LIMOSELLA CONSULTING

THE PROPOSED CONSTRUCTION OF THE TAUNUS DIEPKLOOF 40KM 132KV SERVITUDE, CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY, GAUTENG PROVINCE.

Wetland Specialist Report

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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);
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- 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.

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06.07.2010
Date

Executive Summary

ESKOM is proposing to construct new substations and a 40km, 132 kV overhead powerline from the proposed Taunus substation to the existing Diepkloof substation, City of Johannesburg, Gauteng. An Environmental Impact Assessment process is required for the proposed construction of the powerline and the substation. Limosella Consulting was appointed by Envirolution Environmental Consulting Pty (Ltd) to undertake an independent assessment of potential wetland and riparian conditions that would be affected by the proposed power line.

Six wetland areas were found to intersect with the proposed powerline between the proposed Taunus substation and the existing Diepkloof substation. No wetland or riparian areas were recorded in close proximity to the new substations. The current assessment finds that a 30m buffer zone should be recognised from the edge of the wetlands areas.

Potential impacts associated with the proposed development include:

- Changing the quantity and fluctuation properties of the watercourse
- Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount)
- Alteration of water quality – increasing the amounts of nutrients (phosphate, nitrite, nitrate)
- Alteration of water quality – toxic contaminants (including toxic metal ions (e.g. copper, lead, zinc) and hydrocarbons
- Changing the physical structure within a water resource (habitat)

As far as possible, powerline infrastructure should be excluded from this sensitive area. However, linear developments such as the proposed powerline are rarely able to avoid crossing any watercourses whatsoever. Where alternatives have been investigated and watercourse crossings have been shown to be necessary it is important that appropriate mitigation measures are put into place and carefully monitored to ensure minimal impact to regional hydrology. In the case of the proposed powerline mitigation should focus on:

- Rehabilitation / restoration of indigenous vegetative cover;
- Management of point discharges during construction activities;
- Alien plant control activities;
- Implementation of best management practices regarding stormwater and earthworks;

- Provision of adequate sanitation facilities located outside of the wetland/riparian 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; and particularly; and
- Prevention of erosion, and where necessary rehabilitation of eroded areas.

It is important to note that a Water Use Licence issued from the DWA is required for any structures that are placed within the delineated wetland area, or the 1:100 year floodline. An EMP should be developed to ensure that such mitigation measures are closely monitored.

Alternative alignment two is not favourable in terms of wetland ecology due to its position within the floodplain wetland associated with the Klipriver. Alternative alignment one does not cross any wetlands and is therefore favourable.

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1 INTRODUCTION

ESKOM is proposing to construct new substations and a 40km, 132 kV overhead powerline from the proposed Taunus substation to the existing Diepkloof substation, City of Johannesburg, Gauteng. An Environmental Impact Assessment (EIA) process is required for the proposed construction of the powerline and the substation. The EIA will cover the proposed construction of the powerline, and will also include all the ancillary activities for the proposed project, i.e. construction of access roads, telecommunication structures and/or storage of hazardous substances.

Limosella Consulting was appointed by Envirolution Environmental Consulting Pty (Ltd) to undertake an independent assessment of potential wetland and riparian conditions that would be affected by the proposed power line. This assignment is in accordance with the EIA Regulations (No. R. 385, Department of Environmental Affairs and Tourism, 21 April 2006) emanating from Chapter 5 of the National Environmental Management Act 1998 (Act No. 107 of 1998).

Authoritative legislation that lists impacts and activities on wetlands and riparian areas that requires authorisation includes:

- Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983);
- Environment Conservation Act, 1989 (Act 73 of 1989);
- National Water Act, 1998 (Act 36 of 1998);
- National Environmental Management Act, 1998 (Act No. 107 of 1998); and
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).

Wetlands and riparian areas perform many functions that are valuable to society including the supply of water and the improvement of water quality. The habitats created by wetlands and rivers are also important for many plant and animal species. Not all wetlands or rivers develop in the same way and may not perform ecosystem services to the same extent. Where areas of human settlement and development threaten to encroach and impact on wetlands or riparian areas, it is important that the wetland's ecological integrity be assessed. Appendix A provides the details of the methodology followed during the current assessment.

1.1 Terms of Reference

- Identify the outer edge of the wetland temporary zone, or edge of the riparian zone;

- Classify the wetland or riparian areas according to Ewart-Smith *et al,* 2006,
- Indicate the relative functional importance of the wetland or riparian areas;
- Recommend suitable buffer zones;
- Indicate possible impacts on the wetland or riparian areas; and
- Recommend mitigation measures in order to limit the impact of the proposed development on the wetland or riparian areas.

