Proposed Township Development on the remainder of the farm Leeupoort No 283JS and Prt 79 of the farm Blesboklaagte No 296JS, Emalahleni, Mpumalanga

KOR-EMA-13-12-02

Wetland Delineation and Functional Assessment

May 2014

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:

Shangoni Management Services (Pty) Ltd

Email: info@shangoni.co.za

Block C8, Block@Nature

472 Botterklapper Street

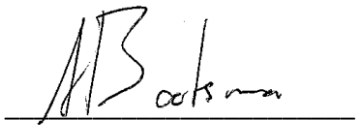
The Willows

Pretoria

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.



2014.07.26

Antoinette Bootsma (PrSciNat) Date

Ecologist/Botanist

SACNASP Reg. No. 400222-09

Indemnity

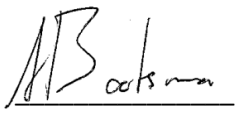
This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as information available at the time of study. Therefore 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.

Although the author exercised due care and diligence in rendering services and preparing documents, she accepts no liability, and the client, by receiving this document, indemnifies the author 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.

Qualification of Specialists

<table>
<tr><td>Report writing assistance and review</td><td>Rudi Bezuidenhoudt
Wetland specialist / Ecologist
SACNASP Reg. No. 500024/13

Antoinette Bootsma
Ecologist/Botanist/Wetland specialist
SACNASP Reg. No. 400222-09

Antoinette Eyssell
Terrestrial Ecologist / Wetland assistant
SACNASP Reg. No. 400019/11</td><td rowspan="2">Antoinette Bootsma (PrSciNat)
Ecologist/Botanist/Wetland specialist
 
May 2014

Date</td></tr>
<tr><td>Field work and data analysis</td><td>Rudi Bezuidenhoudt
Wetland specialist / Ecologist
SACNASP Reg. No.
Pending</td></tr>
</table>

EXECUTIVE SUMMARY

Limosella Consulting (Pty) Ltd was appointed by Shangoni Management Services (Pty) Ltd to undertake a wetland delineation and functional assessment for the proposed township development north of eMalahleni in the Mpumalanga Province. The study site is approximately 506.8 ha. Fieldwork was conducted on the 2nd of May 2014.

The terms of reference for the study were as follows:

- Delineate the wetland areas;
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
- Undertake the functional assessment of wetlands areas within the area assessed;
- Recommend suitable buffer zones; and
- Discuss potential impacts, mitigation and management procedures relevant to the conserving wetland areas on the site.

Four (4) wetland areas were recorded on the study site. The wetland areas were classified as a Channelled valley bottom wetland, and seepage wetlands. All the wetlands recorded on the study site form part of the same wetland system. All the wetland components are thus discussed separately but the wetland as a whole was assessed in terms of the present ecological status and the ecological importance and sensitivity PES and EIS. One of the seepage areas was also split into two parts to indicate the degraded part of the seepage area. The seepage wetland was split up into two areas to better indicate the degraded area that has been affected by the on-site quarrying, this area should however be seen as one large seepage wetland.

The study site comprises approximately 506.8 ha of which approximately 49% was classified as wetland (Excluding buffer zones). The seepage area that has been degraded by quarrying comprises approximately 136 ha.

A summary of the Present Ecological State and Ecological Integrity and Sensitivity for the wetland system as discussed in this report are presented below:

Watercourse Type	Estimated PES Score	Current Impacts	EIS Score
Channelled Valley Bottom	C	The wetland is currently impacted by various anthropogenic activities particularly historical damming at various points. Overgrazing has had an effect on the vegetation component of the wetland. The adjacent degraded seepage area and quarrying area is currently contributing to an increase in sediment input as well as creating numerous erosional gullies. The approximate central coordinates of wetland in relation to the study site are 25°48'9.14"S and 29°11'32.75"E.	1.8
Seepage 1	C	This area has been impacted by cattle farming as well as overgrazing.	1.8

Watercourse Type	Estimated PES Score	Current Impacts	EIS Score
		The approximate central coordinates of wetland in relation to the study site are 25°47'55.84"S and 29°12'1.24"E.	
Seepage 2	C	This area has not been greatly impacted and the majority of the impacts are related to some small scale dumping as well as footpaths. The approximate central coordinates of wetland in relation to the study site are 25°48'42.41"S and 29°12'3.69"E.	1.8
Seepage 3	D	The area has been impacted by the adjacent quarrying as well as overgrazing. Erosion gullies is evident in some areas. The approximate central coordinates of wetland in relation to the study site are 25°48'7.79"S and 29°12'43.51"E.	1.8
Degraded Seepage	F	The hydrology, geomorphology and vegetation of this area have been greatly affected by the historical and current quarrying. The area is heavily fragmented and likely no longer contributes to the various functions associated with a seepage wetland. This area is currently contributing to sediment that enters the channelled valley bottom. The lack of vegetation is also leading to erosional gullies downstream. The approximate central coordinates of wetland in relation to the study site are 25°48'22.84"S and 29°12'37.21"E.	0.4

In the absence of dedicated hydrological, groundwater and geohydrological assessments the current assessment finds that a minimum buffer of 32 m from the edge of the wetland boundaries should be respected.

Wetlands situated within 500 m of proposed activities should be regarded as sensitive features potentially affected by the proposed development (Regulation 1199 of 2009 in terms of the National Water Act, 1998). Development activities close to wetlands are excluded from General Authorisation (GA) for Section 21 (c) and (i) water uses (published in Government Gazette No. 389). In this instance the Department of Water Affairs should be contacted regarding the application for a Water Use License. In terms of the current study the northern wetland is likely to be well enough buffered and no further buffer zone is suggested in this report, however the wetland found south of the study site is likely to be impacted by the proposed activities and mitigation measures should be strictly adhered to.

Table of Contents

Figures

Tables

1 INTRODUCTION

Limosella Consulting (Pty) Ltd was appointed by Shangoni Management Services (Pty) Ltd to undertake a wetland delineation and functional assessment for the proposed township development north of eMalahleni in Mpumalanga Province. The study site is approximately 506.8 ha. Fieldwork was conducted on the 2nd of May 2014.

1.1 Terms of Reference

The terms of reference for the study were as follows:

- Delineate the wetland areas;
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
- Undertake the functional assessment of wetlands areas within the area assessed;
- Recommend suitable buffer zones; and
- Discuss potential impacts, mitigation and management procedures relevant to the conserving wetland areas on the site.

1.2 Assumptions and Limitations

The Garmin Montana 650 used for wetland and riparian delineations is accurate to within five meters. Therefore, the 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.

Furthermore, the assessment of wetlands is based on environmental indicators such as vegetation, that are subjected to seasonal variation as well as factors such as fire and drought. Although background information was gathered, the information provided in this report was mainly derived from what was observed on the study site at the time of the field survey. A Red Data scan, fauna and flora, and aquatic assessments were not included in the current study. Description of the depth of the regional water table and geohydrological processes falls outside the scope of the current assessment.

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 Water Affairs (DWA). The NWA sets out a range of water use related principles that are to be applied by DWA 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 DWA are indicated in Section 21 of the NWA. Section 21 (c) and (i) is applicable to any activity related to a wetland:
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 Notices R.1198 and R.1199 of 18 December 2009. GN 1198 and 1199 of 2009 grants General Authorisation (GA) for the above water uses on certain conditions:
GN R.1198: Any activity in a wetland for the rehabilitation of a wetland for conservation purposes.
GN R.1199: Any activity more than 500 m from the boundary of a wetland.

These regulations also stipulate that these 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. Wetlands situated within 500 m of

proposed activities should be regarded as sensitive features potentially affected by the proposed development (GN 1199). Such an activity requires a Water Use Licence (WUL) from the relevant authority.

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.543, R.544 and R.545 of 2010, 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).

1.4 Locality of the study site

The study site is situated approximately 6 km north of the town of eMalahleni in the Mpumalanga Province. The site is located north of the R544 road. The southern border of the study site is formed by the residential area of Pine Ridge. The approximate central coordinates of the main site are 25°48'28.50"S and 29°12'17.03"E.

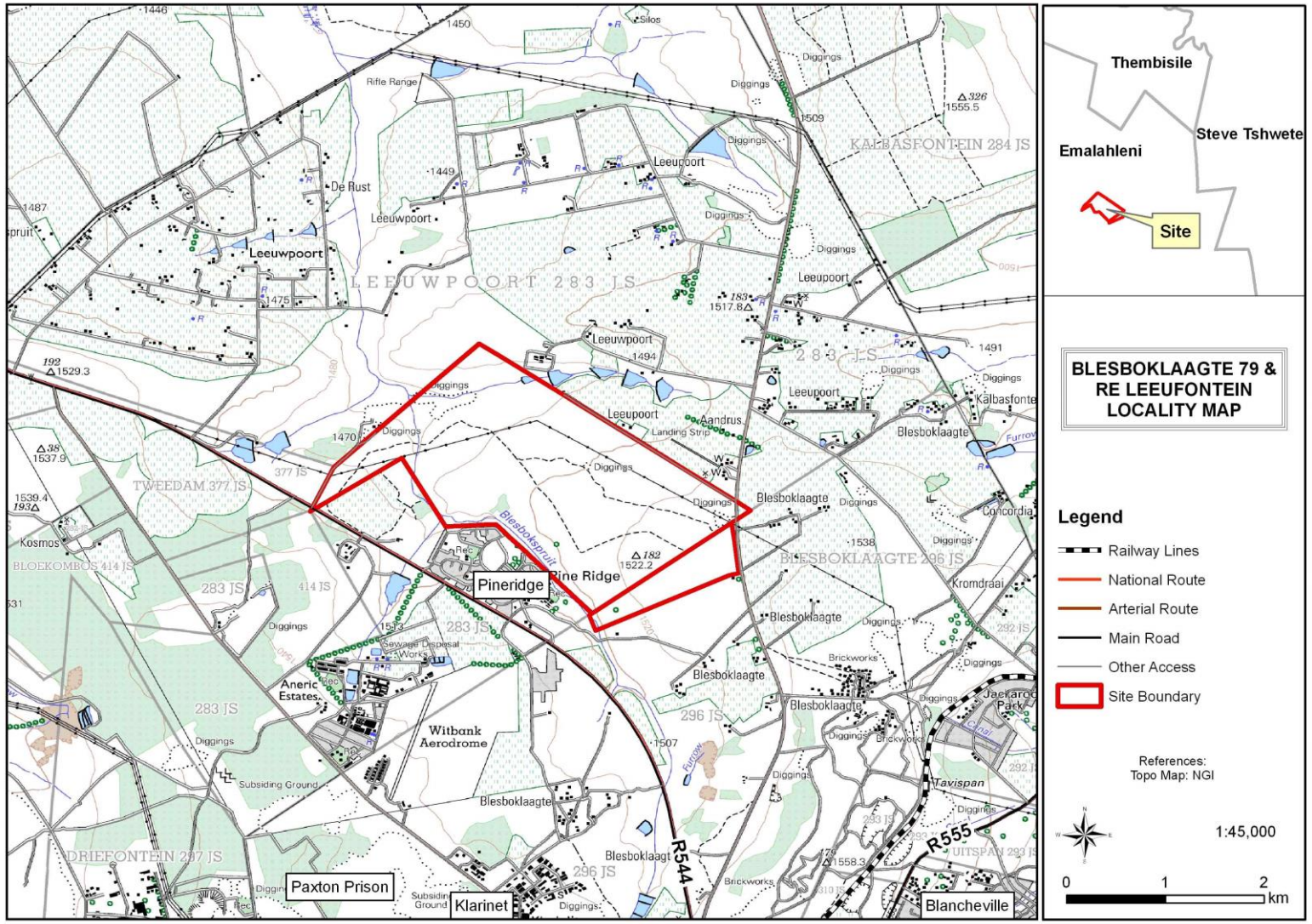


Figure 1: Locality Map

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:

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 the Quaternary Catchment B11K. In this catchment, the precipitation rate is lower than the evaporation rate with a Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) of 0.31. 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.

