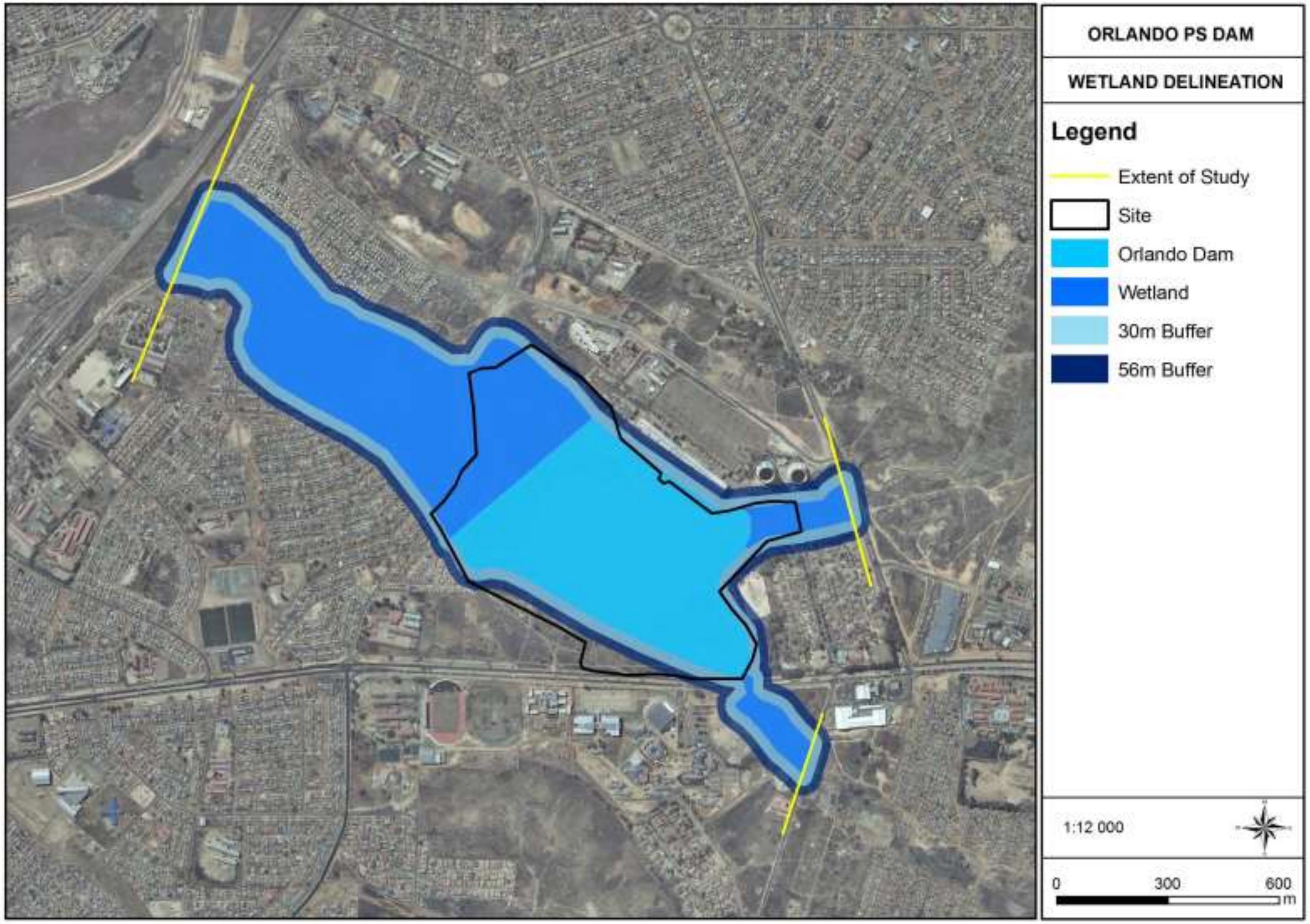


Figure 7:Dam and associated wetland and their associated buffer zone.

3.1.1 Soil Indicators & Vegetation Indicators

The soil profile of the area is predominantly disturbed by anthropogenic activities associated with construction of commercial and residential infrastructure and roads as well as the construction of the dam. The vegetation associated with the wetland is similar to that usually found in the disturbed wetlands in parts of Johannesburg. Some woody vegetation was recorded in the wetlands flowing into the dam, these include *Salix babylonica, Eucalyptus grandis, Ligustrum sp.* The wetlands were also characterised by large areas of subsistence farming on the banks of the streams. These areas, if not actively used for farming, are usually dominated by exotic species. The dominant wetland vegetation include the cosmopolitan pioneer *Phragmites australis* which is known to colonises areas with high sedimentation rates, as well as *Typha capensis* (Bullrushes). Large areas were colonised by the invasive grass *Pennisetum clandestinum* Kikuyu Grass) and the indigenous wetland grass *Paspalum dilatatum.* Other exotic species recorded on the study include *Mirabilis jalapa, Solanum mauritianum, Ricinus communis, Nasturtium officinale, Cortaderia selloana, Tagetes minuta, Arundo donax, Verbena bonariensis, and Amaranthus hybridus* (Figure 8).

Figure 8: General characteristics of the wetland in the study area including dense reed beds and invasive trees.

3.2 Wetland Functional Assessment

The increased hardened surfaces in its catchment due to increased development as well as the intensive changes to the hydrology of the system have significantly impacted the functionality of the wetland. This has led to an increase in exotic species in the area, increased sediment and a change in geomorphology. The hydrology has been impacted by impounding water, the input of foreign materials input from the roads and industrial areas, inadequate stormwater management. Run-off from roads and surfaces lead to an increase in hydro-carbon contamination and sediment pollution. Dumping and littering also pollutes the watercourse. The geomorphology of the wetlands has been impacted by dumped material including rubble and garden refuse, trenches, gullies and many roads and footpaths traversing the wetland. Lastly, the vegetation composition has also been impacted as a result of the changes discussed above. The current species composition is dominated by exotic plants with a few hardy indigenous individuals surviving.

3.2.1 Scores

The wetland scored a PES of **E - Largely modified**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable. The wetland conditions recorded on the study site are likely to remain stable over the next 5 years. This is due to the prolonged altered state of the wetland area, although it is likely that the vegetation composition will deteriorate slightly over the next 5 years given the amount of exotic species located on the study site that tend to grow into dense exclusive stands. The PES scores of the wetland are reflected in Table 3 below.

Table 3: Summary of hydrology, geomorphology and vegetation health assessment for wetland on the study site (Macfarlane *et al*, 2009).

Wetland Unit	Hydrology		Geomorphology		Vegetation		Overall Score	
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Channelled Valley Bottom	7.6	0	7.1	0	6.5	-1	7.4	0
PES Category and Projected Trajectory	**E**	→	**E**	→	**E**	↓	**E**	→

Ecological Importance and Sensitivity (EIS)

The EIS score of **1.3** for the wetland falls into a category characterised by **Moderate** ecological importance and sensitivity. Wetlands that fall into this category are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers (DWAF, 1999). The dense stands of vegetation are likely to contribute in some degree to the hydro-functionality of the wetland and is likely to enhance water quality to some degree although it is likely still very much pollute and unsuitable for human consumption or use explaining the low score for human benefits (Table 4).

Table 4: WIS including EIS scores obtained for the wetland on the study site. (DWAF, 1999).

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	**1.3**	**3.0**
Hydro-functional importance	1.4	2.5
Direct human benefits	0.2	3.0

The ecosystem services provided by the wetland on the study site is summarised in the table below (Table 5). The table lists scores from the lowest scores to the highest. The threats to the wetlands are very high as a result of exotic plant invasion however, there exists several opportunities to enhance the wetlands such as mechanical enhancement and removal of exotic vegetation.

Table 5: Results and brief discussion of the Ecosystem Services provided by the wetland on the study site.

Function	Score	Significance
Tourism and recreation	0.0	Low
Opportunities	0.0	Low
Education and research	0.5	Low
Maintenance of biodiversity	0.9	Low
Cultural significance	1.0	Moderately Low
Carbon storage	1.3	Moderately Low
Water supply for human use	1.3	Moderately Low
Streamflow regulation	1.8	Moderately Low
Natural resources	2.2	Moderate
Cultivated foods	2.2	Moderately High
Erosion control	2.4	Moderately High
Flood attenuation	2.6	Moderately High
Sediment trapping	2.7	Moderately High
Nitrate removal	2.8	Moderately High
Phosphate trapping	2.9	Moderately High
Toxicant removal	3.0	High
Threats	3.0	High

3.3 Summary of Findings

Table 6 provides a summary of the results recorded for each wetland unit potentially affected by the proposed development.