1.2 Assumptions and Limitations

Compilation of ecological datasets should include repetitive sampling across seasonal variation. However, since project constraints rarely allow for exhaustive sampling along the entire proposed alignment and its alternatives, the fieldwork during the current assessment aimed to describe general site conditions and highlight important issues relevant to the construction of powerlines. Available GIS data together with groundtruthing conducted during the 2nd of June, 2010, was relied on to identify wetland and riparian boundaries along the proposed powerline. Although wetland and riparian areas extend to the north and south of the proposed alignment, the current report focused only on the areas where the proposed powerline and wetland areas intersect.

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 no-go areas identified be pegged in the field in collaboration with the surveyor prior to commencement of construction activities.

1.3 Location of the Study Site

The proposed area of the development falls within the boundaries of the City of Johannesburg Metropolitan Municipality, in the Gauteng province. To the north of the proposed powerline lies Soweto, and to the south lies Lenasia. The N1 runs to the east of the proposed powerline and the N12 runs slightly north of the greater part of the powerline (Figure 1).

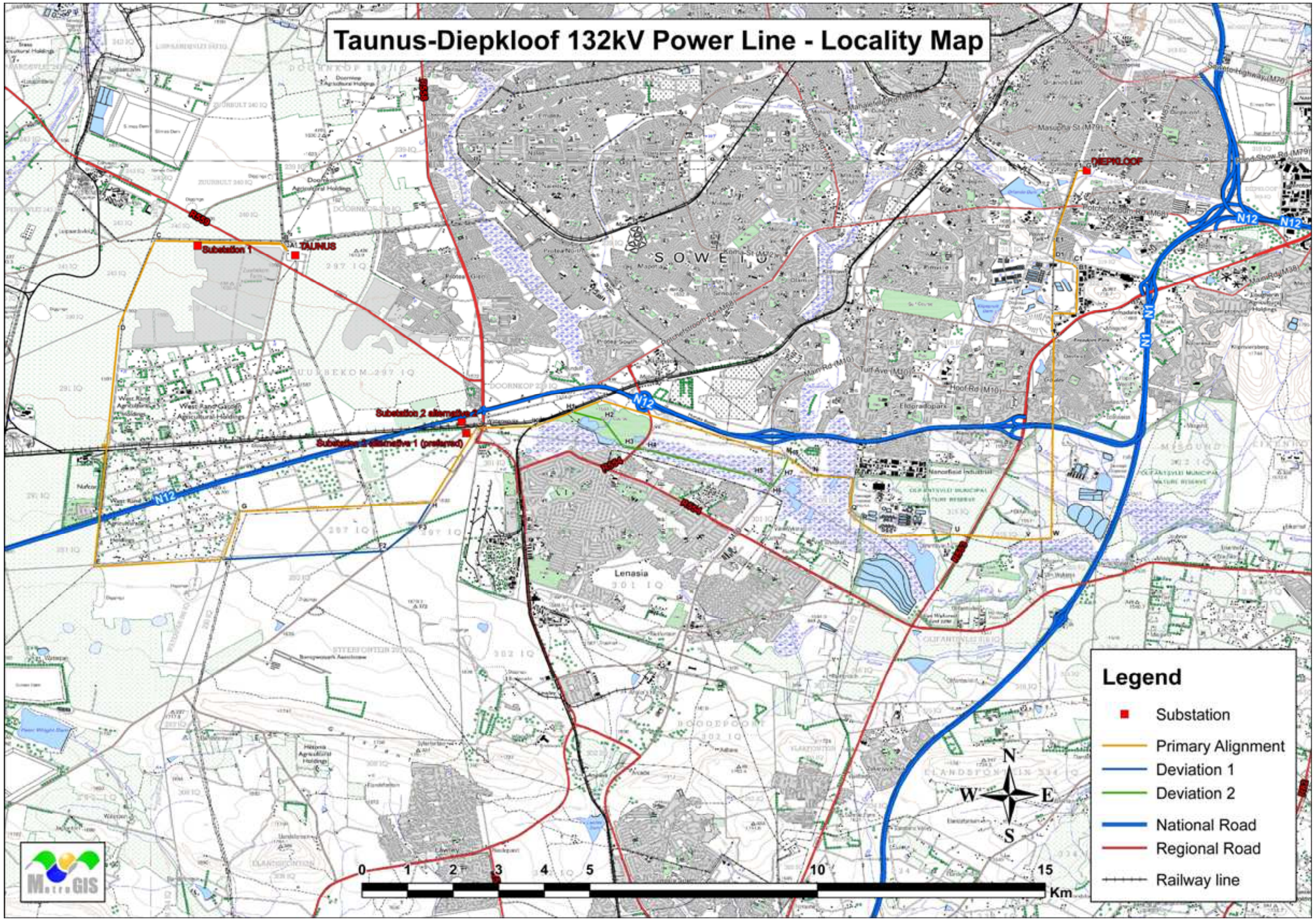


Figure 1: Location of the study site relative to regional hydrology

1.4 Description of the Receiving Environment

The proposed alignment intersects vegetation units classified at a regional scale and includes Carletonville Dolomite Grassland, Andesite Mountain Bushveld, and Eastern Temperate Freshwater Wetlands (Mucina & Rutherford, 2006). The Eastern Temperate Freshwater Wetlands are statutorily conserved in the two Ramsar sites, Blesbokspruit, and Seekoevlei as well as several other areas, also known for their high avifaunal diversity. However, the integrity of the Ramsar sites, as well as impacts of mining and residential densification, threaten this vegetation type. Predominant land use in the area includes formal and informal residential, open space, small holdings and commercial areas (City of Johannesburg, 2009).

The geology of the area is dominated by alluvial, aeolian, soil, gravel and other differentiated surface deposits predominantly in the area also classified as Eastern Temperate Freshwater Wetlands (DDPLG, 2002). Dolomite and chert deposits characterise the surrounding geology although large areas are described as Unconsolidated which refers to its lack of structure associated with anthropogenic disturbance such as mining. Soil forms associated with the alignment include Hutton and Rensburg soils (GDACE, 2002) Rensburg soil is associated with the wetland areas and is dark coloured and chemically fertile soil with a high clay content (Fey, 2005).