Hydrology:

According to the NFEPA (National Freshwater Ecological Protected Areas) a perennial river known as the Blesbokspruit River flows through the site in the west and forms the border of the study site in the south. It also dissects the northern corner of the study site. The NFEPA layers also indicate a wetland area around the Blesbokspruit River (Figure 2).

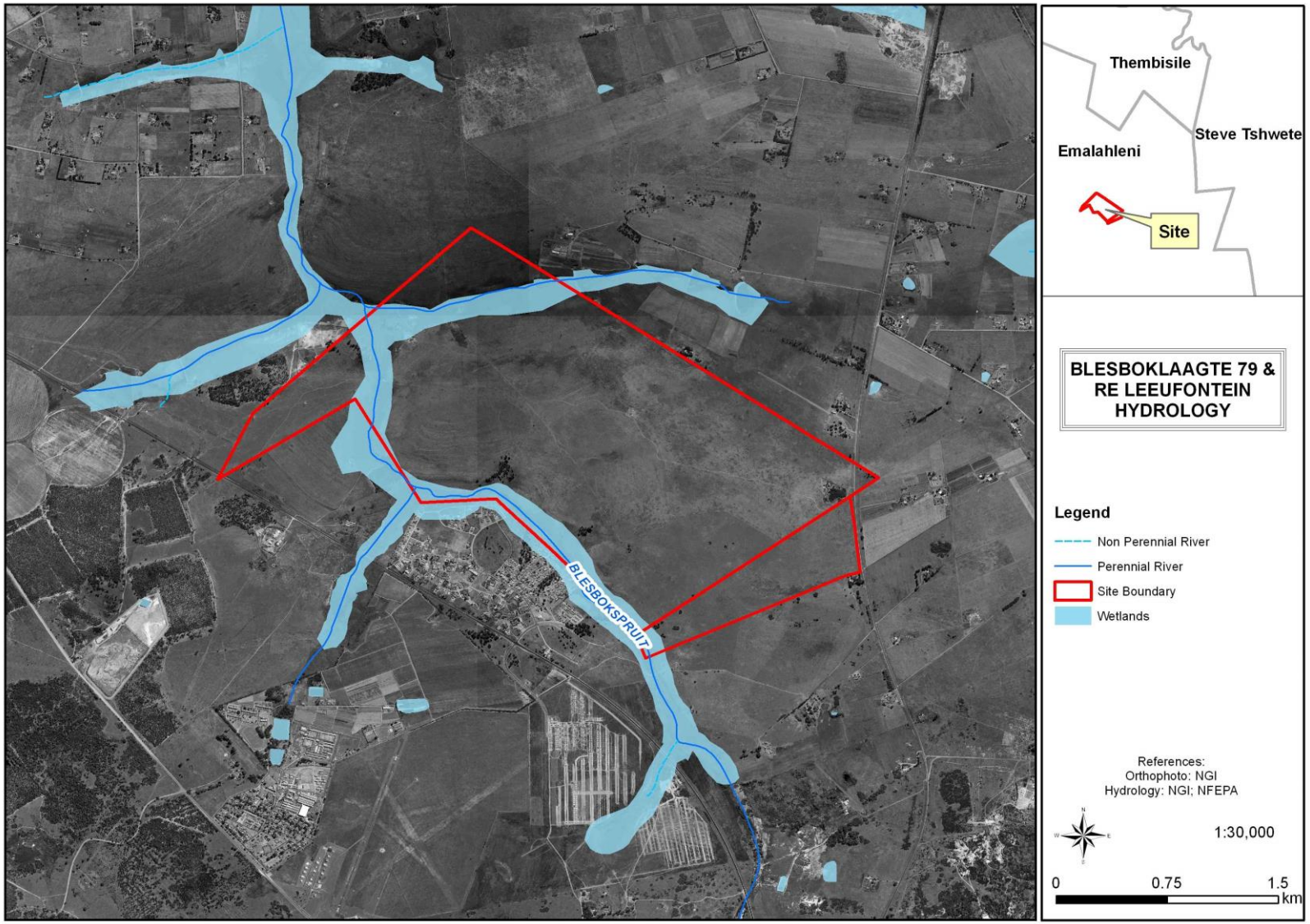


Figure 2: Hydrology of the study site and surrounds as per existing spatial layers.

Regional Vegetation:

The vegetation type occurring in the study area is Rand Highveld Grassland (Mucina & Rutherford, 2006). Rand Highveld Grassland comprises species rich, wiry, sour grassland alternating with low, sour shrubland on rocky outcrops and steeper slopes. This vegetation unit is poorly conserved with much of its area transformed by cultivation, plantations, urbanisation or dam-building and mining. Where disturbances occurred, the invasive exotic tree *Acacia mearnsii* (Black Wattle) can become dominant and displace the natural vegetation. Due to the extensive usage of the areas once covered by Rand Highveld Grassland vegetation types, the remaining portions are of high conservation value and sensitivity and are thus classified as endangered vegetation types (Mucina & Rutherford, 2006).

Geology and soils:

The geology underlying the western section of the study site is comprised mainly of Arenite (ENPAT, 2001). Arenite (wind-blown sands) weather to form deep sandy soils which are highly mobile when disturbed and could therefore result in erosion problems during and after the proposed activities. The eastern section of the study site is underlain by Tillite.

S2 soil forms are characteristic of this area. S2 soils may have restricted depth and excessive drainage. S2 soils have low natural fertility and a high erosion potential (www.agis.agric.za).

Mpumalanga Biodiversity Conservation Plan (MBCP)

The Mpumalanga Biodiversity Conservation Plan reflects only a small area in the west of the study site as important and necessary in terms of conservation while the majority of the site is classified as least concern with a few small areas classified as areas where no natural habitat remains (Figure 3).

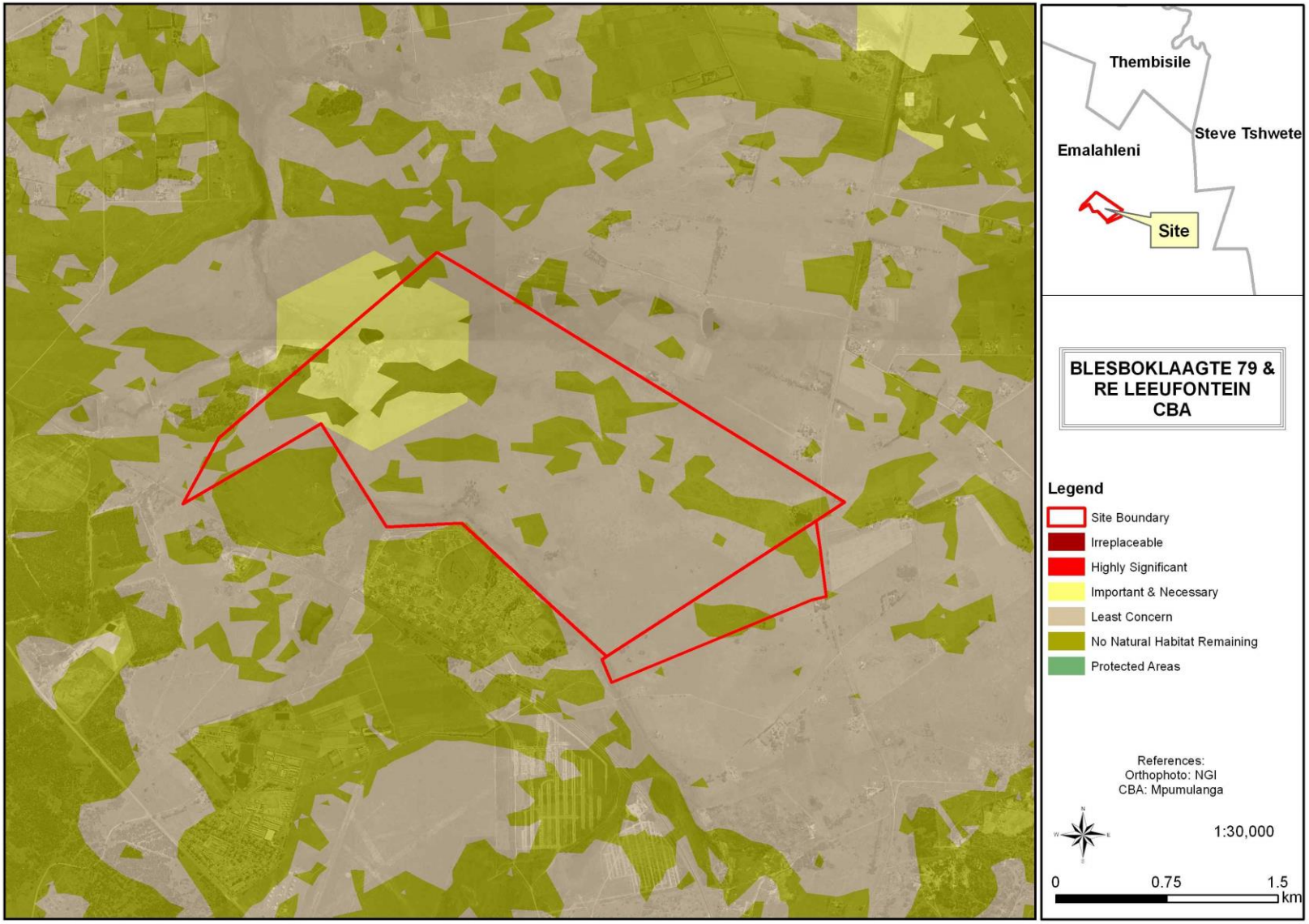


Figure 3: Conservation plan of Mpumalanga Province indicating different areas of importance.

2 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 all,* 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.

2.1 Wetland and Riparian Delineation

Wetlands are identified based on the following characteristic attributes (DWAF, 2005) (Figure 4):

- 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.