Table 6: Summary of results for each wetland unit discussed

Classification (SANBI, 2013)	PES (Macfarlane *et al*, 2007)	EIS (DWAF, 1999)	WetEcoServices (3 most prominent scores)	Scientific Buffer (Macfarlane *et al* 2015)		REC
				Construction	Operational	
Channelled Valley Bottom	7.1 (E)	1.4 (C)	Phosphate trapping - 2.9 Toxicant removal - 3.0 Threats - 3.0	56 m	23 m	D

3.4 Impacts and Mitigations

Repair and upgrade of the auxiliary spillway, repair and upgrade of the upstream and downstream face of the embankment as well as the upper section of the embankment and associated infrastructure will require work within the watercourse itself. These are activities that should be informed by careful design and intensive monitoring to ensure that no unintended negative impacts result on the local and downstream areas. It is important that any mitigation be implemented in the context of an Environmental Management Plan to in order to ensure accountability and ultimately the success of the mitigation. The risk to the surrounding environment due to the proposed upgrade and rehabilitation of the Orlando dam is small since structures are existing and no expansion of the footprint will occur. The expected impacts are primarily linked to vegetation clearing and possible sedimentation. Expected impacts are discussed in the impact assessment scores derived according to the NEMA 2014 regulations, as amended (Tables 7 to 11) as well as the DWS (2016) Risk Matrix spreadsheet presented in Table 12. They show that the risk score fall in the **Low** risk categories after implementation of effective mitigation.

Table 7: Changes in water flow regime impact ratings

Nature: Changing the quantity and fluctuation properties of the watercourse by for example restricting water flow or increasing flood flows

ACTIVITY: The sources of this impact are limited since no hydrological changes will occur. During the construction phase it is possible that the compaction of soil temporary removal of vegetation may affect local water flow

	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Probable (3)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Regional (3)	Limited to the local area (2)
Magnitude	Moderate (6)	Low (4)
Significance	**36 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Probable (3)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Limited to the local area (2)	Limited to the local area (2)
Magnitude	Low (4)	Low (4)
Significance	**27 (low)**	**18 (low)**
Status (positive or negative)	Negative	Neutral
Reversibility	Moderate	Moderate
Irreplaceable loss of resources?	Low	None
Can impacts be mitigated?	Yes	

Mitigation:

- A temporary fence or demarcation must be erected around no-go areas outside the proposed works area prior to any construction taking place as part of the contractor planning phase when compiling work method statements to prevent access to the adjacent portions of the watercourse.
- Effective stormwater management should be a priority during both construction and operational phase. This should be monitored as part of the EMP.
- Managed flow releases to ensure no negative impact to the downstream watercourse

Cumulative impacts: No cumulative impacts are expected to be associated with upgrades of the existing dam infrastructure

Residual Risks: Impacts to the flow characteristics of this watercourse are likely to be the same as before the dam expansion as permanent changes have already taken place.

Table 8: Changes in sediment entering and exiting the system impact ratings

Nature: Changes in sediment entering and exiting the system may result in smothering of vegetation and habitats and may lead to loss of niche habitats.

Activity: Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount). Construction activities will result in earthworks and local soil disturbance as well as the removal of natural vegetation. This could result in the loss of topsoil, sedimentation of the watercourse and increase the turbidity of the water. Possible sources of the impacts include:

- Earthwork activities within the watercourse during construction
- Clearing of surface vegetation will expose the soils, which in rainy events would wash through the watercourse, causing sedimentation. In addition, indigenous vegetation communities are unlikely to colonise eroded soils successfully and seeds from proximate alien invasive plants can spread easily into these eroded soil.
- Disturbance of slopes through creation of roads and tracks adjacent to the watercourse

	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Highly probable (4)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Limited to Local Area (2)	Limited to the local area (2)
Magnitude	High (8)	Low (4)
Significance	**52 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Probable (3)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Regional (3)	Limited to the local area (2)
Magnitude	Moderate (6)	Low (4)
Significance	**36 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	High	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Consider the various methods and equipment available and select whichever method(s) that will have the least impact on watercourses.
- It is possible that water will be contaminated within earthworks and should thus be cleaned or dissipated into a structure that allows for additional sediment input and slows down the velocity of the water thus reducing the risk of erosion. Effective sediment traps should be installed.
- Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area
- Remove only the vegetation where essential for construction and do not allow any disturbance to the adjoining natural vegetation cover.
- Sediment control should be effective and not allow any release of sediment pollution downstream from activities upslope of the wetland. This should be audited on a weekly basis to demonstrate compliance with upstream conditions.

Cumulative impacts: Expected to be limited and localized since the
Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and sedimentation is effectively managed.

Table 9: Introduction and spread of alien vegetation impact ratings

Nature: Introduction and spread of alien vegetation.

Activity: The moving of soil and vegetation resulting in opportunistic invasions after disturbance and the introduction of seed in building materials and on vehicles. Invasions of alien plants will outcompete natural vegetation, decreasing the natural biodiversity. Once in a system alien invasive plants can spread through the catchment. If allowed to seed before control measures are implemented alien plans can easily colonise and impact on downstream users.

	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Probable (3)	Probable (3)
Duration	Medium-term (3)	Short duration (2)
Extent	Regional (4)	Local (2)
Magnitude	Low (4)	Low (4)
Significance	**33 (moderate)**	**24 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Probable (3)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Regional (4)	Limited to Local Area (2)
Magnitude	Low (4)	Low (4)
Significance	**33 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	High	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Undertake an Alien Vegetation Management Plan which specifies actions and measurable targets
- Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area and returning it where possible afterwards.
- Relocate conservation-worthy species under the supervision of a vegetation or horticultural specialist
- Long-term monitoring for the establishment of alien invasive species within the areas affected by the construction and maintenance and take immediate corrective action where invasive species are observed to establish, as specified in the Alien Vegetation Management Pan
- Rehabilitate or revegetate disturbed areas

Cumulative impacts: Regular monitoring should be implemented during construction, rehabilitation including for a period after rehabilitation is completed.

Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

Table 10: Loss and disturbance of watercourse habitat and fringe vegetation impact ratings

Nature: Loss and disturbance of watercourse habitat and fringe vegetation.

Activity: Direct development within watercourse areas. Loss and disturbance of watercourse habitat and fringe vegetation due to changes in water flow, fire regime and habitat fragmentation. Changes have already occurred and raising the existing dam walls will have minimal impact.

	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Probable (3)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Limited to Local Area (2)	Limited to the local area (2)
Magnitude	Moderate (6)	Low (4)
Significance	**33 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Possible (2)	Probable (3)
Duration	Medium-term (3)	Short duration (2)
Extent	Limited to Local Area (2)	Local (2)
Magnitude	Low (4)	Low (4)
Significance	**18 (low)**	**24 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	High	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Since the raising of the dam walls inevitably results in the clearing of vegetation, mitigation measures for this permanent impact are not relevant. However, the remaining vegetation should be protected from invasion by alien invasive species through an Alien Vegetation Management Plan
- Ensure that vehicles used on site are cleaned before access to the site to prevent the spread of seeds from other sites

Cumulative impacts: Expected to be moderate. Since vegetation is already significantly changed from its reference condition and many activities around the dam have led to habitat loss, further loss of remaining habitat should be avoided.

Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

Table 11: Changes in water quality due to pollution impact ratings

Nature: Changes in water quality due to pollution.

Activity: Construction activities may result in the discharge of solvents and other industrial chemicals, leakage of fuel/oil from vehicles and the disposal of sewage resulting in the loss of sensitive biota in the watercourse and a reduction in watercourse function.

	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Probable (3)	Possible(2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Regional (3)	Local Area (2)
Magnitude	High (8)	Low (4)
Significance	**42 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Highly probable (4)	Probable (3)
Duration	Medium-term (3)	Short Term (2)
Extent	Local Area (2)	Local Area (2)
Magnitude	High (8)	Low (4)
Significance	**52 (moderate)**	**24 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Provision of adequate sanitation facilities located outside of the watercourse or its associated buffer zone during construction.
- Implementation of appropriate stormwater management around the excavation to prevent the ingress of run-off into the excavation and to prevent contaminated runoff into the watercourse.
- The development footprint must be fenced off from the watercourses and no related impacts may be allowed into the watercourse e.g. water runoff from cleaning of equipment, vehicle access etc.
- After construction, the land must be cleared of rubbish, surplus materials, and equipment, and all parts of the land shall be left in a condition as close as possible to that prior to use.
- Maintenance of construction vehicles / equipment should not take place within the watercourse or watercourse buffer.
- Control of waste discharges and do not allow dirty water from operational activities to enter the watercourse
- Treatment of pollution identified should be reported to the DHWS and prioritized accordingly.

