Environmental Scoping Report for the Proposed Expansion of the Pietermaritzburg Airport

APPENDIX 4
DRAFT WETLAND ASSESSMENT REPORT
August 2011

Institute of Natural Resources

INR Report No.

Environmental Scoping Report for the Proposed Expansion of the Pietermaritzburg Airport

APPENDIX 3:

DRAFT WETLAND ASSESSMENT REPORT

Prepared for

CITY OF CHOICE

PIETERMARITZBURG
MSUNDUZI

Prepared by

Institute of Natural Resources NPC

P.O. Box 100396, Scottsville, 3209

Tel: +27 33 3460 796, Fax: +27 33 3460895, info@inr.org.za

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LIST OF ACRONYMS

DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EKZNW	Ezemvelo KwaZulu-Natal Wildlife
EIA	Environmental Impact Assessment
GIS	Global Information System
GPS	Global Positioning System
HGM	Hydro-geomorphic
INR	Institute of Natural Resources
NEMA	National Environmental Management Act
NWA	National Water Act
PES	Present Ecological State
WGS	World Geodetic System

1. INTRODUCTION

The Msunduzi Municipality owns and manages the Oribi Airport which is located on the outskirts of Pietermaritzburg. They have proposed the expansion of the airport precinct, which is estimated at approximately 140ha and which potentially could include:

- The extension of the runway to accommodate larger aircraft; and
- The construction of support infrastructure and the development and sale of land within the precinct for retail purposes.

Several of these activities require environmental authorisation in terms of the Environmental Impact Assessment (EIA) regulations promulgated in terms of Section 24 (5) of the National Environmental Management Act (NEMA), including Activity 15 of GNR 545 for which scoping and environmental impact assessments are required. Specialist information is required to inform the EIA process, which includes a wetland assessment. In addition to informing the EIA process the wetland assessment will also inform the review of the 1996 Master Plan for the Oribi Airport, which is being undertaken at the same time (the review is however a separate process to the EIA). The wetland assessment will initially provide specialist input into the planning process and once detailed plans have been finalized the findings from the assessment will then be taken into consideration for the EIA process.

2. TERMS OF REFERENCE

The following scope of work was required to be carried out to inform the review of the Master Plan for Oribi Airport and the EIA process for the proposed developments:

- The delineation of the wetland zones (i.e. temporary, seasonal and permanent zones) of all wetlands identified on site;
- A WET-Health Assessment (level 2);
- A WET-Ecoservices Assessment (level 2); and
- The provision of recommendations regarding appropriate buffers for all identified wetlands.

The primary objective for the wetland assessment is to provide specialist input into the planning process. Once detailed plans are available the assessment of potential impacts on wetlands will be undertaken (i.e. the EIA process).

3. THE STUDY AREA

A broad study area was identified based on Msunduzi Municipality owned land, the outdated Master Plan and the need for approximately 140ha for the proposed developments. The study area is situated predominately to the north of Gladys Manzi Road (there is a small portion to the south of the road that falls within the University of KwaZulu-Natal's Ukulinga Research Farm) and south of Oribi Road. The demarked study area, as illustrated in Figure 1, allowed for the assessment of wetlands in the general vicinity of the existing airport infrastructure, which insured that all areas of concern would be taken into consideration for the review of the Master Plan and the EIA process.