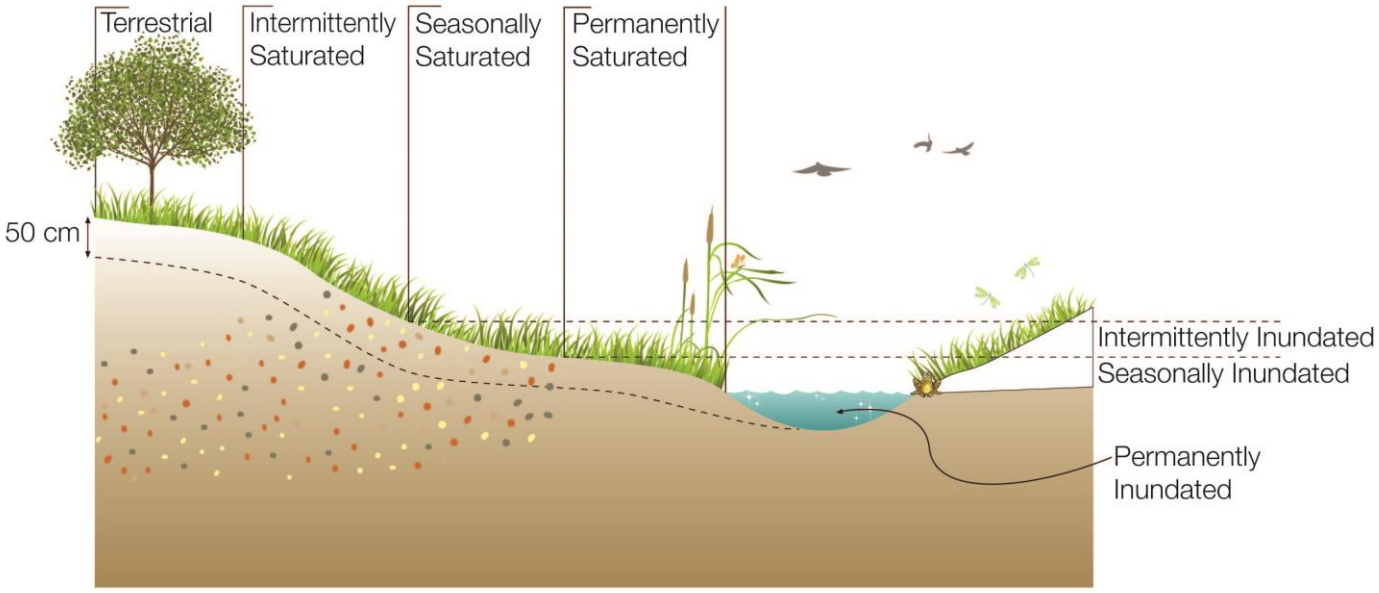


Figure 4: Typical cross section of a wetland (Ollis, 2013)

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 has also been referred to as active features or wet bank (Van Niekerk and Heritage, 1993). It 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 5).

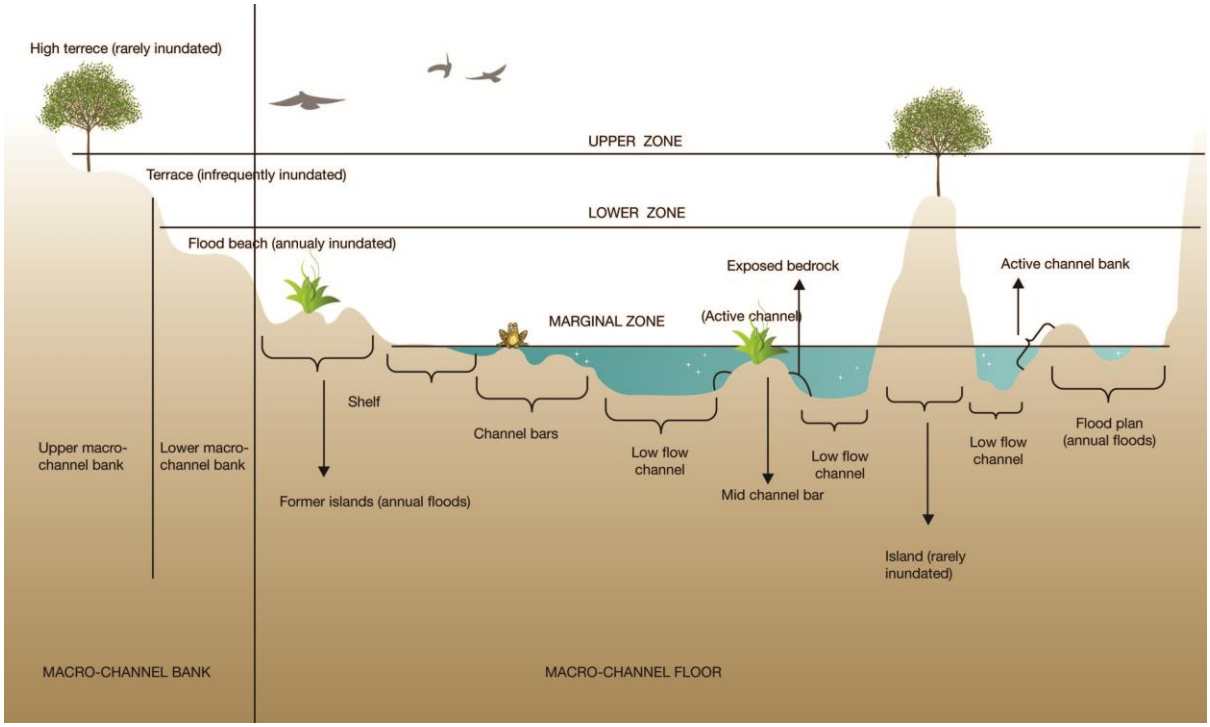


Figure 5: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhanset al., 2007)

2.2 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, 2009). 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 (2009). 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.

Channelled valley bottom wetland:

Linear fluvial, net depositional valley bottom surfaces which have a straight channel with flow on a permanent or seasonal basis. Episodic flow is thought to be unlikely in this wetland setting. The straight channel tends to flow parallel with the direction of the valley (i.e. there is no meandering), and no ox-bows or cut-off meanders are present in these wetland systems. The valley floor is, however, a depositional environment such that the channel flows through fluvially-deposited sediment. These systems tend to be found in the upper catchment areas (Figure 6).

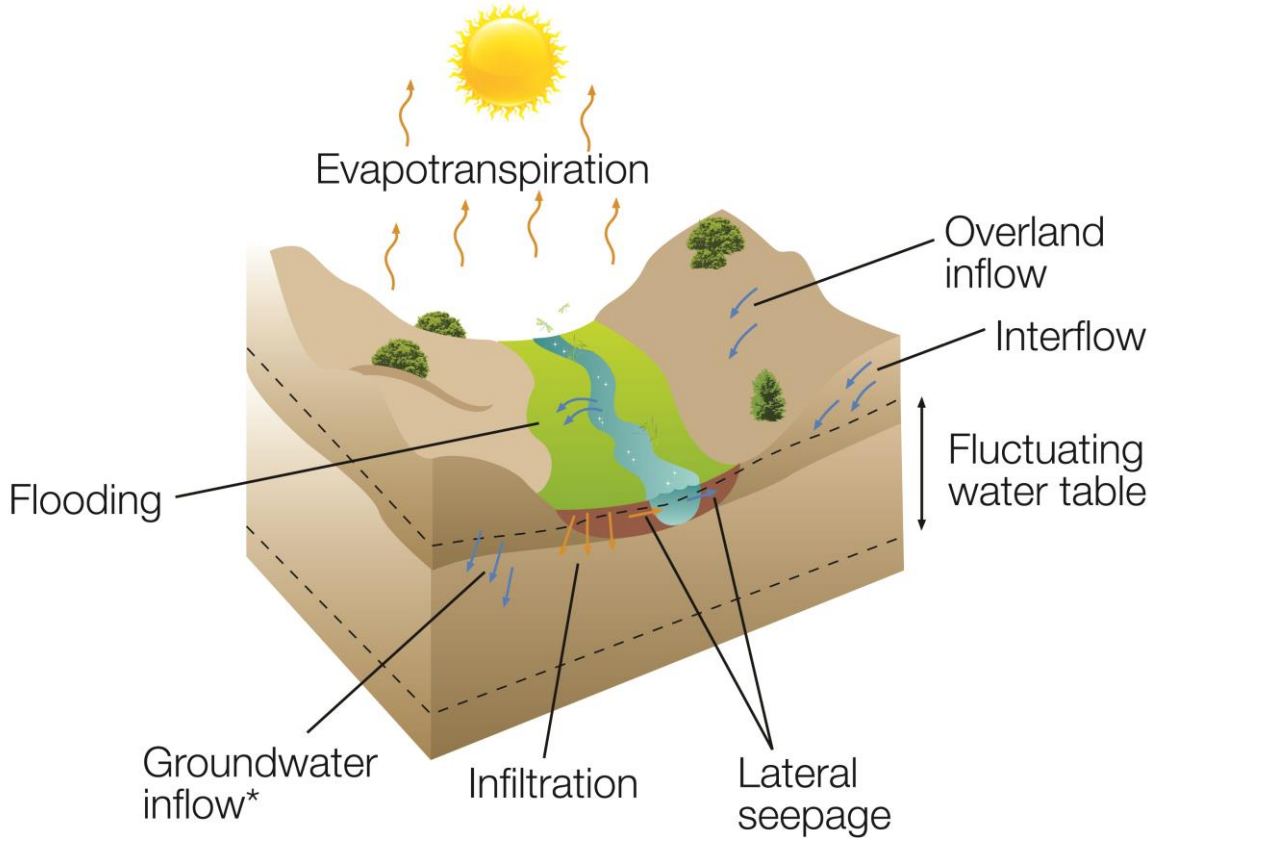


Figure 6: A schematic representation of the processes characteristic of channelled valley bottom wetlands (Ollis *et al*, 2013).

Seepage Wetland:

Seepage wetlands are the most common type of wetland (in number), but probably also the most overlooked. These wetlands can be located on the mid- and footslopes of hillsides; either as isolated systems or connected to downslope valley bottom wetlands (Figure 7). They may also occur fringing depressional pans. Seepages occur where springs are decanting into the soil profile near the surface, causing hydric conditions to develop; or where through flow in the soil profile is forced close to the surface due to impervious layers (Frey, 1999).