Cumulative impacts: Expected to be moderate. Once in the system it may take many years for some toxins to be eradicated.

Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

1.1.1 DWS (2016) Impact Register and Risk Assessment

An extract from the Risk Matrix spreadsheet presented in Table 12 below show the expected risk score categories which can be used to guide decision-making with regards to the authorization of the proposed road and dam through a Water Use Licence or General Authorization obtained from the DHWS.

Table 12: DWS 2016 Risk scores for the proposed dam expansion, assuming that effective mitigation is implemented.

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol): Upgrade and Rehabilitation of Orlando Dam

NAME and REGISTRATION No of SACNASP Professional member: A Bootsma SACNASP # 400222/09

Phases	Activity	Aspect	Impact	Severity: Flow Regime	Severity: Physico & Chemical (Water Quality)	Severity: Habitat (Geomorph+Vegetation)	Severity: Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Negative or positive effect	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
C	Dam Raising	Clear vegetation	Changes to flow characetristics in the ephemeral stream, compaction of soils, sedimentation, pollution and alien invasive plant establishment, erosion downstream	1	1	2	1	1	1	1	3	1	2	5	2	10	30	L	N	80%	• During the detailed design phase, the footprint and design of structures should aim to have the least impact on habitat quality and hydrology of the river. • Designs should take into account soil properties, slopes and runoff energy. • Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area • Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. • Project engineers should compile a method statement, outlining the construction and earthwork methodologies. The method statement must be approved by the ECO and be available on site for reference purposes • Standard best practice mitigation measures should be implemented during the construction phase	N	PES: E WIS:C
		Preparation of dam bed/earthworks		1	1	2	1	1	1	1	3.3	1	2	5	2	10	32.5	L	N	80%		N	
		Construction of infrastructure		1	1	2	1	1	1	1	3	1	2	5	2	10	30	L	N	80%		N	
O	Opeartion of the dam	Day to day operation of the dam	Permanent loss of vegetation and habutats, altered water flow volumes	1	1	1	1	1	1	1	3	1	2	5	2	10	30	L	N	80%	• During the detailed design phase, the footprint and design of structures should aim to have the least impact on habitat quality and hydrology of the river • Formulate an Alien Vegetation Management Plan to be implemented as part of the maintenance plan • Management of point discharges to prevent pollution and sedimentation • Maintenance activities should follow best practice • Monitoring for downstream degradation and effective rehabilitation where necessary	N	PES: E WIS:C
		Maintenenace		1	1	1	1	1	1	1	3	1	1	5	2	9	27	L	N	80%		N	

3.5 CONCLUSION

One watercourse was recorded during the site visit (Figure 7). The watercourse was classified as a large dam area constructed on the confluence of two small channelled valley bottom wetlands. When the water exits the constructed dam it forms an unchannelled valley bottom wetland with elements of floodplain wetland characteristics. The aforementioned area is thus described as a dam within a wetland system. The construction of the Orlando Power station started in 1939 and the wetland has thus been impacted on for 81 years or longer. Not only does the wetland have numerous impoundments, trenches but it also has numerous stormwater drains and canals entering and exiting the wetland. Leaking sewerage is also an issue. The system is subsequently greatly altered from the theoretical natural state. The hydrology, geomorphology and vegetation has changed significantly, however, the wetland and dam provide habitat and breeding ground for a variety of faunal species, especially avifaunal species

The important factors relevant to the project are summarised in Table 13 below:

Table 13: Summary of findings

	Quaternary Catchment and WMA areas	**Important Rivers possibly affected**	
	C22A – 5th WMA Vaal	Tributary of the Klip River	
Integrity and functional assessment	Present Ecological Status (PES): 7.1 (**E – Low)**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable. The status of this wetlands is likely to remain stable over the next 5 years.		
	Ecological Importance and Sensitivity (EIS): 1.4 (**C - Moderate**). Wetlands in this category are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers		
	Recommended Ecological Category (REC): **D**		
	WetEcoServices: Phosphate trapping - 2.9 Toxicant removal - 3.0 Threats - 3.0		
Buffer zones	Generic (GDARD, 2014; CoJ, 2010): **30m**		
	Calculated (Macfarlane *et al*, 2015): **23m Operational & 56m Construction**		
NEMA 2014 Impact Assessment	The impact scores for the following aspects are relevant:	Without Mitigation	With Mitigation
	Changes to flow dynamics	M	L
	Sedimentation	M	L
	Establishment of alien plants	M	L
	Pollution of watercourses	M	L
	Loss of fringe vegetation and habitat	M	L
DWS 2016 Risk Assessment	The proposed upgrade and rehabilitation of the Orlando dam are likely to have minimal additional impact and construction and operational phase fall in the **Low** risk category.		
Does the specialist support the development?	Yes. Given that the mitigation measures are adhered to.		
Recommendations	In particular, the following mitigation measures should be awarded a high priority: • Particular attention should be given to the protection of downstream areas during the construction		

	phase, particularly erosion and sedimentation. • Sediment control should be audited on a weekly during construction to demonstrate compliance with upstream conditions. • Rigorous monitoring should determine if design and rehabilitation targets are being met, and should aim to highlight any unintended negative impacts downstream resulting from changed hydrology, for example bank instability or erosion where water flowpaths have been altered • Where necessary, corrective action should be determined by a team of specialists including engineers, hydrologists and ecologists

4 METHODOLOGY

The delineation method documented by the Department of Water affairs and Forestry in their document "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008), and the Minimum Requirements for Biodiversity Assessments (GDACE, 2009) as well as the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al,* 2013) was followed throughout the field survey. These guidelines describe the use of indicators to determine the outer edge of the wetland and riparian areas such as soil and vegetation forms as well as the terrain unit indicator.

A hand held Garmin Montana 650 was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and available GIS data were used as reference material for the mapping of the preliminary watercourse boundaries. These were converted to digital image backdrops and delineation lines and boundaries were imposed accordingly after the field survey.

4.1 Wetland and Riparian Delineation

Wetlands are delineated based on scientifically sound methods, and utilizes a tool from the Department of Water and Sanitation 'A practical field procedure for identification and delineation of wetlands and riparian areas' (DWAF, 2005) as well as the "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008). The delineation of the watercourses presented in this report is based on both desktop delineation and groundtruthing.

Desktop Delineation

A desktop assessment was conducted with wetland and riparian units potentially affected by the proposed activities identified using a range of tools, including:

- 1: 50 000 topographical maps;
- S A Water Resources;
- Recent, relevant aerial and satellite imagery, including Google Earth.

All areas suspected of being wetland and riparian habitat based on the visual signatures on the digital base maps were mapped using google earth.

Ground Truthing

Wetlands were identified based on one or more of the following characteristic attributes (DWAF, 2005) (Figures 9 & Figure 10):

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur (Figure 10 and Figure 11);
- The presence of plants adapted to or tolerant of saturated soils (hydrophytes);
- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation; and
- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing within 50cm of the soil surface.