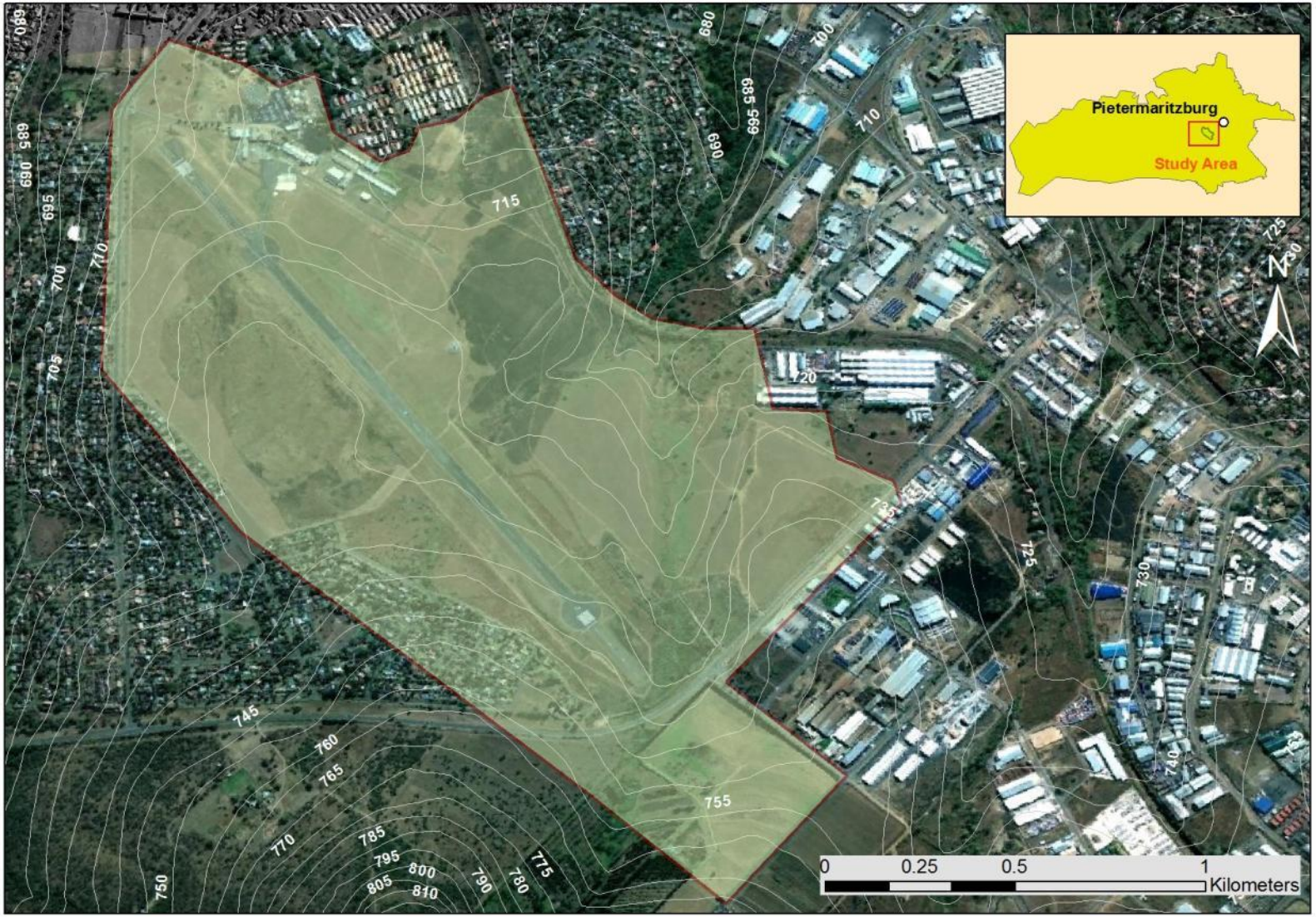


Figure 1: Study Area

4. METHODOLOGY

A field investigation was undertaken on the 28th of July and the 1st of August 2011, in order to confirm and delineate the presence of wetland habitats within the demarcated study area, and undertake functional (WET-Health) and ecosystem services assessments (WET-Ecoservices) on the relevant wetlands. Prior to the field investigation ortho photographs, 1:50 000 topographical maps, 5m contours and Google imagery were used as reference material to identify the presence of potential wetlands. These data sources were also used to demarcated the catchments of the wetlands and identify relevant activities / conditions within them.

Methods used in the assessment of wetland resources included:

4.1. Wetland delineation and mapping

For the purposes of this assessment, wetlands are considered as those ecosystems defined by the National Water Act (No 36 of 1998) as:

"land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or land that is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typical of life in saturated soil."

Furthermore, wetlands must have one or more of the following attributes (Figure 2):

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;
- The presence, at least occasionally, of water loving plants (hydrophytes); and
- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil (DWAF, 2005).