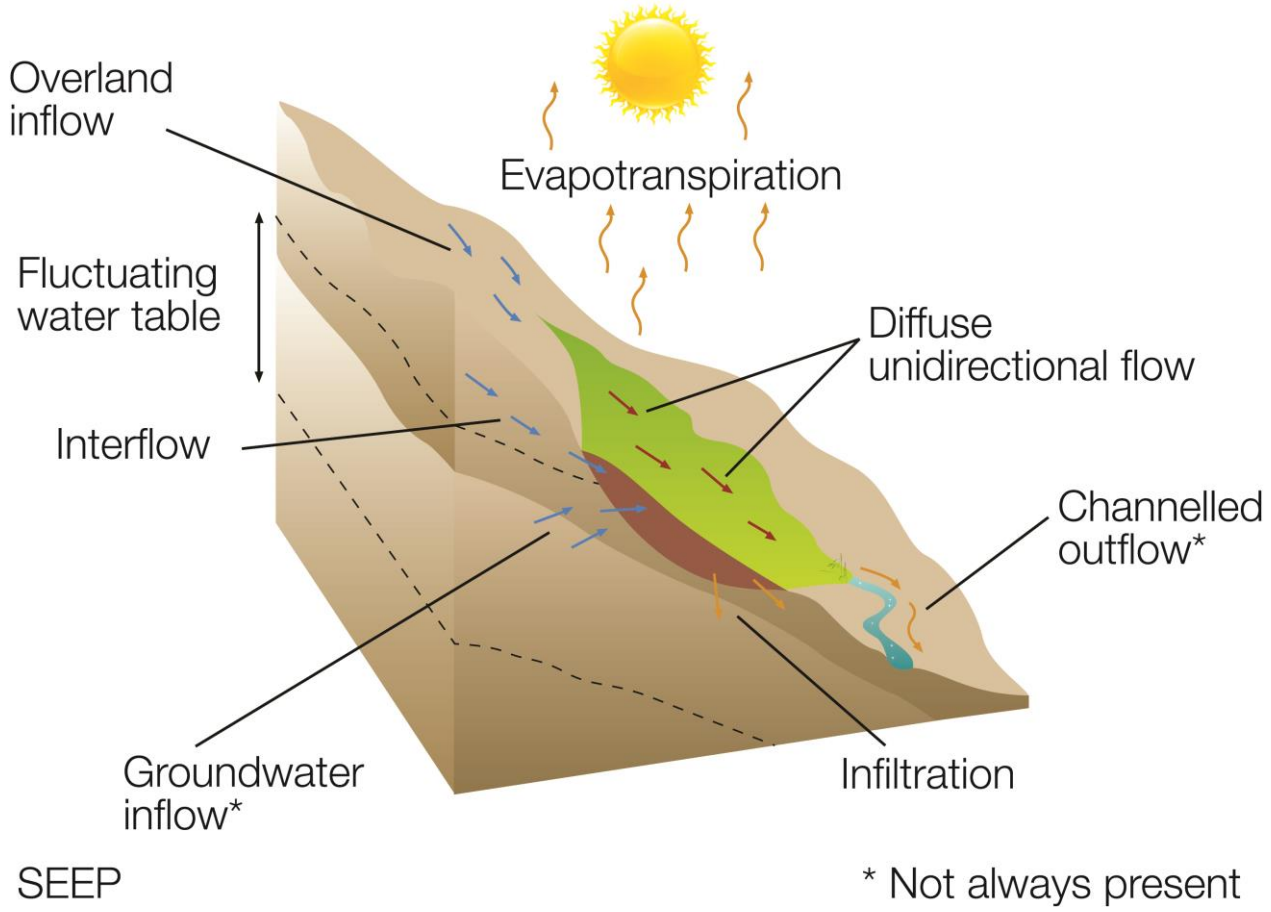


Figure 7: A schematic representation of the processes characteristic of Seepage Wetlands (Ollis *et al*, 2013).

Although the majority of the wetlands found on the study site were natural wetlands some areas did prove to be difficult. One of the seepage areas has been used as a quarry area and has subsequently been heavily degraded and is described in the green highlighted area in the table below (Table 1).

Table 1: List of types of sites that are difficult to delineate. (*N.Jobs*, 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.
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.

The degraded area is thus unlikely to contribute to the functionality of the adjacent wetlands to a large degree and likely does not function as a wetland anymore. However, an experienced soil specialist and a groundwater specialist should be consulted to determine the functionality of this wetland area.

2.3 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

Primary Role	Buffer Functions
	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.

Local government policies require that protective buffer zones be calculated from the outer edge of the temporary zone of a wetland (KZN DAEA, 2002; CoCT, 2008; GDACE, 2009). Although research is underway to provide further guidance on appropriate defensible buffer zones, there is no current standard other than the generic recommendation of 30m for wetlands inside the urban edge and 50 m outside the urban edge (GDARD, 2012). The current report suggests that a generic 30 m buffer zone be applied to the outer edge of the wetlands in the urban edge and 50 m buffer zone be applied to the outer edge of the wetlands outside of the urban edge. As for riparian areas a 32 m buffer zone should be applied from the outer edge of the riparian area within the urban edge and a 100 m buffer zone should be applied to the edge of the riparian area outside of the urban edge. An understanding of the origin of water that results in the wetland/riparian conditions should ideally form the basis of refining this generic buffer zone through an analysis of empirical data.

2.4 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 impacts observed for the affected wetlands on the study site are summarised in for each wetland under section 3.2. These impacts are based on evidence observed during the field survey and land-use changes visible on aerial imagery.

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), WetEcoServices (Kotze 2005) and EIS (DWAF, 1999).

2.4.1 Provision of Goods and Services - WET-Ecoservices

Hydro-geomorphic units are per definition characterised by physical and hydrological features that allow them to perform specific ecosystem services. The degree of disturbance and modification of wetlands results in a decrease in the ability to which they are able to perform these ecosystem services.

A Wet-Ecoservice evaluation was done for the hydro-geomorphic types found on site to determine the services provided by the wetlands and are discussed in the results.

2.4.2 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 3. 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 3: 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

Description	Impact Score Range	PES Score	Summary
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 4.

Table 4: 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	(↓↓)

2.4.3 Ecological Importance and Sensitivity (EIS)

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 each of the wetlands is represented are described in the results section. Explanations of the scores are given in Table 5.

Table 5: 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

3 RESULTS

3.1 Land Use and Land Cover

The study site is currently disturbed by a large area of quarrying in the east. Large numbers of cattle were also observed which is likely to have an impact on the study area and the wetlands. From historical aerial imagery it can be seen that large areas of the study site has been used for agriculture. Furthermore various infrastructures such as roads, paths, pylons and telephone poles were found throughout the study site.

3.1.1 Soil and Vegetation Indicators

Soil

The soil of the western section was predominantly sandy soil. Within the wetland areas the top layer (1-10 cm) was brown with grey sandy soil underneath (10-50 cm). Adjacent to the channelled valley bottom there was a sediment layer. In some areas a thin layer of dark organic material was evident. Farther away from the wetland the soil was a sandy soil ranging from orange to red soil with some areas being rocky. In the eastern section of the study site large areas of the wetland had been disturbed by various activities including quarrying and soil samples often lacked wetland indicators. In the less disturbed areas in the eastern section the soil ranged from rocky to sandy. Mottling and gleying were found throughout the channelled valley bottom area as well as the seepage areas except in some of the quarry areas. Iron oxidation was especially evident in some of the seepage areas higher up. Where water seeped out of the soil large areas could be seen with iron oxidation. Sediment deposit into the wetland was evident throughout the system.

Vegetation

The channelled valley bottom section of the wetland was colonised by plants such as *Typha capenis* and *Phragmites australis* with small patches of exotic woody vegetation found adjacent the channelled valley bottom area. The seepage areas had a higher density of grasses and sedges. Exotic species was found throughout the study site and especially at a high density and frequency in the quarry area. Large sections of the wetland system were fringed on the edges by *Seriphium plumosum* which is likely due to overgrazing (Figure 8). Some areas located within the seepage area in the east had a low density of vegetation and erosion gullies was prominent in this area.

Figure 8: *Seriphium plumosum* located on the edge of the wetland and the terrestrial area.

Exotic plants include:

- *Seriphium plumosum.*
- *Senecio gregatus.*
- *Asclepias fruticosa.*
- *Pennisetum clandestinum.*
- *Tagetes minuta.*

- *Bidens pilosum.*
- *Pennisetum clandestinum.*
- *Datura ferox.*
- *Cyperus rotundus* subsp. *Rotundus.*
- *Cynodon dactylon.*
- *Verbena bonariensis.*
- *Datura stramonium.*
- *Cirsium vulgare.*
- *Eucalyptus sp.*

Wetland indicators include:

- *Phragmites australis.*
- *Typha capensis.*
- *Juncus rigidus.*
- *Paspalum urvillei.*
- *Imperata cylindrica*
- *Persicaria lapathofolia.*
- *Nymphaea nouchali.*
- *Andropogon eucoms.*
- *Haplocarpha scaposa.*
- *Cyperus marginatus.*
- *Fimbristylis complanata* subsp. *Complanata.*

3.2 Wetland Classification and Delineation

Four (4) wetland areas were recorded on the study site. The wetland areas were classified as a Channelled valley bottom wetland, and seepage wetlands. All the wetlands recorded on the study site form part of the same wetland system. All the wetland components are thus discussed separately but the wetland as a whole is assessed for the purpose of PES and EIS. One of the seepage areas was also split into two parts to indicate the degraded part of the seepage area (Figure 9).