The hydrology associated with the proposed alignment and its alternatives revolves mainly around the Klipriver, Harringtonspruit, Diepkloofspruit and Baileyspruit, as well as several smaller non perrenial rivers (CDSM, 1996). Rainfall is strongly seasonal, occurring mainly in the summer. Winter frost results in vegetation reduced vegetation cover in winter. The result is that the amount of live, transpiring plant material is limited in winter. Standing dead material prevents water being lost from a wetland through evapotranspiration (Kotze *et al,* 2005). Table 1 displays hydrological parameters specifically pertinent to wetlands in Quaternary Catchment C22A. The ratio of Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) is 0.33 and 0.30 respectively. This indicates that wetlands lose more water through evapotranspiration, than they received through precipitation unless they are associated with water input from river systems. The functional assessment methodology proposed by Macfarlane *et al*, (2006) classifies the vulnerability of wetlands in this region, based on these values, as Moderately High.

Table 1: Characteristics of Quaternary Catchment C22A relevant to the assessment of wetland health. Adapted from Schultze (1997)

Catchment	MAP * (mm)	PET**(mm)	Median Annual Simulated Runoff (mm)
C22A	693.6	2123.0	39.1

* Mean Annual Precipitation

** Potential Evapotranspiration

1.5 Definitions

In a South African legal context, the term *watercourse* is often used rather than the terms *wetland*, or *river*. The National Water Act (NWA) (1998) includes *wetland*s and *rivers* into the definition of the term *watercourse* in the following definition.

Watercourse means:

a) A river or spring;
b) A natural channel in which water flows regularly or intermittently;
c) A wetland, lake or dam into which, or from which, water flows, and
d) Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Riparian habitat is the accepted indicator used to delineate the extent of a river's footprint (DWAF, 2005). The National Water Act, 1998 (Act No. 36 of 1998), defines a riparian habitat 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.".

In contrast, the National Water Act, 1998 (Act 36 of 1998) 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."

2 RESULTS

2.1 Classification

Wetland classification in South Africa has received academic attention during the past thirty years. However, there is to date no nationally accepted standard classification system (Ewart-Smith *et al,* 2006).

Differential weathering of geological formations may create steep slopes with shallow soils. In this instance, water is expected to flow in well defined channels at a high velocity. These conditions are conducive to the deposition of alluvial soils and the formation of channelled valley bottom wetlands and rivers. Where gentle slopes allow sediments to be accumulated and vegetation attenuates water flow velocity, waterlogging may occur. This in turn, leads to the formation of anaerobic conditions in the soil and unchannelled wetlands and floodplains are often the result. The reasoning follows that wetlands (particularly valley bottom wetlands) are most likely to occur at the lowest point of gravity in the landscape.

The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification (Ewart-Smith *et al*, 2006). 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 Ewart-Smith *et al* (2006). HGM units take into consideration factors that determine the nature of water movement into, through and out of the wetland system. HGM units encompass three key elements (Kotze *et al*, 2005):

(1) 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);

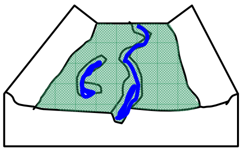
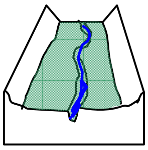
(2) Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and

(3) Hydrodynamics - This refers to how water moves through the wetland.