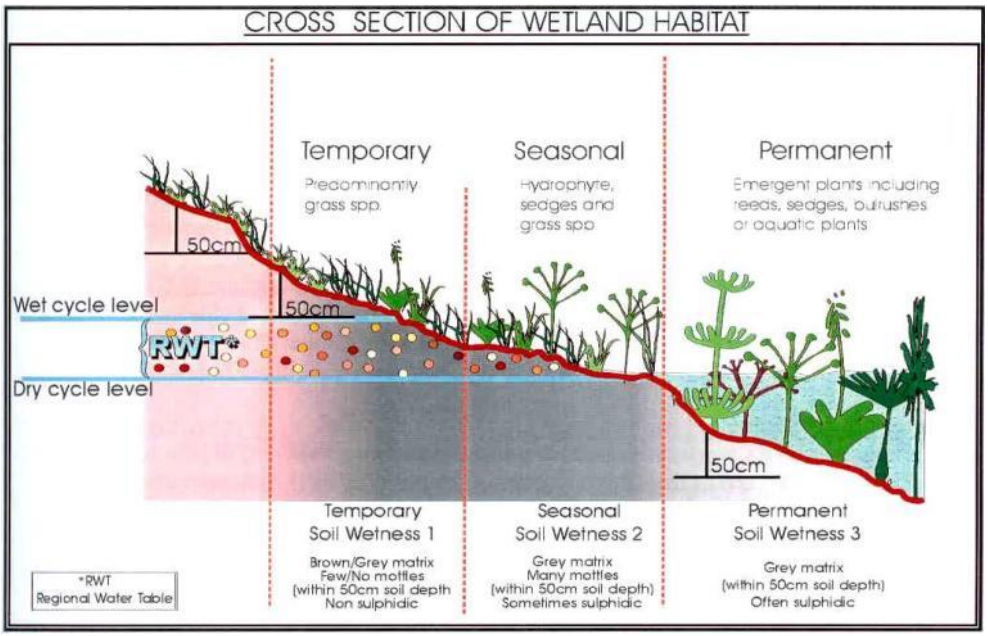


Figure 2: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland (Kotze, 1996; DWAF, 2005)

The outer wetland boundary was delineated according to 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005). This involved the on-site assessment of wetland indicators, with a primary focus on wetland vegetation and soil wetness indicators. The latter was determined through soil sampling with an auger to differentiate between permanent, seasonal, temporary and non-wetland soils. Sampling points were recorded with a Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing. Aerial photography, field notes and mapped sampling sites were then used in combination to estimate and map the extent of wetland zone.

It should be noted that the wetness zones within wetlands were identified and classified along a gradient that makes it difficult to identify the exact boundary of each zone. The boundaries mapped in this specialist report therefore represent the approximate zonation of these wetlands as evaluated by an assessor familiar and practiced in the delineation technique.

Each of the wetlands on site were traversed on foot along transect lines. Soil samples, within the top 50cm of the soil profile, were taken using a hand auger at random intervals along the transect lines and assessed for wetland characteristics. Each auger point sampled was marked with a handheld Global Positioning System (GPS) device (GPSMAP60CX), which has an accuracy of between 3 to 5m.

Mapping of the wetlands was carried out using ArcGIS 9 (the coordinates of sampling sites were recorded as geographic projections, WGS 84 Datum). Mapping was based on the field data collected,

and the interpretation of aerial photography and Google imagery of the route. Soil and vegetation change indicated the interface between wetlands and non-wetlands. These boundaries were then extrapolated to follow local contours.

4.2. Wetland Classification

A draft wetland classification system was developed for the WRC in 2006 (Ewart-Smith, *et al*, 2006). This system is currently under review but is near completion, with a draft revision of the classification system has been submitted to SANBI for review (SANBI, 2009). Given that this is the classification likely to be adopted for the National Wetland Inventory, this is the system that was used to inform wetland classification in this study. It was developed subsequent to the identification of HGM types supporting inland wetlands in South Africa (modified from Brinson, 1993; Kotze, 1999; and Marneweck and Batchelor, 2002) for the WET-Ecoservice tool (Kotze, *et al*., 2007), and is very similar. It does however, differentiate between hillslope seeps and valleyhead seeps, which is relevant for the wetlands being assessed. For the purposes of this study, wetlands have been assigned to landscape setting (Level 3) and hydrogeomorphic (HGM) unit (Level 4A) as described in Table 1.