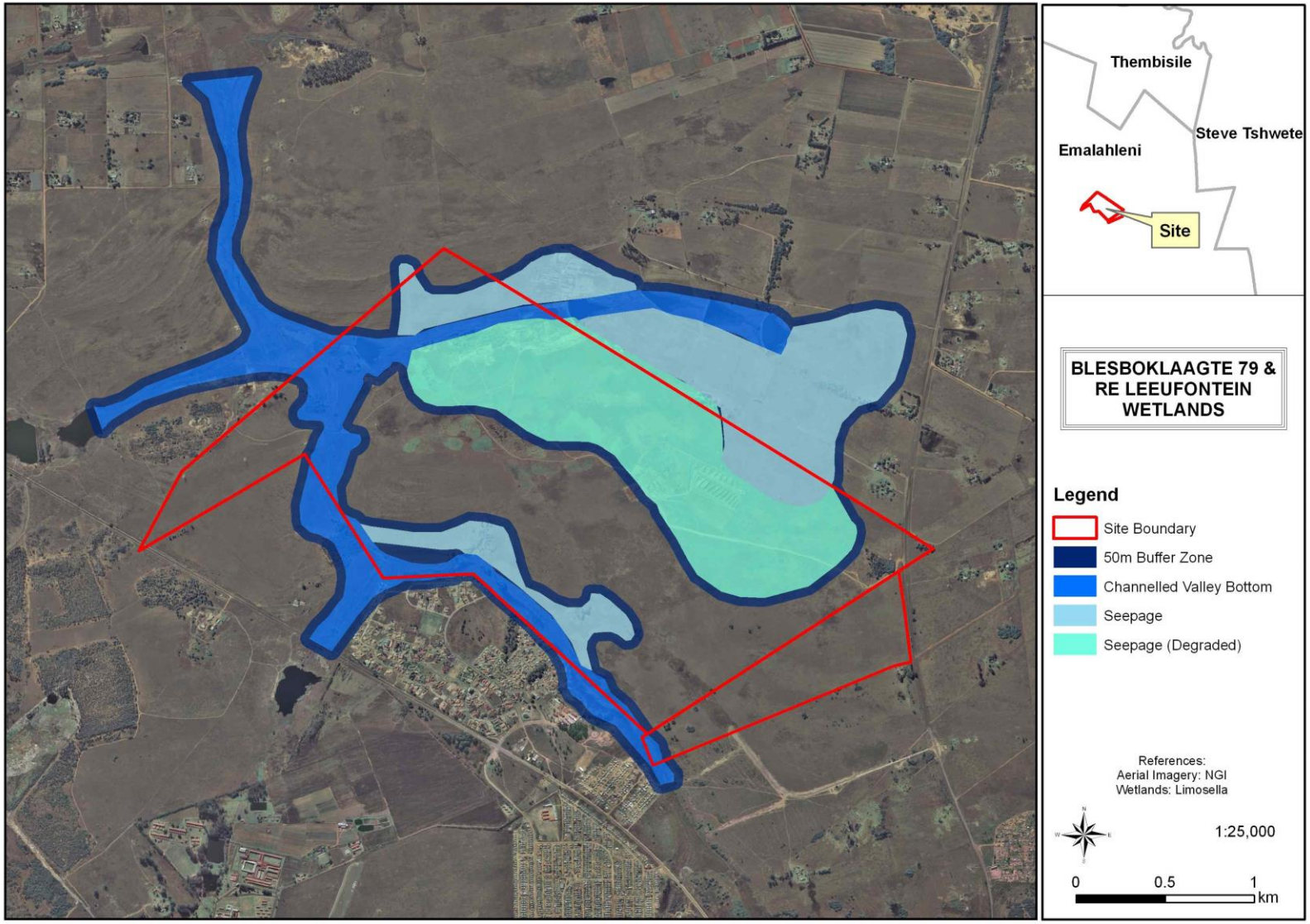


Figure 9: Wetland sensitivity areas delineated together with associated buffer zones.

Wetlands associated with the study site

Channelled Valley Bottom

The channelled valley bottom found on the site extends through the northern section of the study site as well as bordering the southern section of the study site. A clear channel can be seen throughout most of the wetland. The wetland has been impacted by roads, grazing and some patches of exotic woody vegetation such as *Eucalyptus sp.* and *Acacia mearnsii.* The main impact associated with this wetland is the numerous areas where the wetland has been dammed up, thus preventing the transport of sediment through the wetland as well as preventing the migration of faunal species through the wetland (Figure 10).

Figure 10: Damming of the channelled valley bottom.

In the northern corner of the study site a large section of exposed soil can be seen, this area has numerous erosional gullies likely due to the upstream quarrying in the adjacent seepage wetland. The close association with the town of Pine Ridge also has an impact on the wetland by creating footpaths, dumping and fringing construction of houses. The wetland vegetation here is mostly intact with thick stands of *Phragmites australis.* Sediment was seen in the edges of the wetland suggesting that the wetland contributes to sediment trapping in conjunction with the associated seepage areas (Figure 11).

Figure 11: Channelled Valley Bottom (Blue) in relation to the study area (Red).

Seepage Area 1

The seepage area is found north of the channelled valley bottom wetland, in the northern most corner of the study site (Figure 12). The wetland is found on the foot slopes of a mountainous area. The main impact associated with this wetland is the cattle farm located on the wetland. Grazing has thus had a large impact on the area and large areas of overgrazing were recorded.

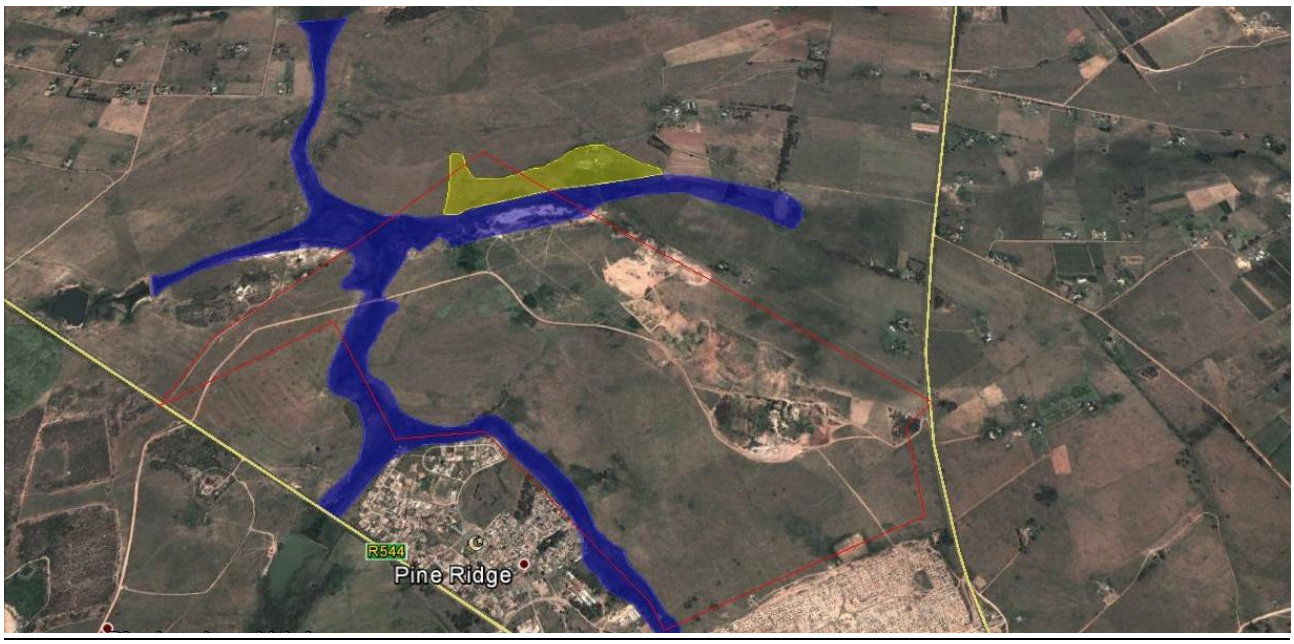


Figure 12: Seepage area (Yellow) in relation to the Channelled Valley Bottom (Blue) and the study area (Red).

Seepage Area 2

This seepage area is located at the southern border of the study site north of the channelled valley bottom wetland (Figure 13). The area is also located on the foot slopes of a small rocky outcrop. The western section of the seepage area is located between two small rocky outcrops. Water thus collects from both rocky outcrops into this small area where it creates wetland conditions.

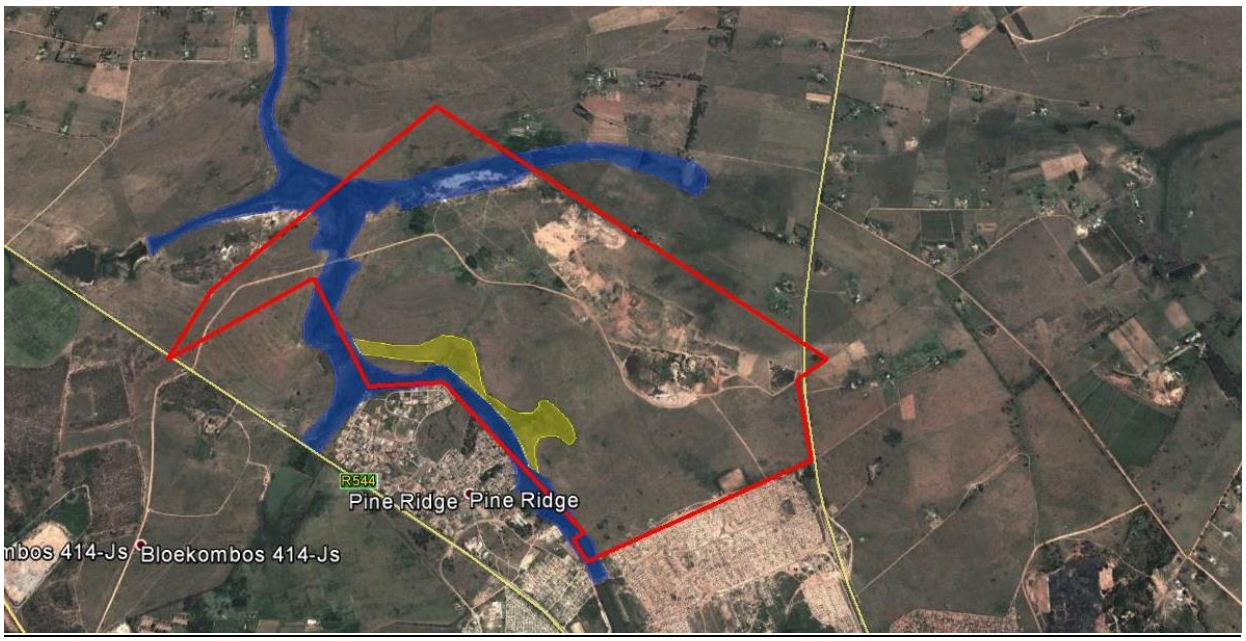


Figure 13: Seepage area (Yellow) in relation to the Channelled Valley Bottom (Blue) and the study area (Red).

Seepage Area 3

This seepage area is part of a larger seepage wetland that has become degraded due to the quarrying of the area. This section of the seepage wetland is however still functional and not as impacted as the rest of the seepage area. On a small part of this seepage area is located on the study site (Figure 14).