Datasets that closely correspond to wetlands delineated in the current study (such as rivers recorded by the Chief Directorate Surveys and Mapping, 1996) classify hydrological features according to their seasonality, namely perennial and non-perennial rivers. The current study classifies wetlands based on their HGM attributes. These two classification systems should not be confused or used interchangeably. Table 2 presents the criteria for classification for each of the hydro-geomorphic units identified in this report.

Six wetlands areas potentially affected by the proposed powerline and its alternative are classified in the current study as channelled valley bottom wetlands and a floodplain. Figure 2 provides an overview of the relative location of the wetland areas.

Table 2: Classification of wetland and riparian areas used in this study (Kotze *et al*, 2005)

Hydro-geomorphic types	Description
Floodplain 	Valley bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley bottom with a channel 	Valley bottom areas with a well defined stream channel lack characteristic floodplain features. The may be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.

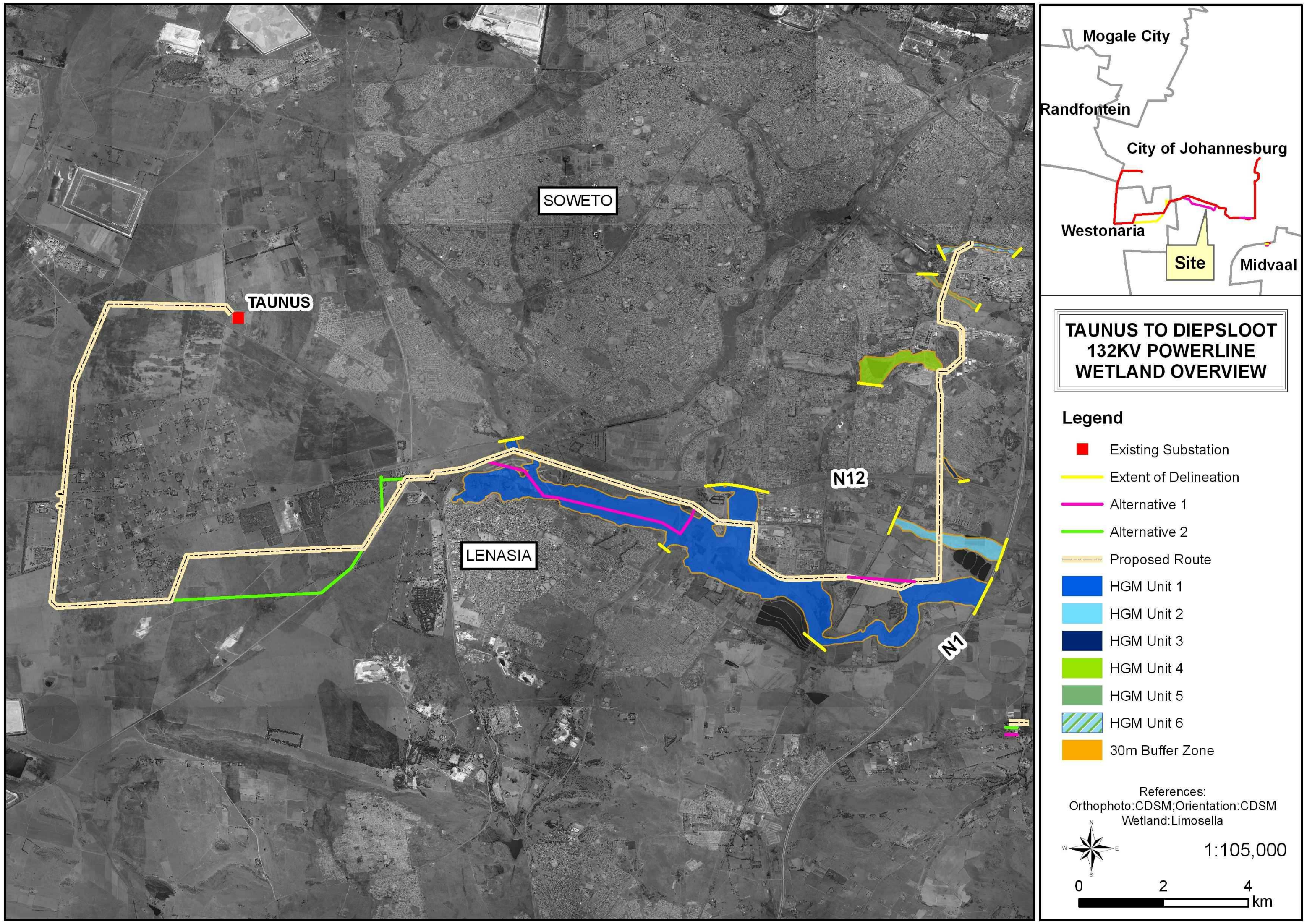


Figure 2: An overview of the relative location of wetland and riparian areas delineated in the current study

2.2 Functional Assessment

Wetland functionality is defined as a measure of the deviation of wetland structure and function from its natural reference condition. In the current assessment the hydrological, geomorphological and vegetation integrity was assessed for each HGM unit to provide a Present Ecological Status (PES) score (Macfarlane *et al*, 2007). Table 3 provides a summary of the location, impacts and PES scores for each HGM unit. Table 4 provides descriptions for each PES score in accordance with the DWAF (2007) classification.