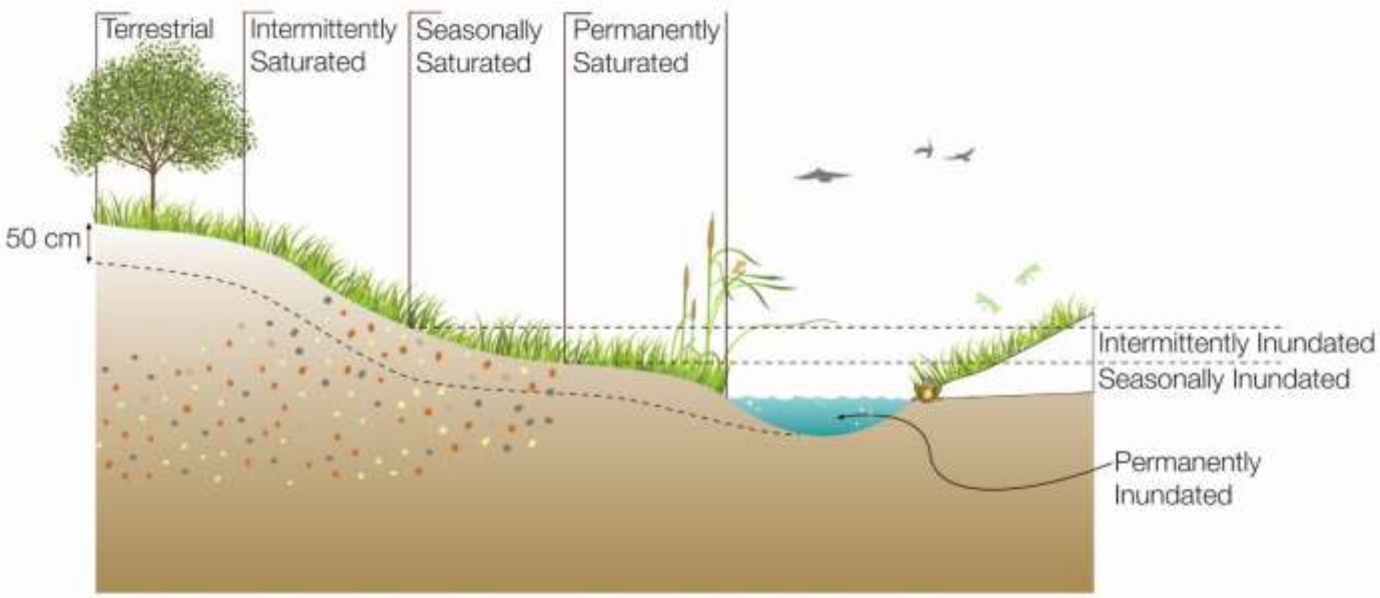


Figure 9: Typical cross section of a wetland (Ollis, 2013)

<u>The Terrain Unit Indicator</u>

The terrain unit indicator (Figure 8) is an important guide for identifying the parts of the landscape where wetlands might possibly occur. Some wetlands occur on slopes higher up in the catchment where groundwater discharge is taking place through seeps. An area with soil wetness and/or vegetation indicators, but not displaying any of the topographical indicators should therefore not be excluded from being classified as a wetland. The type of wetland which occurs on a specific topographical area in the landscape is described using the Hydrogeomorphic classification which separates wetlands into 'HGM' units. The classification of Ollis, *et al*. (2013) is used, where wetlands are classified on Level 4 as either Rivers, Floodplain wetlands, Valley-bottom wetlands, Depressions, Seeps, or Flats (Figure 10).

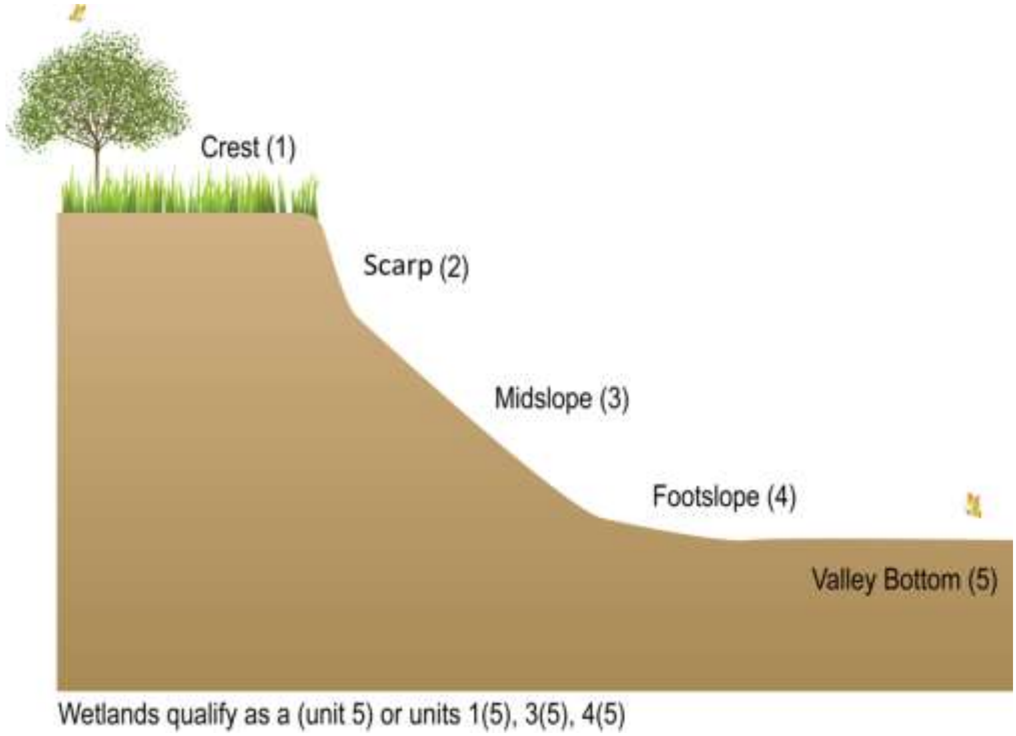


Figure 10. Terrain units (DWAF, 2005).

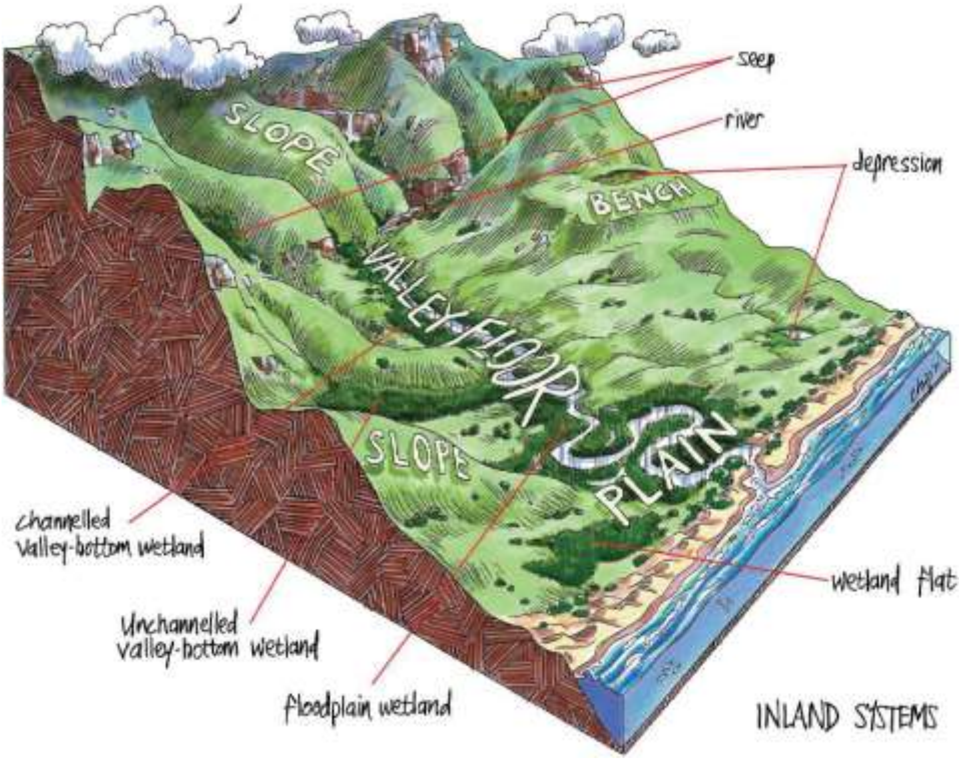


Figure 11: Wetland Units based on hydrogeomorphic types (Ollis *et al.* 2013)

Difficult to Delineate Wet Areas

Table 14 summarises the types of difficult wetland/ wetland-like areas and the best approach to take in such circumstances.

Table 14: List of types of sites that are difficult to delineate. (Job, 2009)

Type of "difficult site"	Approach
Some or all, wetland indicators are present but is a non-natural wetland (e.g. some dams, road islands)	• Decide on the relative permanence of the change and whether the area can now be said to be functioning as a wetland. • Time field observations during the wet season, when natural hydrology is at its peak, to help to differentiate between naturally-occurring versus human-induced wetland. • Decide appropriate policy/management i.e. can certain land uses be allowed due to "low" wetland functional value, or does the wetland perform key functions despite being artificial.
Indicators of soil wetness are present but no longer a functioning wetland (e.g. wetland has been drained)	• Look for evidence of ditches, canals, dikes, berms, or subsurface drainage tiles. • Decide whether or not the area is currently functioning as a wetland.
Indicators of soil wetness are present but no longer a functioning wetland (e.g. relic / historical wetland)	• Decide whether indicators were formed in the distant past when conditions were wetter than the area today. • Obtain the assistance of an experienced soil scientist.