Table 1: Wetland classification to be applied to mapped wetlands

LEVEL 3	LEVEL 4A
Landscape Setting	**HGM Type**
SLOPE	Channel (river)
	Hillslope seep
VALLEY FLOOR	Channel (river)
	Channelled valley-bottom wetland
	Unchannelled valley-bottom wetland
	Floodplain wetland
	Depression
	Valleyhead seep
PLAIN	Channel (river)
	Floodplain wetland
	Unchannelled valley-bottom wetland
	Depression
	Flat
BENCH (HILLTOP / SADDLE / SHELF)	Depression
	Flat

4.3. Wetland Present Ecological State (PES) assessment using Wet-Health

Wet-Health (Macfarlane *et al*, 2008) provides an appropriate framework for undertaking an assessment to indicate the functional importance of each of the wetland systems that will be impacted. The outcomes of the assessment also highlight specific impacts therefore highlighting issues that should be addressed through mitigation and rehabilitation interventions. This approach

relies on a combination of desktop and on-site indicators to assess various aspects of wetland condition, including:

- ***Hydrology*:** defined as the distribution and movement of water through a wetland and its soils.
- ***Geomorphology*:** defined as the distribution and retention patterns of sediment within the wetland.
- ***Vegetation*:** defined as the vegetation structural and compositional state.

Each of these modules follows a broadly similar approach and is used to evaluate the extent to which anthropogenic changes have had an impact on wetland functioning or condition. While the impacts considered vary considerably across each module, a standardized scoring system is applied to facilitate the interpretation of results (Table 2). Scores range from 0 indicating no impact to a maximum of 10 which would imply that impacts had totally destroyed the functioning of a particular component. The reader is encouraged to refer back to the tables below to help interpret the results presented in the site assessment.

Table 2: Guideline for interpreting the magnitude of impacts on wetland integrity

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. These scores are subtracted from 10 to obtain an intactness or health score for the wetland system evaluated. Resultant health scores fall into one of six health categories (A-F) on a gradient from “unmodified/natural” (Category A) to “severe/complete deviation from natural”

(Category F) as depicted in Table 3. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table 3: Health categories used by WET-Health for describing the integrity of wetlands

HEALTH CATEGORY	DESCRIPTION	RANGE
A	Unmodified, natural.	0 – 0.9
B	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
C	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
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9
E	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
F	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

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending rehabilitation measures for the impacted wetlands. The overall health rating can be interpreted as the percentage naturalness of the wetland using the following formula:

% naturalness = (10 - Overall health rating)*10

It should be noted that while Wet-Health is the most appropriate technique currently available to undertake assessments of this nature, it is nonetheless a rapid assessment tool that relies on qualitative information and expert judgment. While the tool has been subjected to an initial peer review process, the methodology is still being tested and will be refined in subsequent versions.

4.4. Wetland Ecological Services

Wetlands are specialised systems that perform ecological functions vital for human welfare and environmental sustainability. The WRC has developed a Wetland Management Series, of which WET – EcoServices is one.

The WET – EcoServices (Kotze *et al*., 2007) is a technique for rapidly assessing ecosystem services supplied by wetlands. This tool has been designed for inland palustrine wetlands, i.e. marshes, floodplains, vleis and seeps, and has been developed to help assess the goods and services that individual wetlands provide in order to allow for more informed planning and decision making.

The process of applying WET – EcoServices begins with the characterization of Hydro-geomorphic (HGM) wetland types (e.g. floodplain, hillslope seep, etc.) based primarily on interpretation of aerial photographs. Individual wetlands are then assessed either at a desktop assessment level (Level 1) or at a rapid field assessment level (Level 2) where 15 benefits are assessed. At a level 2 assessment of ecosystem services / benefits characteristics are grouped according to the effectiveness of the wetland for supplying a particular benefit, and the opportunity afforded the wetland supplying the ecosystem service (it should be noted that some 'opportunities' diminish wetland integrity - e.g. high nitrate point source).

The WET-EcoServices technique was used (where applicable) to determine the key ecological services provided by each wetland. The rapid field assessment (Level 2) approach was applied.