Table 3: A summary of the important features of each HGM unit, including the point at which it intersects with the powerline as well as its ecological status according to Macfarlane *et al* (2007)

HGM Unit	Approximate intersection with the powerline	Classification	Description	Impacts	Ecostatus
1	S 26º 18' 33.44" and E 27º 51' 34.54"	Floodplain	*Phragmites australis* dominated reed stands associated with the Klipriver, plays an important role in water quality improvement, stormwater attenuation, may contain peat	Regionally impacted by pollution from mining and sewage, further impacted by altered hydrology and sedimentation	D
2	S 26º 18' 57.11" and E 27º 55' 44.77"	Valley bottom with a channel	Canalised wetland with loss of temporary and seasonal wetland zone, characterised by grass and sedge species. Associated with the Harringtonspruit	Increased stormwater flows enhance canalisation and erosion, loss of wetland function, sedimentation and pollutant input	E
3	S 26º 18' 3.50" and E 27º 55' 49.17"	Valley bottom with a channel	Canalised wetland with with loss of temporary and seasonal wetland zone	Impacted by the N12 road, polluted by littering and sewage input. Erosion and sedimentation	E
4	S 26º 16' 39.44" and E 27º 55' 6.11"	Valley bottom with a channel	Associated with the Harringtonspruit, large areas of open water created by a dam wall	Altered hydrology through dams and road crossings. Township areas further impact on water quality and ecological integrity	F
5	S 26º 15' 48.51" and E 27º 55' 49.31"	Valley bottom with a channel	Associated with the Diepkloofspruit, canalisation has lead to the loss of temporary and seasonal wetland zones	Dominant impacts appear to be sediment and pollutant input from the adjacent township. Possible gully erosion should be verified	F

6	S 26º 15' 12.32" and E 27º 56' 12.03"	Valley bottom with a channel	Associated with the Bayleyspruit, canalisation has lead to the loss of temporary and seasonal wetland zones	Dominant impacts appear to be sediment and pollutant input from the adjacent township. Possible gully erosion should be verified	F

Table 4: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*, 2007)

DESCRIPTION	HEALTH CATEGORY
Unmodified, natural.	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	F

3 IMPACTS AND MITIGATION

A development has several impacts on the surrounding environment and particularly on a wetland or a river. The development changes habitats, the ecological environment, infiltration rates, amount of runoff and runoff intensity of stormwater, and therefore the hydrological regime of the site including the watercourse. A range of management measures are available to address threats posed to water resources. These management measures are subject primarily to the available budget and the nature of the disturbance. In the context of the proposed powerline, the mitigation measures proposed below are intended to prevent further degradation to the wetland as a result of the construction of the powerline. It is important to note that this section aims to highlight areas of concern (Table 5). The details of the mitigation measures that are finally put in place should ideally be based on these issues, but must necessarily take into consideration the physical and economical feasibility of mitigation. 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.

Table 5: Impacts and suggested management procedures relevant to the proposed development (modified from Macfarlane *et al*, 2010)

Threat	Source of the threat	Primary Management Procedure
Changing the quantity and fluctuation properties of the watercourse	• Development within water resources • Invasion by woody alien invasive plants • Discharges into the water resource • Impeding features redirecting flows • Alteration of surface characteristics (roughness)	• Control of activities directly impacting on water resources • Rehabilitation / restoration of indigenous vegetative cover • Management of on-site water use • Management of point discharges • Alien plant control activities
Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount)	• Bulk earthwork activities • Disturbance of soil surface • Disturbance of slopes through creation of roads and tracks • Poor land management • Changes in runoff characteristics • Artificial infilling (affecting water distribution) • Erosion (e.g. gully formation, bank collapse)	• Implementation of best management practices o Roads and associated drainage o Earthwork activities • Source-directed controls • Buffer zones to trap sediments • Active rehabilitation
Alteration of water quality – increasing the amounts of nutrients (phosphate, nitrite, nitrate)	• Disposal or discharge of human (including partially treated and untreated) sewage during the construction phase of the development	• Provision of adequate sanitation facilities located outside of the wetland/riparian area or its associated buffer zone • Establishment of buffer zones to reduce nutrient inputs in diffuse flow • Implementation of appropriate stormwater management around the excavation to prevent the ingress of run-off into the excavation.