Type of "difficult site"	Approach
Some, or all, wetland indicators are absent at certain times of year (e.g. annual vegetation or seasonal saturation)	• Thoroughly document soil and landscape conditions, develop rationale for considering the area to be a wetland. • Recommend that the site be revisited in the wet season.
Some, or all, wetland indicators are absent due to human disturbance (e.g. vegetation has been cleared, wetland has been ploughed or filled)	• Thoroughly document landscape conditions and any remnant vegetation, soil, hydrology indicators, develop rationale for considering the area to be wetland. • Certain cases (illegal fill) may justify that the fill be removed and the wetland rehabilitated.

Riparian Indicators

Riparian habitat is classified primarily by identifying riparian vegetation along the edge of the macro stream channel. The macro stream channel is defined as the outer bank of a compound channel and should not be confused with the active river bank. The macro channel bank often represents a dramatic change in the energy with which water passes through the system. Rich alluvial soils deposit nutrients making the riparian area a highly productive zone. This causes a very distinct change in vegetation structure and composition along the edges of the riparian area (DWAF, 2008). The marginal zone includes the area from the water level at low flow, to those features that are hydrologically activated for the greater part of the Year (WRC Report No TT 333/08 April, 2008). The non-marginal zone is the combination of the upper and lower zones (Figure 12).

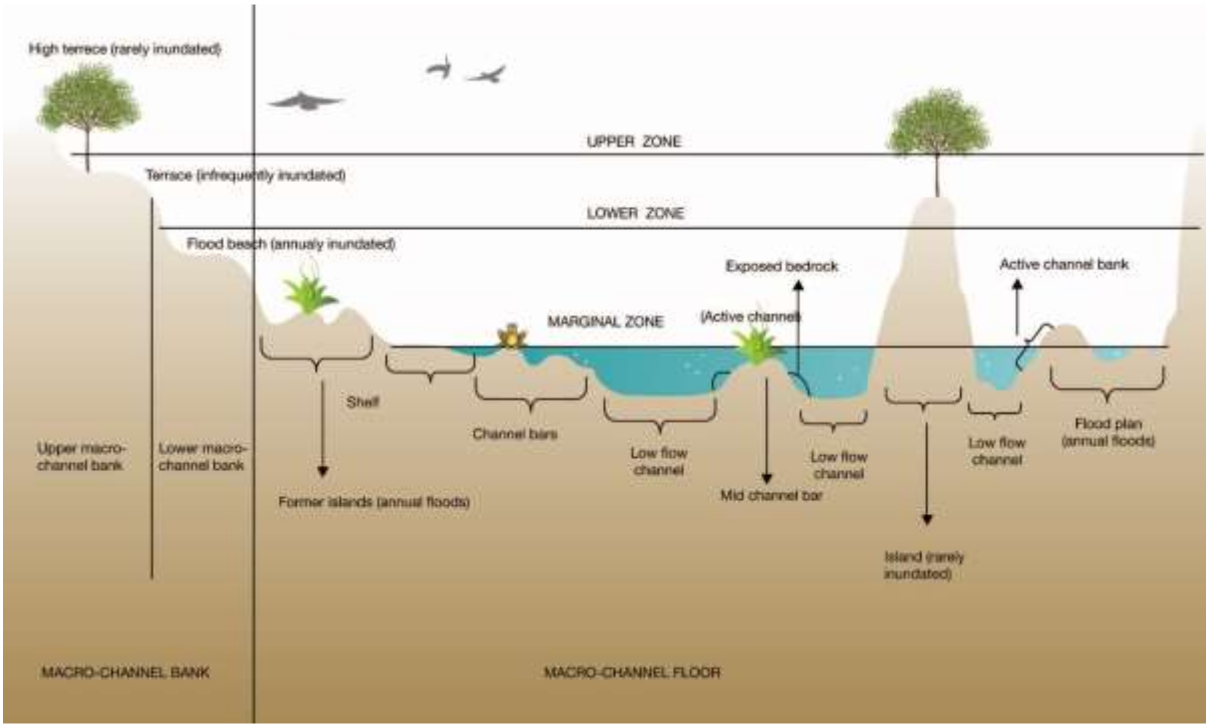


Figure 12: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans *et al*, 2007)

The vegetation of riparian areas is divided into three zones, the marginal zone, lower non-marginal zone and the upper non-marginal zone (Table 15). The different zones have different vegetation growth.

Table 15: Description of riparian vegetation zones (Kleynhans *et al*, 2007).

	Marginal	**(Non-marginal) Lower**	**(Non-marginal) Upper**
Alternative descriptions	Active features Wet bank	Seasonal features Wet bank	Ephemeral features Dry bank
Extends from	Water level at low flow	Marginal zone	Lower zone
Extends to	Geomorphic features / substrates that are hydrologically activated (inundated or moistened) for the Greater part of the year.	Usually a marked increase in lateral Elevation.	Usually a marked decrease in lateral elevation
Characterized by	See above ; Moist substrates next to water's edge; water loving- species usually vigorous due to near permanent access to soil moisture	Geomorphic features that are hydrologically activated (inundated or moistened) on a Seasonal basis. May have different species than marginal zone	Geomorphic features that are hydrological activated (inundated or moistened) on an Ephemeral basis. Presence of riparian and terrestrial species Terrestrial species with increased stature

<u>Riparian Area:</u>
A riparian area can be defined as a linear fluvial, eroded landform which carries channelized flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The "river" includes both the active channel (the portion which carries the water) as well as the riparian zone (Figure 13) (Kotze, 1999).

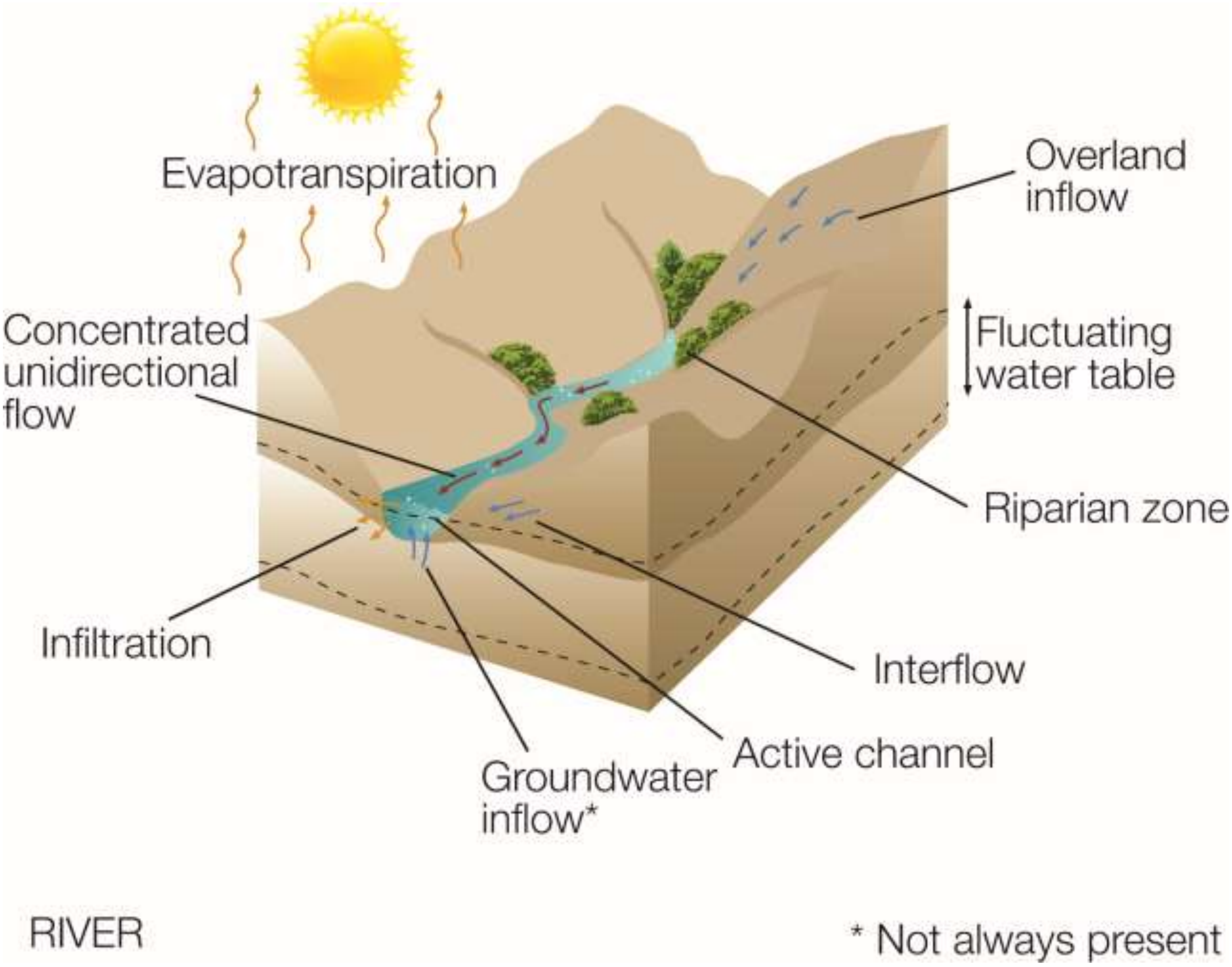


Figure 13: A schematic representation of the processes characteristic of a river area (Ollis *et al*, 2013).