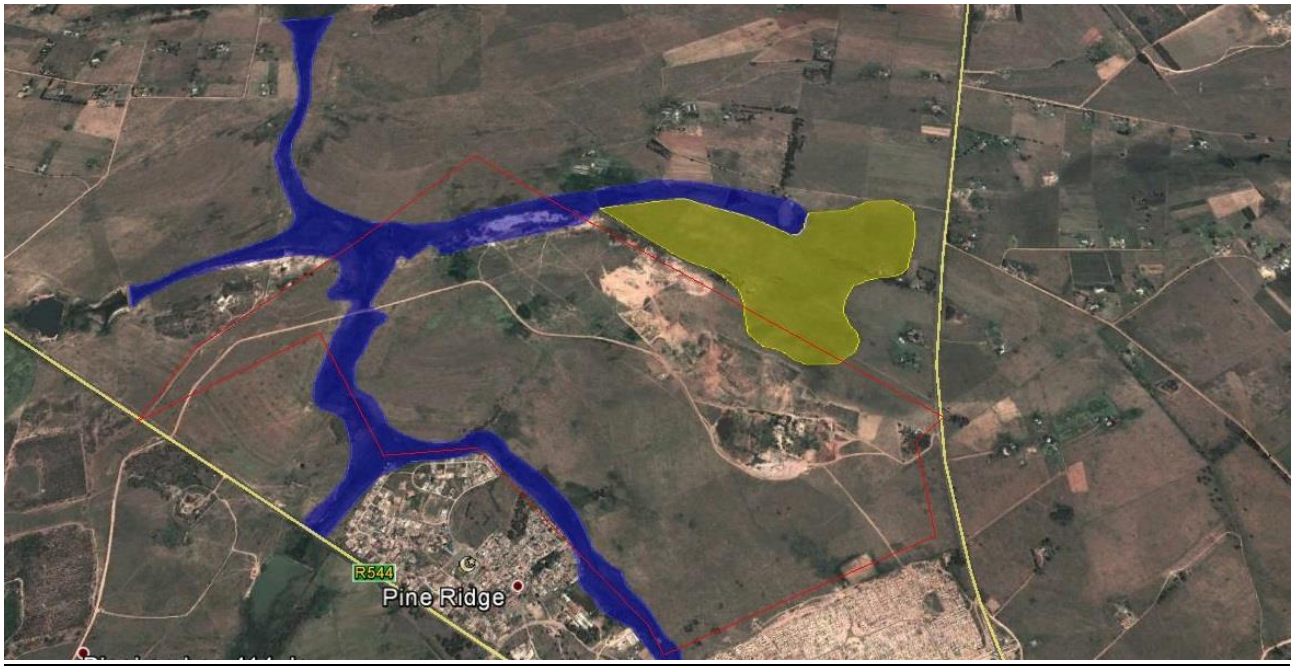


Figure 14: Seepage area (Yellow) in relation to the Channelled Valley Bottom (Blue) and the study area (Red).

Degraded Seepage Area

This seepage area forms part of Seepage area 3 (Figure 15).

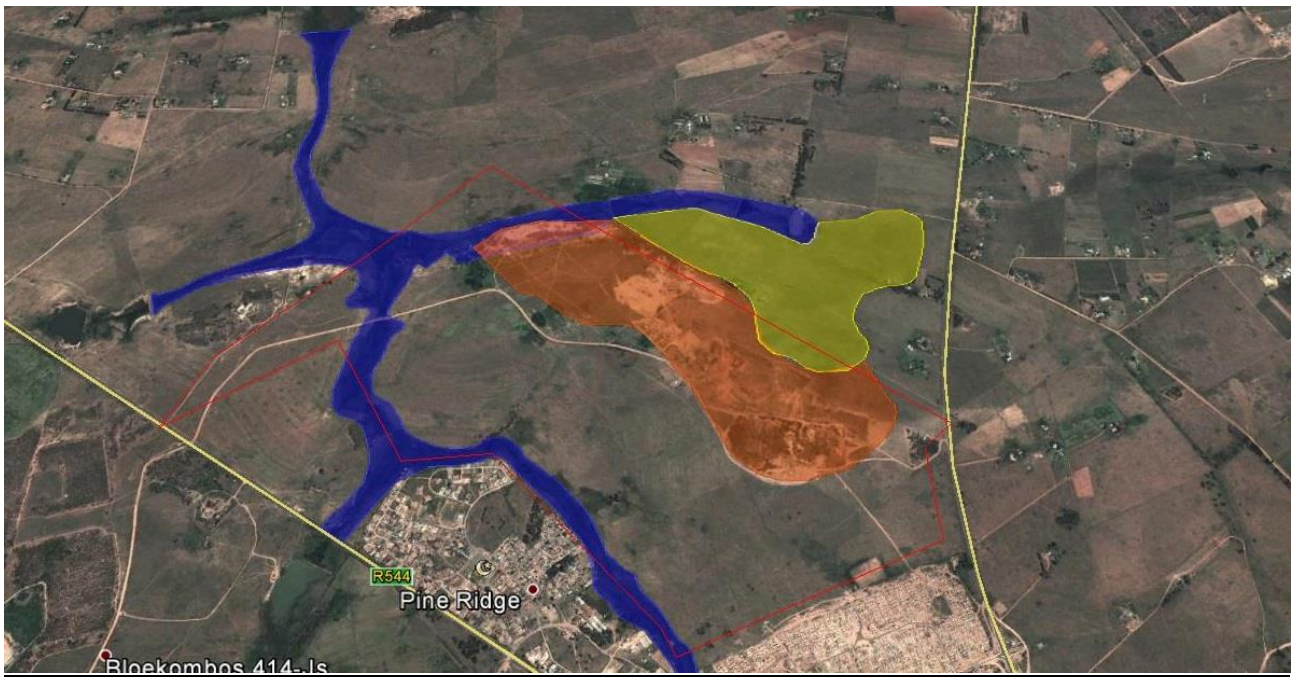


Figure 15: Seepage area (Yellow) in relation to the Channelled Valley Bottom (Blue) and the study area (Red).

This area has been greatly impacted by quarrying and other anthropogenic activities. Large gullies and pits are located within this area. The vegetation of this area is mostly exotic with large stands of *Datura stramonium* found within the seepage area. Numerous dams have formed within this area. The area is greatly fragmented and is likely not functional as a wetland anymore. The hydrology and geomorphology has been greatly impacted. The excess sediment due to quarrying is impacting on the adjacent valley bottom wetland. Large erosional gullies were recorded in this wetland (Figure 16).

Figure 16: Quarry area located within a seepage area.

In summary, the hydrology of the wetland system as a whole has been greatly impacted by the quarrying in the seepage wetland as well as the damming up of the channelled valley bottom. The geomorphology of the area has been impacted by various dumping and digging areas as well as quarrying. The vegetation of the wetland system has also been impacted by the quarrying as well as over grazing. The degraded wetland thus scored the highest with regards to the PES score, and the seepage area 2 scored the lowest and is therefore considered to be the most natural wetland on site. The other wetlands on site scored similar scores (Table 6).

Table 6: Summary of hydrology, geomorphology and vegetation health assessment for the Wetland system on the study site (*Macfarlane et al*, 2009).

Wetland Unit	Ha	Extent (%)	Hydrology		Geomorphology		Vegetation	
			Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Channelled Valley Bottom	128	40	3.7	-1	3.2	-1	3.5	-2
Seepage 1	24	7	2.8	-1	2.4	1	3.5	-1
Seepage 2	20	6	3.0	0	3.0	0	5.0	0
Seepage 3	88	27	4.0	-2	4.2	0	3.7	0
Degraded Seepage	64	20	8.9	-2	8.2	-2	8.1	-2
Area weighted impact scores			**4.6**	**-1.2**	**4.2**	**-0.8**	**4.6**	**-1.0**
PES Category and Projected Trajectory			**D**	**↓↓**	**D**	**↓**	**D**	**↓↓**

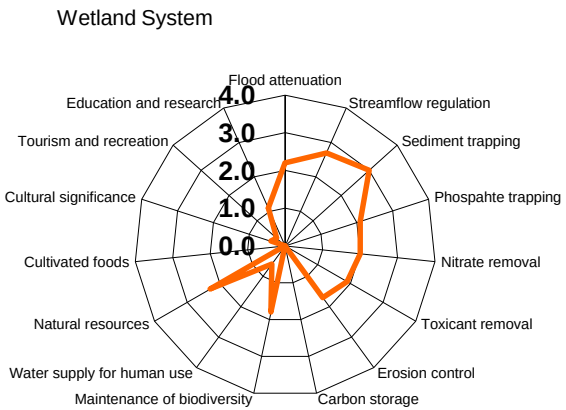
The EIS score falls into a category characterised by moderate ecological importance and sensitivity and is considered to be ecologically important and sensitive on a provincial or local scale. According to the generic description of this class the biodiversity of this wetland is not usually sensitive to flow and habitat modifications, although this may be contested by the results of an avifaunal study. Wetlands in this category further play a small role in moderating the quantity and quality of water in major rivers (DWAF, 1999) (Table 7).

Table 7: Combined EIS scores obtained for the Wetland system on the study site. (DWAF, 1999).

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	2.3	3.0
Hydro-functional importance	2.3	3.0
Direct human benefits	0.7	3.0
Overall score	**1.8**	

The ecosystem services provided by this wetland according to the WetEcoservices assessment are summarised in the Table 8 below (Kotze *et al* 2005).

Table 8: Results and brief discussion of the Ecosystem Services provided by the Wetland system on the study site.



Function	Score	Significance
Flood attenuation	2.2	Moderately High
Stream flow regulation	2.7	Moderately High
Sediment trapping	3.0	High
Phosphate trapping	2.1	Moderately High
Nitrate removal	2.0	Moderately High
Toxicant removal	1.9	Moderately Low
Erosion control	1.7	Moderately Low
Maintenance of biodiversity	1.8	Moderately Low
Water supply for human use	0.6	Low
Natural resources	2.3	Moderately High
Cultivated foods	0.0	Low
Cultural significance	1.9	Low
Tourism and recreation	0.3	Low
Education and research	1.1	Moderately Low

Anthropogenic impacts associated with the three wetlands are summarised in Table 9.

Table 9: The impacts associated with the wetland on the site as used in the determination of the functionality, status and sensitivity.

Area	Current Impacts	Potential Impacts related to construction activities
Channelled Valley Bottom	The wetland is currently impacted by various anthropogenic activities especially the historical damming up of the wetland at various points. Overgrazing has had an effect on the vegetation component of the wetland. The adjacent degraded seepage area and quarrying area is currently contributing to an increase in sediment input as well as creating numerous erosional gullies. The approximate central coordinates of wetland in relation to the study site are 25°48'9.14"S and 29°11'32.75"E.	The proposed construction is likely to contribute to an increase in sediment input as well as erosion if proper storm water management does not occur. This wetland forms part of a large wetland system and it is important that no activities takes place within the wetland area or the buffer.
Seepage Area 1	This area has been impacted by cattle farming as well as overgrazing. The approximate central coordinates of wetland in relation to the study site are 25°47'55.84"S and 29°12'1.24"E.	This area is located on a slope with sandy soil and erosion is thus prone to occur. This seepage area is important to manage the spread of floodwaters as well as contributing to sediment trapping. This area is located on the northern most corner of the study site. No activities should take place within this area or the buffer zone.
Seepage Area 2	This area has not been greatly impacted and the majority of the impacts are related to small scale dumping as well as footpaths. The approximate central coordinates of wetland in relation to the study site are 25°48'42.41"S and 29°12'3.69"E.	This area is located between two sensitive rocky outcrops and construction in this area is likely to increase the amount of sediment that enters the wetland as well as erosion.
Seepage Area 3	The area has been impacted by the adjacent quarrying as well as overgrazing. Erosion gullies are evident in some areas. The approximate central coordinates of wetland in relation to the study site are 25°48'7.79"S and 29°12'43.51"E.	Only a small section of this wetland is located within the study site, however any construction of this area is likely to have a negative effect on the wetland as well as the adjacent valley bottom. The area is very sandy and any construction is likely to create erosional gullies as well as contributing to erosion and thus the loss of vegetation.
Degraded Seepage Area	This hydrology, geomorphology and vegetation of this area have been greatly affected by the historical and current	The area is already greatly impacted and fragmented. The proposed construction is unlikely to have any further negative effects on

Area	Current Impacts	Potential Impacts related to construction activities
	quarrying. The area is heavily fragmented and likely no longer contributes to the various functions associated with a seepage wetland. This area is currently increasing the amount of sediment that enters the channelled valley bottom, the lack of vegetation is also leading to erosional gullies downstream. The approximate central coordinates of wetland in relation to the study site are 25°48'22.84"S and 29°12'37.21"E.	this area.