Alteration of water quality – toxic contaminants (including toxic metal ions (e.g. copper, lead, zinc) and hydrocarbons	• Runoff from road surfaces • Discharge of solvents, and other industrial chemicals	• Maintenance of construction vehicles • Control of waste discharges • Guidelines for implementing Clean Technologies • Maintenance of buffer zones (especially wooded areas) to trap sediments with associated toxins
Changing the physical structure within a water resource (habitat)	• Encroachment to achieve maximum commercial returns • Loss of fringing vegetation and erosion • Alteration in natural fire regimes • Shading of natural vegetation	• Delineation and protection of water resource • Establishment of buffer zones to limit disturbance • Weed control in buffer zone

3.1 Recommended Buffer Zone

Local government policies require that protective wetland 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 guidance on appropriate defensible buffer zones, there is no current standard other than the generic recommendation of 30m for wetlands inside the urban edge. Given the nature of the potential impacts of the proposed development, a generic 30m buffer zone is considered suitable for the wetlands and rivers that intersect the proposed alignments. It may not be economically or physically feasible for powerline infrastructure to be excluded from the wetlands and their associated buffers. Therefore these areas should be considered as highly sensitive and where these areas cannot be avoided, alternative mitigation measures should be put into place in order to prevent degradation of the wetland as discussed in the section above. Figure 3 shows the wetland areas together with their associated proposed buffer zones.