Riparian areas can be grouped into different categories based on their inundation period per year. Perennial rivers are rivers with continuous surface water flow, intermittent rivers are rivers where surface flow disappears but some surface flow remains, temporary rivers are rivers where surface flow disappears for most of the channel (Figure 14). Two types of temporary rivers are recognized, namely “ephemeral” rivers that flow for less time than they are dry and support a series of pools in parts of the channel, and “episodic” rivers that only flow in response to extreme rainfall events, usually high in their catchments (Seaman *et al*, 2010). The riparian areas recorded on site are thus classified as episodic streams due to the high elevation of these streams.

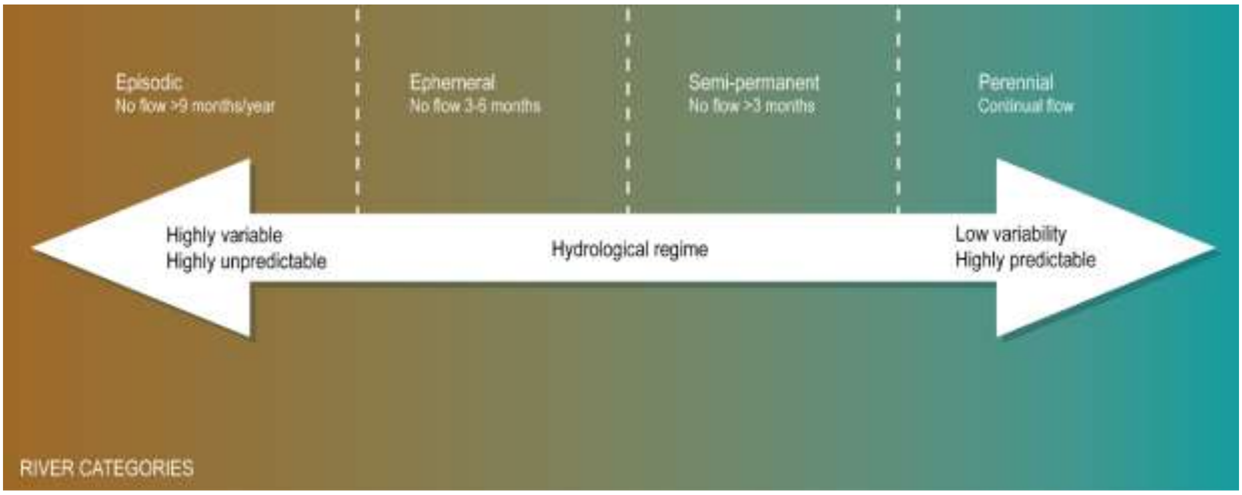


Figure 14: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman *et al*, 2010).

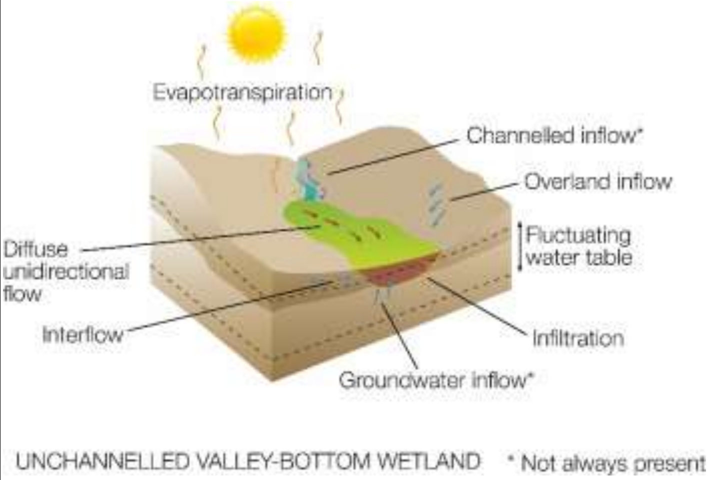
4.2 Wetland Classification and Delineation

The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification (SANBI, 2013). The current wetland study follows the same approach by classifying wetlands in terms of a functional unit in line with a level three category recognised in the classification system proposed in SANBI (2013). HGM units take into consideration factors that determine the nature of water movement into, through and out of the wetland system. In general HGM units encompass three key elements (Kotze *et al*, 2005):

- Geomorphic setting - This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
- Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
- Hydrodynamics - This refers to how water moves through the wetland.

The classification of wetland areas found within the study site and/or within 500 m of the study site (adapted from Brinson, 1993; Kotze, 1999, Marneweck and Batchelor, 2002 and DWAF, 2005) are as follows (Table 16):

Table 16: Wetland Types and descriptions

Wetland Type:	Description:
Valley bottom without a channel 	Linear fluvial, net depositional valley bottom surfaces which do not have a channel. The valley floor is a depositional environment composed of fluvial or colluvial deposited sediment. These systems tend to be found in the upper catchment areas, or at tributary junctions where the sediment from the tributary smothers the main drainage line.

4.3 Wetland Functionality, Status and Sensitivity

Wetland functionality is defined as a measure of the deviation of wetland structure and function from its natural reference condition. The natural reference condition is based on a theoretical undisturbed state extrapolated from an understanding of undisturbed regional vegetation and hydrological conditions. In the current assessment the hydrological, geomorphological and vegetation integrity was assessed for the wetland unit associated with the study site, to provide a Present Ecological Status (PES) score (Macfarlane *et al*, 2007) and an Environmental Importance and Sensitivity category (EIS) (DWAF, 1999).

The allocations of scores in the functional and integrity assessment are subjective and are thus vulnerable to the interpretation of the specialist. Collection of empirical data is precluded at this level of investigation due to project constraints including time and budget. Water quality values, species richness and abundance indices, surface and groundwater volumes, amongst others, should ideally be used rather than a subjective scoring system such as is presented here.

The functional assessment methodologies presented below take into consideration subjective recorded impacts to determine the scores attributed to each functional Hydrogeomorphic (HGM) wetland unit. The aspect of wetland functionality and integrity that are predominantly addressed include hydrological and geomorphological function (subjective observations) and the integrity of the biodiversity component (mainly based on the theoretical intactness of natural vegetation) as directed by the assessment methodology.

In the current study the wetland was assessed using, WET-Health (Macfarlane *et al*, 2007), EIS (DWAF, 1999) and WetEcoServices, (Kotze *et al*, 2006).

4.3.1 Present Ecological Status (PES) – WET-Health

A summary of the three components of the WET-Health namely Hydrological; Geomorphological and Vegetation Health assessment for the wetlands found on site is described in Table 17. A Level 1 assessment was used in this report. Level 1 assessment is used in situations where limited time and/or resources are available.

Table 17: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*, 2007)

Description	Impact Score Range	PES Score	Summary
Unmodified, natural.	0.0.9	A	Very High
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B	High
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C	Moderate
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D	Moderate
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E	Low
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.10	F	Very Low

A summary of the change class, description and symbols used to evaluate wetland health are summarised in Table 18.

Table 18: Trajectory class, change scores and symbols used to evaluate Trajectory of Change to wetland health (Macfarlane *et al*, 2007)

Change Class	Description	Symbol
Improve	Condition is likely to improve over the over the next 5 years	(↑)
Remain stable	Condition is likely to remain stable over the next 5 years	(→)
Slowly deteriorate	Condition is likely to deteriorate slightly over the next 5 years	(↓)
Rapidly deteriorate	Substantial deterioration of condition is expected over the next 5 years	(↓↓)

4.3.2 Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) score forms part of a larger assessment called the Wetland Importance and Sensitivity scoring system which also addresses hydrological importance and direct human benefits relevant to a HGM unit. Both PES and EIS form part of a larger reserve determination process documented by the Department of Water and Sanitation.

Ecological importance is an expression of a wetland's importance to the maintenance of ecological diversity and functioning on local and wider spatial scales. Ecological sensitivity refers to the system's ability to tolerate disturbance and its capacity to recover from disturbance once it has occurred (DWAF, 1999). This classification of water resources allows for an appropriate management class to be allocated to the water resource and includes the following:

- Ecological Importance in terms of ecosystems and biodiversity such as species diversity and abundance.
- Ecological functions including groundwater recharge, provision of specialised habitat and dispersal corridors.
- Basic human needs including subsistence farming and water use.