3.3 Impacts and Mitigation

A development has several impacts on the surrounding environment and particularly on a wetland. The development changes habitats, the ecological environment, infiltration rates, amount of runoff and runoff intensity of stormwater run-off, and therefore the hydrological regime of the site. Site specific mitigation measures should be included in an Environmental Management Plan.

The proposed construction is likely to have some impact on the wetland system especially with regards to erosion and sedimentation of the wetland system. The channelled valley bottom is likely to be sensitive with regards to flow alterations and stormwater management should thus be managed well. The seepage areas are generally on sloped areas where erosion is prone to occur and erosion control methods should be implemented in these areas.

Generic suggested primary management procedures are summarised in Table 10.

Table 10: Impacts and suggested management procedures relevant to the proposed development (modified from Macfarlane *et al*, 2010)

Threat / Impact	Source of the threat	Primary Management Procedure
Changing the quantity and fluctuation properties of the watercourse.	*Construction:* • Development within wetland. • Lack of adequate rehabilitation resulting in invasion by exotic plants into the wetland. *Operational:* • Material draining into wetland. • Damage to vegetated areas.	• No activities should take place in the watercourses and associated buffer zone. • Where the above is unavoidable construction in and around watercourses must be restricted to the dryer winter months. • A temporary fence or demarcation must be erected around the works area to prevent access to sensitive environs. The works areas generally include the servitude, construction camps, areas where material is stored. • Prevent pedestrian and vehicular access into the wetland and buffer. • Formalise access roads and make use of existing roads

Threat / Impact	Source of the threat	Primary Management Procedure
		and tracks where feasible, rather than creating new routes through naturally vegetated areas. • Management of on-site water use and prevent stormwater or contaminated water directly entering the watercourse • Management of point discharges • Planning of construction site must include eventual rehabilitation / restoration of indigenous vegetative cover • Alien plant eradication and follow-up control activities prior to construction, to prevent spread into disturbed soils, as well as follow-up control during construction • The amount of vegetation removed should be limited to the least amount possible. • Rehabilitation plans must be submitted and approved for rehabilitation of damage during construction and that plan must be implemented immediately upon completion of construction.
Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount)	Construction: • Clearing of surface vegetation will expose the soils, which in rainy events would wash down into wetlands, causing sedimentation. In addition, indigenous vegetation communities are unlikely to colonise eroded soils successfully and seeds from proximate exotic vegetation can spread easily into these eroded soil. • Disturbance of soil surface • Disturbance of slopes through creation of roads and tracks • Changes in runoff characteristics • Erosion (e.g. gully formation, bank collapse) *Operational:* • Vehicles impacting on surface vegetation	• Construction in and around watercourses must be restricted to the dryer winter months. • A temporary fence or demarcation must be erected around the works area to prevent water runoff and erosion of the disturbed or heaped soils into wetland areas. • Access roads and bridges should span the wetland area, without impacting on the permanent or seasonal zones. • Formalise access roads and make use of existing roads and tracks where feasible, rather than creating new routes through naturally vegetated areas. • Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area (DWAF, 2005). • A vegetation rehabilitation plan should be implemented. Grassland can be removed as sods and stored within transformed vegetation. The sods must preferably be removed during the winter months and be replanted by latest springtime. The sods should not be stacked on top of each other or within sensitive environs. Once construction is completed, these sods should be used to rehabilitate the disturbed areas from where they have been removed. In the absence of timely rainfall, the sods should be watered well after planting and at least twice more over the next 2 weeks. • Remove only the vegetation where essential for construction and do not allow any disturbance to the

Threat / Impact	Source of the threat	Primary Management Procedure
		adjoining natural vegetation cover. • Rehabilitation plans must be submitted and approved for rehabilitation of damage during construction and that plan must be implemented immediately upon completion of construction. • Cordon off areas that are under rehabilitation as no-go areas using danger tape and steel droppers. If necessary, these areas should be fenced off to prevent vehicular, pedestrian and livestock access. • Delay the re-introduction of livestock (where applicable) to all rehabilitation areas until an acceptable level of re-vegetation has been reached. • During the construction phase measures must be put in place to control the flow of excess water so that it does not impact on the surface vegetation. • 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. • Runoff from roads must be managed to avoid erosion and pollution problems. • Implementation of best management practices • Source-directed controls • Buffer zones to trap sediments • Active rehabilitation
Alteration of water quality – toxic contaminants (including toxic metal ions (e.g. copper, lead, zinc) and hydrocarbons.	Construction: • Runoff from road surfaces • Discharge of solvents, and other industrial chemicals *Operational:* • Runoff from road surfaces • Discharge of solvents, and other industrial chemicals	• 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. • Ensure that maintenance work does not take place haphazardly, but, according to a fixed plan, from one area to the other. • Maintenance of construction vehicles • Control of waste discharges • Guidelines for implementing Clean Technologies • Maintenance of buffer zones to trap sediments with associated toxins
Changing the physical structure within a water resource (habitat)	Construction: • Encroachment to achieve maximum commercial returns • Deposition of wind-blown sand	• Other than approved and authorized structure, no other development or maintenance infrastructure is allowed within the delineated wetland or their associated buffer zones. • Demarcate the wetland areas and buffer zones to limit disturbance, clearly mark these areas as no-go areas

Threat / Impact	Source of the threat	Primary Management Procedure
	• Loss of fringing vegetation and erosion • Alteration in natural fire regimes *Operational:* Loss of vegetation	• Linear developments (e.g. roads) should span the watercourse • Weed control in buffer zone • Monitor rehabilitation and the occurrence of erosion twice during the rainy season for at least two years and take immediate corrective action where needed. • Monitor 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.

4 CONCLUSION

The wetland system is described as separate wetland units namely a Channelled valley bottom, seepage areas and a degraded seepage area. All the separate hydrogeomorphic units supports each other and function as one wetland system.

An estimate of the Present Ecological State and Ecological Integrity and Sensitivity for the wetlands discussed in this report is presented in Table 11 below.

Table 11: Summary of the PES, EIS scores and impacts obtained for the wetland and surrounding areas.

Watercourse Type	Estimated PES Score	Current Impacts	EIS Score
Channelled Valley Bottom	C	The wetland is currently impacted by various anthropogenic activities especially the historical damming up of the wetland at various points. Overgrazing has had an effect on the vegetation component of the wetland. The adjacent degraded seepage area and quarrying area is currently contributing to an increase in sediment input as well as creating numerous erosional gullies. The approximate central coordinates of wetland in relation to the study site are 25°48'9.14"S and 29°11'32.75"E.	1.8
Seepage 1	C	This area has been impacted by cattle farming as well as overgrazing. The approximate central coordinates of wetland in relation to the study site are 25°47'55.84"S and 29°12'1.24"E.	1.8
Seepage 2	C	This area has not been greatly impacted and the majority of the impacts are related to small scale dumping as well as footpaths.	1.8

Watercourse Type	Estimated PES Score	Current Impacts	EIS Score
		The approximate central coordinates of the wetland in relation to the study site are 25°48'42.41"S and 29°12'3.69"E.	
Seepage 3	D	The area has been impacted by the adjacent quarrying as well as overgrazing. Erosion gullies are evident in some areas. The approximate central coordinates of wetland in relation to the study site is 25°48'7.79"S and 29°12'43.51"E.	1.8
Degraded Seepage	F	This hydrology, geomorphology and vegetation of this area have been greatly affected by the historical and current quarrying. The area is heavily fragmented and likely no longer contributes to the various functions associated with a seepage wetland. This area is currently increasing the amount of sediment that enters the channelled valley bottom, the lack of vegetation is also leading to erosional gullies downstream. The approximate central coordinates of wetland in relation to the study site are 25°48'22.84"S and 29°12'37.21"E.	0.4

The wetland system has been impacted by various anthropogenic activities including quarrying, over grazing, and infrastructure. The channelled valley bottom as well as Seepage 1, Seepage 2 and a section of Seepage 3 should be considered as sensitive areas and construction should be avoided in these areas and the associated buffer zones. The degraded seepage area has lost the majority of its functionality and is therefore considered to be less sensitive.

In the absence of dedicated hydrological, groundwater and geohydrological assessments the current assessment finds that a minimum buffer of 32 m from the edge of the wetland boundaries should be respected.

It is important that appropriate mitigation measures are put into place and carefully monitored to ensure minimal impact to regional hydrology. Mitigation should focus on:

- Rehabilitation / restoration of indigenous vegetative cover.
- Management of point discharges during construction activities.
- Alien plant control.
- Implementation of best management practices regarding stormwater and earthworks.
- Provision of adequate sanitation facilities located outside of the wetland area or its associated buffer zone during construction activities.
- Implementation of appropriate stormwater management around the excavation to prevent the ingress of run-off into the excavation.

- Prevention of erosion, and where necessary rehabilitation of eroded areas.

Wetlands situated within 500 m of proposed activities should be regarded as sensitive features potentially affected by the proposed development (Regulation 1199 of 2009 in terms of the National Water Act, 1998). Development activities close to wetlands are excluded from General Authorisation (GA) for Section 21 (c) and (i) water uses (published in Government Gazette No. 389). In this instance the Department of Water Affairs should be contacted regarding the application for a Water Use License.

REFERENCES

Armstrong A. (2009). WET-Legal:Wetland rehabilitation and the law in South Africa. WRC Report TT 338/09. Water research Comission, Pretoria

Brinson, M. (1993). A hydrogeomorphic classification for wetlands. Prepared for US Army Corps of Engineers. 101pp. Wetlands Research Programme Technical Report WRP-DE-4

Chief Directorate: Surveys & Mapping. 1996: Hydrology. Cape Town: CDSM.

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.

Department of Water Affairs and Forestry (1999). Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0. Pretoria

Department of Water Affairs and Forestry (2008). Updated Manual for the identification and delineation of wetlands and riparian areas. Department of Water affairs and Forestry. Pretoria. South Africa Second Edition. September 2008.

Ewart-Smith J., Ollis D., Day J. and Malan H. (2006). National Wetland Inventory: Development of a Wetland Classification System for South Africa. Water Research Council project number K8/652

Fey M. (2005). Soils of South Africa: Systematics and environmental significance. Lombardi Trust. Draft submitted for comment

Fey M. (2010). Soils of South Africa: The distribution, properties, classification, genesis, use and environmental significance.

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

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.