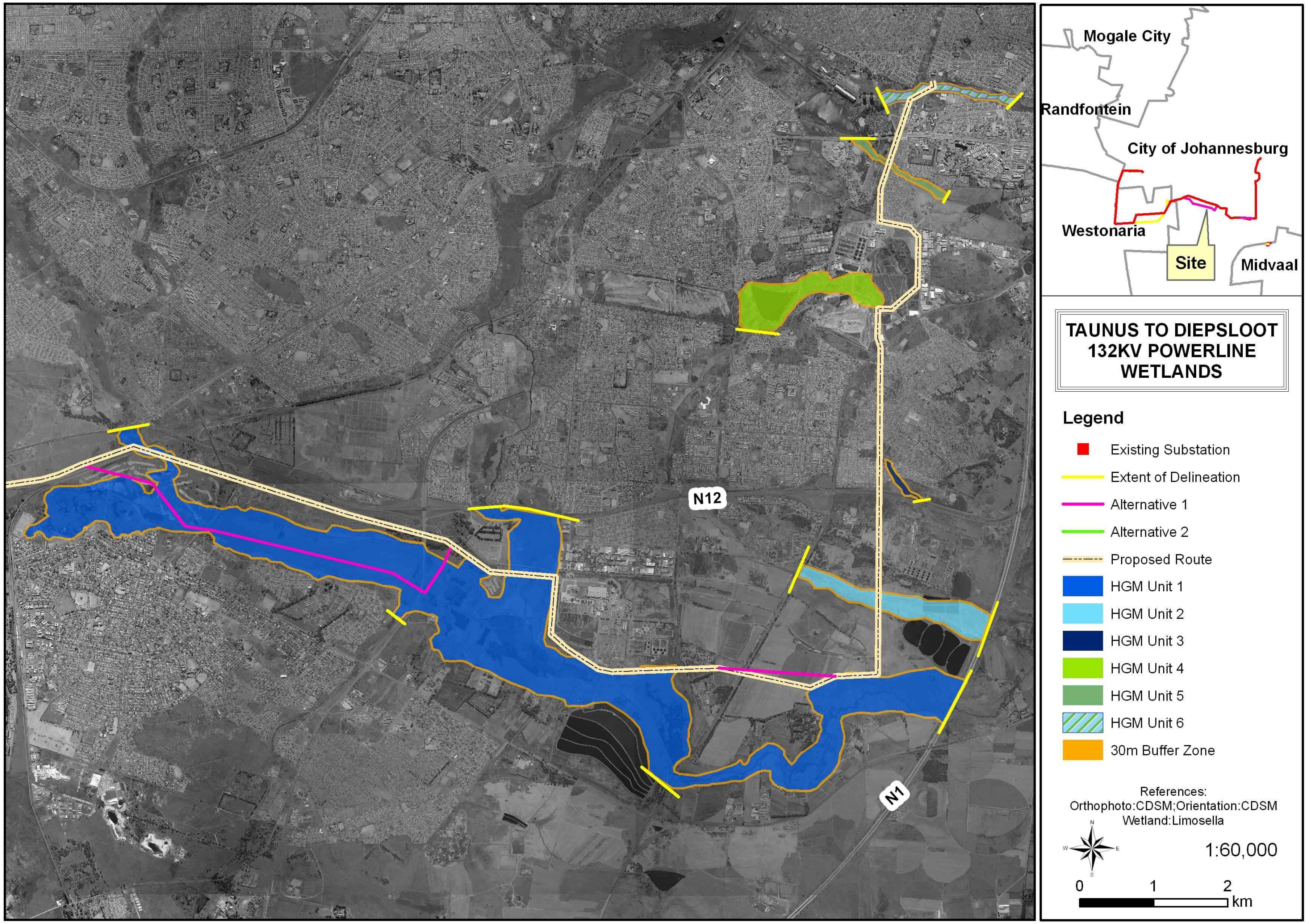


Figure 3: Wetland HGM units with their buffer zones

4 CONCLUSION

Six wetland areas were found to intersect with the proposed powerline between the proposed Taunus substation and the existing Diepkloof substation. No wetland or riparian areas were recorded in close proximity to the new substations. The current assessment finds that a 30m buffer zone should be recognised from the edge of the wetlands areas.

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5 REFERENCES

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.

City of Johannesburg (2009). Audit of wetlands within the City of Johannesburg. City of Johannesburg, Environmental Management Division

Department of Development Planning & Local Government (2002) Geotechnical suitability study of vacant land in Gauteng Province. Johannesburg: DDPLG.

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

Department of Water Affairs (2007). Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types by M. Rountree (ed); C.P Todd, C. J. Kleynhans, A. L. Batchelor, M. D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. and G.C. Marneweck. Report no. N/0000/00/WEI/0407. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

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

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

Gauteng Department of Agriculture, Conservation & Environment (2009) GDACE Minimum Requirements for Biodiversity Assessments Version 2. Directorate Nature Conservation, Johannesburg

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

KwaZulu Natal Department of Agriculture and Environmental Affairs: Chief Directorate Environmental Management (2002). Interim Guidelines for Development Activities that may Affect Wetlands

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

Macfarlane DM, Kotze DC, Ellery WN, Walters D, Koopman V, Goodman P and Goge C. (2007). WET-Health: A technique for rapidly assessing wetland health. WRC Report No TT 340/08, Water Research Commission, Pretoria.

Marneweck G C, and Batchelor A L, (2002). Wetland classification, mapping and inventory. In: PALMER R W, TURPIE J, MARNEWECK G C, and BATCHELOR A L. Ecological and economic evaluation of wetlands in the upper Olifants River Catchment, South Africa. WRC Report No. 1162/1/02. Water Research Commission, Pretoria.

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

National Department of Agriculture (2002): Final Report to Directorate Agricultural Land Resource Management. Development and application of a land capability classification system for South Africa. (Report GW/A/2000/57 of the Agricultural Research Commission - Institute for Soil, Climate and Water). Pretoria: ARC.

Appendix A: Methodology

The wetland identification method documented by the Department of Water affairs and Forestry in their document “A practical field procedure for identification and delineation of wetlands and riparian areas” (DWAF, 2005) was followed throughout the field survey. This guideline describes the use of indicators to determine the outer edge of the wetland such as soil and vegetation forms as well as the terrain unit indicator.

A hand held GPSmap 76CSx was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and georeferenced 1:10 000 ortho-rectified digital aerial photos were used as reference material.

WET-Health (Macfarlane *et al*, 2007) was used to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function from its natural reference condition. This technique aims to assess hydrological, geomorphological and vegetation health and is suitable for the functional assessment of floodplain, channelled and unchannelled valley bottom, seepage wetlands and pans. It is a modular approach that uses:

- An impact-based approach for those activities that do not produce clearly visible responses in wetland structure and function. The impact of irrigation or aforestation in the catchment, for example, produces invisible impacts on water inputs. This is the main approach used in the hydrological assessment.
- An indicator-based approach for activities that produce clearly visible responses in wetland structure and function such as the presence of gullies or alien species. This approach is mainly used in the assessment of geomorphological and vegetation health.

Each of these modules follows a broadly similar approach that examines extent, intensity and magnitude of impact. This is translated into a health score that is compatible with the standard DWAF A-F ecological categories. The approach is as follows:

- The extent of impact is measured as the proportion of a wetland and/or its catchment that is affected by an activity. Extent is expressed as a percentage.
- The intensity of impact is estimated by evaluating the degree of alteration that results from a given activity.
- The magnitude of impact for individual activities is the area-weighted product of extent and intensity.
- The magnitude of individual activities are combined in a structured and transparent way to calculate the overall impact of all activities that affect hydrology, geomorphology or vegetation.
- The overall magnitude of impact is then translated into an estimate of wetland health for hydrology, geomorphology or vegetation.