The Ecological Importance and Sensitivity of the wetlands is represented are described in the results section. Explanations of the scores are given in Table 19.

Table 19: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999)

Ecological Importance and Sensitivity Categories	Rating
Very High Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers	>3 and <=4
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	>2 and <=3
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	>1 and <=2
Low/Marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers	>0 and <=1

"Upon completion of the PES and EIS assessments for the wetland, a Recommended Ecological Category for the Recommended Ecological Category (REC) of the water resource must be determined.

The REC is determined by the Present Ecological State of the water resource and the importance and/or sensitivity of the water resource. Water resources which have Present Ecological State categories in an E or F ecological category are deemed unsustainable by the DWA. In such cases the REC must automatically be increased to a D.

Where the PES is in the A, B, C, D or E the EIS components must be checked to determine if any of the aspects of importance and sensitivity (Ecological Importance; Hydrological Functions and Direct Human Benefits) are high or very high. If this is the case, the feasibility of increasing the PES (particularly if the PES is in a low C or D category) should be evaluated. This is recommended to enable important and/or sensitive wetland water resources to maintain their functionality and continue to provide the goods and services for the environment and society.

If:

- PES is in an E or F category:
  The REC should be set at at least a D, since E and F EC's are considered unsustainable.
    - The PES category is in a A, B, C or D category, AND the EIS criteria are low or moderate OR the EIS criteria are high or even very high, but it is not feasible or practicable for the PES to be improved:
- The REC is set at the current PES.
    - The PES category is in a B, C or D category, AND the EIS criteria are high or very high AND it is feasible or practicable for the PES to be improved:
- The REC is set at least one Ecological Category higher than the current PES." (Rountree *et al,* 2013)

4.3.3 <u>WetEcoServices</u>

The Department of Water and Sanitation authorisations related to wetlands are regulated by Government Notice 267 published in the Government Gazette 40713 of 24 March 2017 regarding Section 21(c) and (i). Page 196 of this notice provides a detailed terms of reference for wetland assessment reports and includes the requirement that the ecological integrity and function of wetlands be addressed.

Although it is our opinion that this section should draw from site specific fauna and flora data this requirement is addressed through the WetEcoServices toolkit (Kotze *et al*. 2006). This wetland assessment method is an excel based tool which is based on the integral function of wetlands in terms of their hydrogeomorphic setting. Each of seven benefits are assessed based on a list of characteristics (e.g. slope of the wetland) that are relevant to the particular benefit. Scores are subjectively awarded to characteristics of the wetland and its catchment relative to the proposed activity.

4.4 Impact Assessments

4.4.1 NEMA (2014) Impact Ratings

As required by the 2014 NEMA regulations, impact assessment should provide quantified scores indicating the expected impact, including the cumulative impact of a proposed activity. This assessment follows the format presented below. The impact assessment score below are calculated using the following parameters:

- Direct, indirect and cumulative impacts of the issues identified through the specialist study, as well as all other issues must be assessed in terms of the following criteria:
  - The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
  - The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
  - The **duration**, wherein it will be indicated whether:
    - The lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
    - The lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
    - Medium-term (5–15 years) – assigned a score of 3;
    - Long term (> 15 years) - assigned a score of 4; or
    - Permanent - assigned a score of 5;
  - The consequences (magnitude), quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
  - The probability of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
  - The significance, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
  - The status, which will be described as either positive, negative or neutral.
  - The degree to which the impact can be reversed.
  - The degree to which the impact may cause irreplaceable loss of resources.
  - The degree to which the impact can be mitigated.

The **significance** is calculated by combining the criteria in the following formula:

- S=(E+D+M)P
- S = Significance weighting

- E = Extent
- D = Duration
- M = Magnitude
- P = Probability

The **significance weightings** for each potential impact will be determined as follows (Table 20):

Table 20: Significance Weightings

Points	Significant Weighting	Discussion
< 30 points	Low	This impact would not have a direct influence on the decision to develop in the area.
31-60 points	Medium	The impact could influence the decision to develop in the area unless it is effectively mitigated.
> 60 points	High	The impact must have an influence on the decision process to develop in the area.

REFERENCES

Department of Water Affairs and Forestry, (2005): Environmental Best Practice Specifications: Construction for Construction Sites, Infrastructure Upgrades and Maintenance Works. Version 3

Department of Water Affairs (2008): Updated Manual for the Identification and Delineation of Wetlands and Riparian areas.

Department of Water Affairs (2010). National Water Act, 1998 (Act No 36 of 1998) S21(c) & (i) Water Uses. Version: February 2010. Training Manual.

Gauteng Department of Agriculture Conservation & Environment (2002). Gauteng Agricultural Potential Atlas. Johannesburg

Gauteng Department of Agriculture, Conservation & Environment (2012) GDARD Minimum Requirements for Biodiversity Assessments Version 3. Directorate Nature Conservation, Johannesburg.

Gauteng Department of Agriculture and Rural Development, (2011): Gauteng Conservation Plan Version 3 ArcGIS Spatial data

Gauteng Department of Agriculture and Rural Development (2012). Approval of the Environmental Management Plan (EMP) for Project Reference GAUT: 002/456: Proposed Development of a Filling Station on Portion 125 (a Portion of Portion 1) of the Farm Leeuwpoort 113 IR, Boksburg, Gauteng.

Kleynhans, C.J. (1999): A procedure for the determination of the for the determination of the ecological reserve for the purpose of the national water balance model for South African Rivers. Institute for Water Quality Studies Department of Water Affairs and Forestry, Pretoria.

Kleynhans C.J., MacKenzie J. and Louw M.D. (2007). Module F: Riparian Vegetation Response Assessment Index in River Classification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forrestry report. WRC Report No. TT 333/08

Kotze D C, (1999): A system for supporting wetland management decisions. Ph.D. thesis. School of Applied Environmental Sciences, University of Natal, Pietermaritzburg.

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D, Koopman V, Goodman P and Goge C. (2008). WET-Health: A technique for rapidly assessing wetland health. Water Research Commission, Pretoria. WRC Rport TT340/08 February 2008

Macfarlane D.M., Teixeira-Leite A., Goodman P., Bate G and Colvin C. (2010) Draft Report on the Development of a Method and Model for Buffer Zone Determination. Water Research Commission project K5/1789. The Institute of Natural Resources and its Associates

Micheal J and Rutehrford N. (2013). Oil Spills in Marshes PLANNING & RESPONSE CONSIDERATIONS

Mucina L., & Rutherford M. C. (2006). Vegetation Map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. South African National Biodiversity Institute., Pretoria.

Schultze R.E. (1997). South African Atlas of Agrohydrology and Climatology. Water Research Commission, Pretoria, Report TT82/96

APPENDIX A: Abbreviated CVs of participating specialists

Name:	**ANTOINETTE BOOTSMA nee van Wyk**
ID Number	7604250013088
Name of Firm:	Limosella Consulting
Position:	Director - Principal Specialist
SACNASP Status:	Professional Natural Scientist # 400222-09 Botany and Ecology

EDUCATIONAL QUALIFICATIONS

- B. Sc (Botany & Zoology), University of South Africa (1997 - 2001)
- B. Sc (Hons) Botany, University of Pretoria (2003-2005). Project Title: A phytosociological Assessment of the Wetland Pans of Lake Chrissie
- Short course in wetland delineation, legislation and rehabilitation, University of Pretoria (2007)
- Short course in wetland soils, Terrasoil Science (2009)
- MSc Ecology, University of South Africa (2010 – submitted 2016). Project Title: Natural mechanisms of erosion prevention and stabilization in a Marakele peatland; implications for conservation management

PUBLICATIONS

- A.A. Boostma, S. Elshehawi, A.P. Grootjans, P.L Grundling, S. Khosa, M. Butler, L. Brown, P. Schot. *In Press.* Anthropogenic disturbances of natural ecohydrological processes in the Matlabas mountain mire, South Africa. South African Journal of Science
- P.L. Grundling, A Lindstrom., M.L. Pretorius, A. Bootsma, N. Job, L. Delport, S. Elshahawi, A.P Grootjans, A. Grundling, S. Mitchell. 2015. Investigation of Peatland Characteristics and Processes as well as Understanding of their Contribution to the South African Wetland Ecological Infrastructure Water Research Comission KSA 2: K5/2346
- A.P. Grootjans, A.J.M Jansen , A, Snijdewind, P.C. de Hullu, H. Joosten, A. Bootsma and P.L. Grundling. (In Press). In search of spring mires in Namibia: the Waterberg area revisited