Kotze D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.S. and Collins, N.B. (2005). WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands

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

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

Vermaak, JF, Swanepoel, JH and Schoonbee, HJ., (1981). The Phosphorous cycle in Germiston Lake. 1. Investigational objectives and aspects of the limnology of the Lake. Water SA Vol 7(3) p160-165.

APPENDIX A: 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

Appendix B: Survey Data

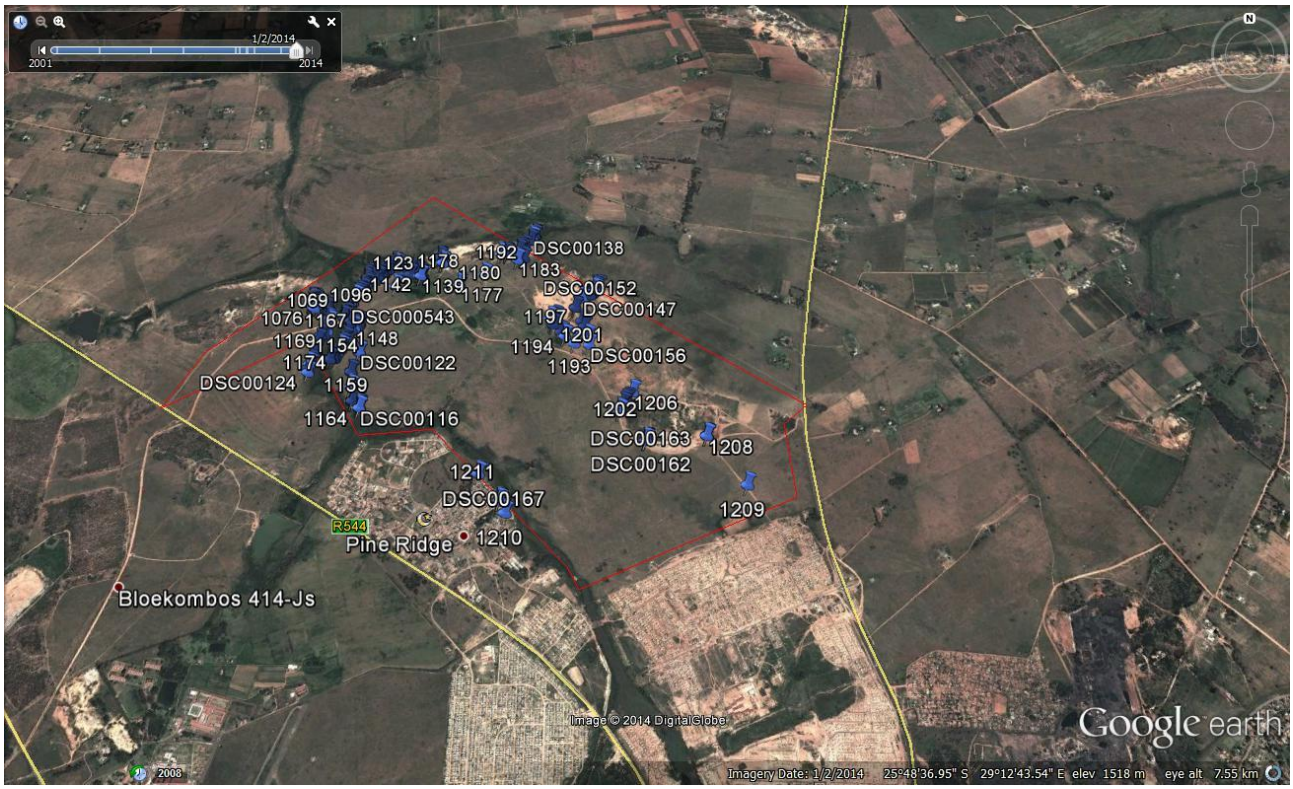


Figure 17: Map indicating location of sample points.

Table 12: Sample area coordinates.

Point	Latitude	Longitude	Elevation
1059	-25.8045	29.19135	1461.143
1060	-25.8045	29.19122	1461.927
1061	-25.8045	29.19095	1463.222
1062	-25.8045	29.1908	1463.832
1063	-25.8043	29.19065	1463.829
1064	-25.8041	29.19058	1464.234
1065	-25.8041	29.19081	1463.908
1066	-25.8042	29.19088	1466.418
1067	-25.8041	29.19068	1465.286
1068	-25.8041	29.19067	1465.62
1069	-25.8043	29.19066	1466.138
1070	-25.8044	29.19052	1465.845
1071	-25.8044	29.19057	1464.635
1072	-25.8044	29.19061	1465.043
1073	-25.8045	29.19067	1465.938
1074	-25.8046	29.19073	1464.632
1075	-25.8046	29.19078	1465.302
1076	-25.8047	29.19083	1465.952

1077	-25.8047	29.19111	1463.3
1078	-25.8047	29.19128	1463.906
1079	-25.8047	29.19137	1463.888
1080	-25.8047	29.19148	1462.254
1081	-25.8047	29.19167	1462.169
1082	-25.8048	29.19176	1462.264
1083	-25.8049	29.19184	1462.376
1084	-25.805	29.19172	1464.047
1085	-25.805	29.19163	1465.032
1086	-25.8051	29.19166	1463.702
1087	-25.8052	29.19165	1464.819
1088	-25.8053	29.19172	1463.063
1089	-25.8054	29.19181	1462.842
1090	-25.8054	29.19183	1463.351
1091	-25.8052	29.19278	1461.007
1092	-25.805	29.19307	1461.418
1093	-25.805	29.19289	1459.798
1094	-25.8046	29.19309	1462.258
1095	-25.8043	29.19321	1461.066
1096	-25.8039	29.19337	1459.599
1097	-25.8037	29.19345	1459.961
1098	-25.8036	29.19359	1460.327
1099	-25.8034	29.19378	1460.735
1100	-25.8033	29.1938	1460.811
1101	-25.8032	29.19385	1461.208
1102	-25.803	29.19396	1461.672
1103	-25.803	29.19403	1461.732
1104	-25.8028	29.19442	1463.488
1105	-25.8027	29.1939	1461.149
1106	-25.8026	29.19394	1461.303
1107	-25.8025	29.194	1460.324
1108	-25.8024	29.19415	1463.687
1109	-25.8023	29.19429	1460.791
1110	-25.8024	29.19451	1462.42
1111	-25.8025	29.19457	1463.797
1112	-25.8025	29.19465	1465.704
1113	-25.8025	29.19476	1464.794
1114	-25.8025	29.1949	1465.84
1115	-25.8021	29.19507	1464.745
1116	-25.8021	29.19523	1464.651
1117	-25.802	29.1953	1464.486
1118	-25.8019	29.19538	1464.847
1119	-25.8019	29.19546	1464.779

1120	-25.8019	29.19553	1465.31
1121	-25.8016	29.19565	1463.342
1122	-25.8016	29.19565	1464.791
1123	-25.8017	29.19584	1464.75
1124	-25.8018	29.19612	1467.395
1125	-25.8019	29.19618	1465.393
1126	-25.802	29.19622	1468.639
1127	-25.8022	29.19622	1469.26
1128	-25.8023	29.19633	1469.699
1129	-25.8024	29.1964	1470.663
1130	-25.8024	29.19651	1470.812
1131	-25.8024	29.19662	1471.699
1132	-25.8024	29.19672	1472.675
1133	-25.8023	29.1968	1470.49
1134	-25.8022	29.19692	1471.888
1135	-25.8021	29.19702	1471.474
1136	-25.8023	29.19715	1472.714
1137	-25.8023	29.19724	1472.786
1138	-25.8023	29.19729	1473.083
1139	-25.8025	29.19741	1474.758
1140	-25.8025	29.19743	1474.689
1141	-25.8025	29.19754	1475.979
1142	-25.8032	29.19585	1470.839
1143	-25.8056	29.19328	1467.073
1144	-25.8056	29.19354	1469.118
1145	-25.8057	29.19387	1472.133
1146	-25.8058	29.19384	1470.908
1147	-25.8059	29.19374	1471.035
1148	-25.806	29.19359	1469.963
1149	-25.8062	29.19341	1471.247
1150	-25.8064	29.1932	1469.671
1151	-25.8067	29.19313	1470.13
1152	-25.807	29.19305	1468.753
1153	-25.8071	29.19301	1470.462
1154	-25.8073	29.19295	1470.794
1155	-25.8077	29.19277	1472.861
1156	-25.8079	29.19266	1470.521
1157	-25.808	29.1926	1471.264
1158	-25.808	29.19254	1470.463
1159	-25.8099	29.19391	1477.901
1160	-25.8102	29.19419	1479.511
1161	-25.8105	29.19439	1480.193
1162	-25.8107	29.19446	1478.936

1163	-25.811	29.19454	1479.011
1164	-25.8112	29.1946	1479.618
1165	-25.8108	29.19411	1477.408
1166	-25.8076	29.19413	1476.672
1167	-25.8056	29.19204	1470.826
1168	-25.8059	29.19186	1470.893
1169	-25.8062	29.1919	1468.791
1170	-25.8065	29.19152	1471.987
1171	-25.8068	29.19146	1471.802
1172	-25.8077	29.19136	1472.919
1173	-25.8083	29.19126	1473.161
1174	-25.8084	29.19113	1473.963
1175	-25.8087	29.19107	1474.12
1176	-25.8065	29.19173	1469.173
1177	-25.8032	29.19999	1482.255
1178	-25.8016	29.19876	1475.852
1179	-25.8012	29.19853	1474.866
1180	-25.8025	29.20155	1484.009
1181	-25.801	29.20263	1482.361
1182	-25.801	29.20291	1482.514
1183	-25.8014	29.20362	1486.179
1184	-25.8014	29.20366	1485.34
1185	-25.8013	29.20388	1486.271
1186	-25.8013	29.20404	1486.313
1187	-25.8008	29.20369	1482.642
1188	-25.8007	29.20386	1482.581
1189	-25.8005	29.20403	1482.261
1190	-25.8001	29.2044	1481.466
1191	-25.7997	29.20466	1484.694
1192	-25.801	29.2025	1482.005
1193	-25.8072	29.20754	1505.238
1194	-25.8067	29.20693	1500.966
1195	-25.8065	29.20668	1500.658
1196	-25.806	29.20615	1499.195
1197	-25.8055	29.20595	1498.223
1198	-25.8048	29.20752	1498.568
1199	-25.8035	29.20879	1495.028
1200	-25.8058	29.20795	1504.035
1201	-25.8068	29.20835	1504.161
1202	-25.8116	29.21044	1520.322
1203	-25.8111	29.21061	1519.796
1204	-25.8109	29.2108	1518.145
1205	-25.8108	29.21089	1518.579

1206	-25.8104	29.2112	1518.837
1207	-25.8133	29.21203	1525.656
1208	-25.8131	29.21564	1529.183
1209	-25.8159	29.21792	1532.872
1210	-25.8174	29.20387	1500.969
1211	-25.8152	29.20216	1496.876