Appendix B: Glossary of Terms

Anaerobic	not having molecular oxygen (O_2) present
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
Gley	soil material that has developed under anaerobic conditions as a result of prolonged saturation with water. Grey and sometimes blue or green colours predominate but mottles (yellow, red, brown and black) may be present and indicate localised areas of better aeration
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)
Mottles	soils with variegated colour patters are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles
Seepage	A type of wetland occurring on slopes, usually characterised by diffuse (i.e. unchannelled, and often subsurface) flows
Perched water table	the upper limit of a zone of saturation in soil, separated by a relatively impermeable unsaturated zone from the main body of groundwater
Permanently wet soil	soil which is flooded or waterlogged to the soil surface throughout the year, in most years
Sedges	Grass-like plants belonging to the family Cyperaceae, sometimes referred to as nutgrasses. Papyrus is a member of this family.
Soil horizons	layers of soil that have fairly uniform characteristics and have developed through pedogenic processes; they are bound by air, hard rock or other horizons (i.e. soil material that has different characteristics).
Soil profile	the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991)
Soil saturation	the soil is considered saturated if the water table or capillary fringe reaches the soil surface
Temporarily wet soil	The soil close to the soil surface (i.e. within 50 cm) is wet for periods > 2 weeks during the wet season in most years. However, it is seldom flooded or saturated at the surface for longer than a month.
Temporary zone of wetness	the outer zone of a wetland characterised by saturation within 50cm of the soil surface for less than three months in a year
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 C: Abridged Curriculum Vitae of the Specialist

Name:	**ANTOINETTE BOOTSMA nee van Wyk**
Name of Company:	Limosella Consulting
Position:	Wetland Specialist
SACNASP Status:	Professional Natural Scientist # 400222-09

EDUCATIONAL QUALIFICATIONS

- B. Sc (Botany & Zoology), University of South Africa (1997 - 2001)
- B. Sc (Hons) Botany, University of Pretoria (2003-2005)
- Short course in wetland delineation, legislation and rehabilitation, University of Pretoria (2007)
- Short course in Wetland Soils, Terrasoil Science, (2009)

KEY QUALIFICATIONS

- **Principal Specialist**

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

  - Reviewing of specialist reports as part of a Quality Management System, including faunal and floral assessments, aquatic, wetland and rehabilitation reports;
  - Riparian Management Plan for Mixed-Use developments in Kagiso, Gauteng. August 2009;
  - Rehabilitation Plan for the wetland associated with Heroes Bridge in Soweto. Technical investigation as well as management of a team of specialist, integration of information into a final report. The technical investigation for this project also included an investigation into the occurrence of Red Data vegetation. June 2009;
  - Input into the wetland component of the Green Star SA rating system. April 2009;
  - Strategic analysis of wetlands in Thohyandou in conjunction with a strategic vegetation assessment of the area, March 2009;
  - Strategic analysis of wetlands in Gauteng for the GDACE Regional Management Framework, August 2008;

- Successful completion of 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. July 2008.

- **Wetland Ecology**

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

- Project manager. More than 50 fine scale wetland and ecological assessments in Gauteng, Mpumalanga, KwaZulu Natal, Limpopo and the Western Cape. Liaison with clients, internal and external specialists assigned to projects including billing. April 2007, ongoing.
- Quality Review. Reviewing of specialist studies in the context of scientific defensibility, accuracy of data transfer and the correct use of language and grammar. April 2007, ongoing.
- Wetland specialist. 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, ongoing.
- Wetland specialist. A strategic assessment of wetlands in Gauteng to inform the GDACE Regional Environmental Management Framework. June 2008.
- Wetland specialist. 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.
- Wetland specialist. 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.
- Ecologist. 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

- **Conservation ecology**

The implementation and management of projects related to long and short term studies on impacts and rehabilitation in a mining environment.

- Principal investigator. Species assemblages in the woody vegetation communities of coastal dune forests between the Umfolozi and Umlalazi rivers. This relates to colonisation trends across disturbance and rehabilitation age gradients, including aspects such as seed ecology and phenology. 2006/7

- Principal investigator. Biodiversity of the coastal dune forests and associated habitats in Richards Bay, particularly on the epiphytic orchids and ferns found on the mineral lease area of Richards Bay Minerals. 2006
- Technical assistant. Biodiversity of the coastal dune forests and associated habitats in Richards Bay, particularly on the herpetofauna found on the mineral lease area of Richards Bay Minerals. 2006
- Principal investigator. Baseline vegetation, and topsoil maps for Richards Bay Minerals' Zulti South lease area. 2005/6
- Technical assistant. A species list of woody and herbaceous plants of the Sekhukhune area. 2005
- Principal investigator. A phytosociological study of vegetation associated with the wetlands of Lake Chrissie, Mpumalanga. 2004