- Haagner, A.S.H., van Wyk, A.A. & Wassenaar, T.D. 2006. *The biodiversity of herpetofauna of the Richards Bay Minerals leases.* CERU Technical Report 32. University of Pretoria.
- van Wyk, A.A., Wassenaar, T.D. 2006. *The biodiversity of epiphytic plants of the Richards Bay Minerals leases.* CERU Technical Report 33. University of Pretoria.
- Wassenaar, T.D., van Wyk, A.A., Haagner, A.S.H, & van Aarde, R.J.H. 2006. *Report on an Ecological Baseline Survey of Zulti South Lease for Richards Bay Minerals*. CERU Technical Report 29. University of Pretoria

KEY EXPERIENCE

The following projects provide an example of the application of wetland ecology on strategic as well as fine scale as well as its implementation into policies and guidelines. (This is not a complete list of projects completed, rather an extract to illustrate diversity);

- More than 250 fine scale wetland and ecological assessments in Gauteng, Mpumalanga, KwaZulu Natal, Limpopo and the Western Cape. 2007, ongoing.
- Scoping level assessment to inform a proposed railway line between Swaziland and Richards Bay. April 2013.
- Environmental Control Officer. Management of onsite audit of compliance during the construction of a pedestrian bridge in Zola Park, Soweto, Phase 1 and Phase 2. Commenced in 2010, ongoing.
- Fine scale wetland delineation and functional assessments in Lesotho and Kenya. 2008 and 2009;
- Analysis of wetland/riparian conditions potentially affected by 14 powerline rebuilds in Midrand, Gauteng, as well submission of a General Rehabilitation and Monitoring Plan. May 2013.
- Wetland specialist input into the Environmental Management Plan for the upgrade of the Firgrove Substation, Western Cape. April 2013
- An audit of the wetlands in the City of Johannesburg. Specialist studies as well as project management and integration of independent datasets into a final report. Commenced in August 2007
- Input into the wetland component of the Green Star SA rating system. April 2009;
- A strategic assessment of wetlands in Gauteng to inform the GDACE Regional Environmental Management Framework. June 2008.
- As assessment of wetlands in southern Mozambique. This involved a detailed analysis of the vegetation composition and sensitivity associated with wetlands and swamp forest in order to inform the development layout of a proposed resort. May 2008.
- An assessment of three wetlands in the Highlands of Lesotho. This involved a detailed assessment of the value of the study sites in terms of functionality and rehabilitation opportunities. Integration of the specialist reports socio economic, aquatic, terrestrial and wetland ecology studies into a final synthesis. May 2007.

- Ecological studies on a strategic scale to inform an Environmental Management Framework for the Emakazeni Municipality and an Integrated Environmental Management Program for the Emalahleni Municipality. May and June 2007

Name:	**RUDI BEZUIDENHOUDT**
ID Number	880831 5038 081
Name of Firm:	Limosella Consulting
Position:	Wetland Specialist
SACNASP Status:	Pr. Sci. Nat. (Reg. No. 008867)

EDUCATIONAL QUALIFICATIONS

- B.Sc. (Botany & Zoology), University of South Africa (2008 - 2012)
- B.Sc. (Hons) Botany, University of South Africa (2013 – Ongoing)
- Introduction to wetlands, Gauteng Wetland Forum (2010)
- Biomimicry and Constructed Wetlands. Golder Associates and Water Research Commission (2011)
- Wetland Rehabilitation Principles, University of the Free State (2012)
- Tools for Wetland Assessment, Rhodes University (2011)
- Wetland Legislation, University of Free-State (2013)
- Understanding Environmental Impact Assessment, WESSA (2011)
- SASS 5, Groundtruth (2012)
- Wetland Operations and Diversity Management Master Class, Secolo Consulting Training Services (2015)
- Tree Identification, Braam van Wyk – University of Pretoria (2015)
- Wetland Buffer Legislation – Eco-Pulse & Water Research Commission (2015)
- Wetland Seminar, ARC-ISCW & IMCG (2011)
- Tropical Coastal Ecosystems, edX (2015 – ongoing)

KEY EXPERIENCE

- **Wetland Specialist**

This entails all aspects of scientific investigation associated with a consultancy that focuses on wetland specialist investigations. This includes the following:

- Approximately 200+ specialist investigations into wetland and riparian conditions on strategic, as well as fine scale levels in Gauteng, Limpopo, North-West Province Mpumalanga KwaZulu Natal, North-West Province, Western Cape, Eastern Cape & Northern Cape
- Ensuring the scientific integrity of wetland reports including peer review and publications.

Large Eskom projects include:

- Eskom 88kV Rigi – Sonland

- Eskom 88kV Simmerpan Line
- Eskom 88kV Meteor Line
- Eskom 88kV Kookfontein – Jaguar
- Eskom 132kV Dipomong
- Eskom 132kV Everest – Merapi
- Eskom 132kV Vulcan – Enkangala
- Eskom 400kV Helios – Aggenys
- Eskom 400kV Hendrina – Gumeni
- Eskom 765kV Aries – Helios
- Eskom 765kV Aries – Kronos
- Eskom 765kV Kronos – Perseus
- Eskom 765kV Perseus – Gamma
- Eskom 765kV Helios – Juno
- Eskom 765kV Aries- Helios

➢ **Biodiversity Action Plan**

This entails the gathering of data and compiling of a Biodiversity action plan.

➢ **Wetland Rehabilitation**

This entailed the management of wetland vegetation and rehabilitation related projects in terms of developing proposals, project management, technical investigation and quality control.

➢ **Wetland Ecology**

Experience in the delineation and functional assessment of wetlands and riparian areas in order to advise proposed development layouts, project management, report writing and quality control.

➢ **Environmental Controlling Officer**

Routine inspection of construction sites to ensure compliance with the City's environmental ordinances, the Environmental Management Program and other laws and by-laws associated with development at or near wetland or riparian areas.

- Soweto Zola Park 2011-2013
- Orange Farm Pipeline 2010-2011

➢ **Wetland Audit**

Audit of Eskom Kusile power station to comply with the Kusile Section 21G Water Use Licence (Department of Water Affairs, Licence No. 04/B20F/BCFGIJ/41, 2011), the amended Water Use Licence (Department of water affairs and forestry, Ref. 27/2/2/B620/101/8, 2009) and the WUL checklist provided by Eskom.

- Kusile Powerstation 2012-2013.

EMPLOYEE EXPERIENCE:

➢ **GIS Specialist – AfriGIS**

January 2008 – August 2010

Tasks include:

- GIS Spatial layering

- Google Earth Street View Mapping
- Data Input

➢ **<u>Wetland Specialist - Limosella Consulting</u>**

September 2010 – Ongoing

Tasks include:

- GIS Spatial layering
- Wetland and Riparian delineation studies, opinions and functional assessments including data collection and analysis
- Correspondence with stakeholders, clients, authorities and specialists
- Presentations to stakeholders, clients and specialists
- Project management
- Planning and executing of fieldwork
- Analysis of data
- GIS spatial representation
- Submission of technical reports containing management recommendations
- General management of the research station and herbarium
- Regular site visits
- Attendance of monthly meetings
- Submission of monthly reports

MEMBERSHIPS IN SOCIETIES

- Botanical Society of South African
- SAWS (South African Wetland Society) Founding member
- SACNASP (Cert. Nat. Sci. Reg. No. 500024/13)

APPENDIX B: GLOSSARY OF TERMS

Buffer	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area
Hydrophyte	any plant that grows in water or on a substratum that is at least periodically deficient in oxygen as a result of soil saturation or flooding; plants typically found in wet habitats
Hydromorphic soil	soil that in its undrained condition is saturated or flooded long enough during the growing season to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils)
Seepage	A type of wetland occurring on slopes, usually characterised by diffuse (i.e. unchannelled, and often subsurface) flows
Sedges	Grass-like plants belonging to the family Cyperaceae, sometimes referred to as nutgrasses. Papyrus is a member of this family.
Soil profile	the vertically sectioned sample through the soil mantle, usually consisting of two

	or three horizons (Soil Classification Working Group, 1991)
Wetland:	"*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*." (National Water Act; Act 36 of 1998).
Wetland delineation	the determination and marking of the boundary of a wetland on a map using the DWAF (2005) methodology. This assessment includes identification of suggested buffer zones and is usually done in conjunction with a wetland functional assessment. The impact of the proposed development, together with appropriate mitigation measures are included in impact assessment tables