5. SITE ASSESSMENT

5.1. General Site Description

There are three primary wetlands within the study (Figure 3), which include:

- W1 – Disturbed Hillslope seep / Valleyhead seep linked to a stream channel;
- W2 – Disturbed Hillslope seep / Valleyhead seep linked to a stream channel; and
- W3 – Disturbed Valley bottom with a channel.

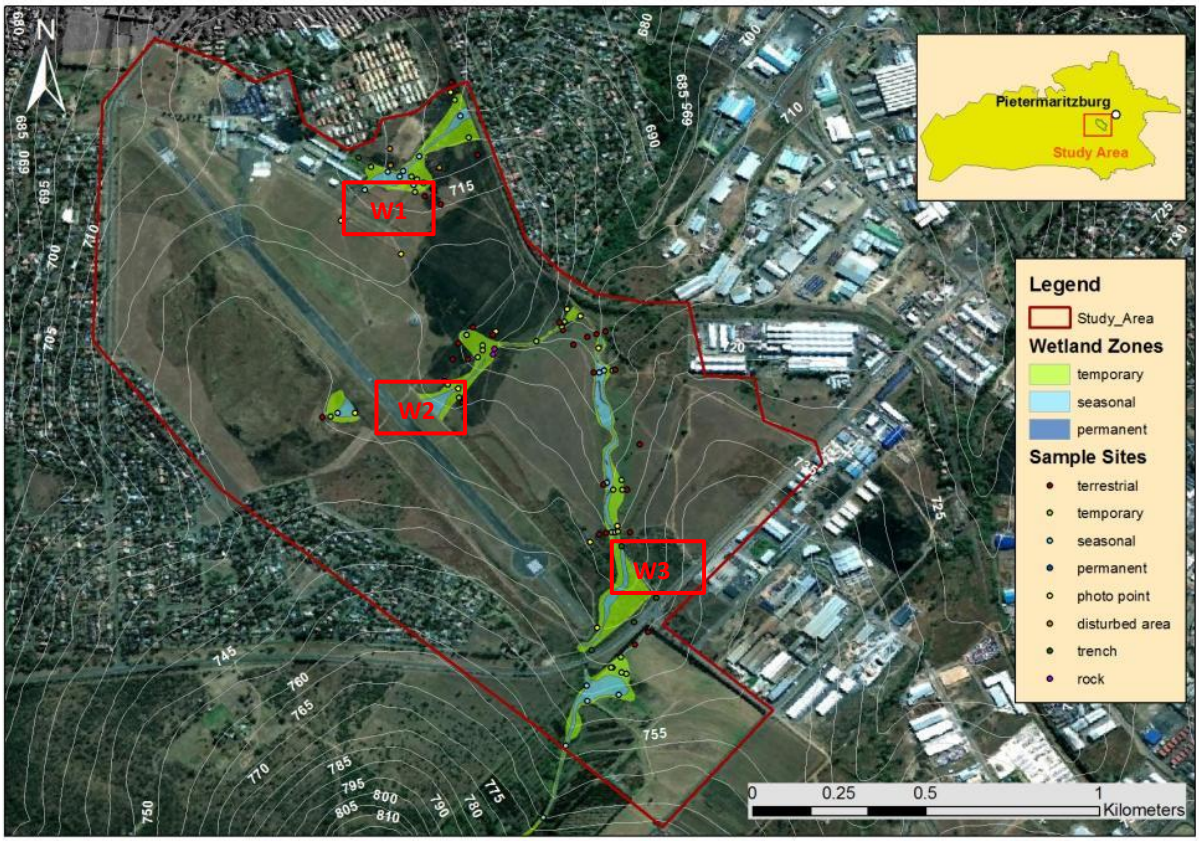


Figure 3: Wetland within the study site

All of these wetlands have extensive anthropogenic impacts, which have diminished their ecological state (some more than others but in general all three are degraded). These disturbances, which will be discussed for the individual wetlands, have played a role in shaping the wetlands that remain today. However, geological features are also playing a significant role in the functioning and shaping of the wetlands (primarily W2 and W3). Figure 4 below highlights the board underlying geological features in the area.

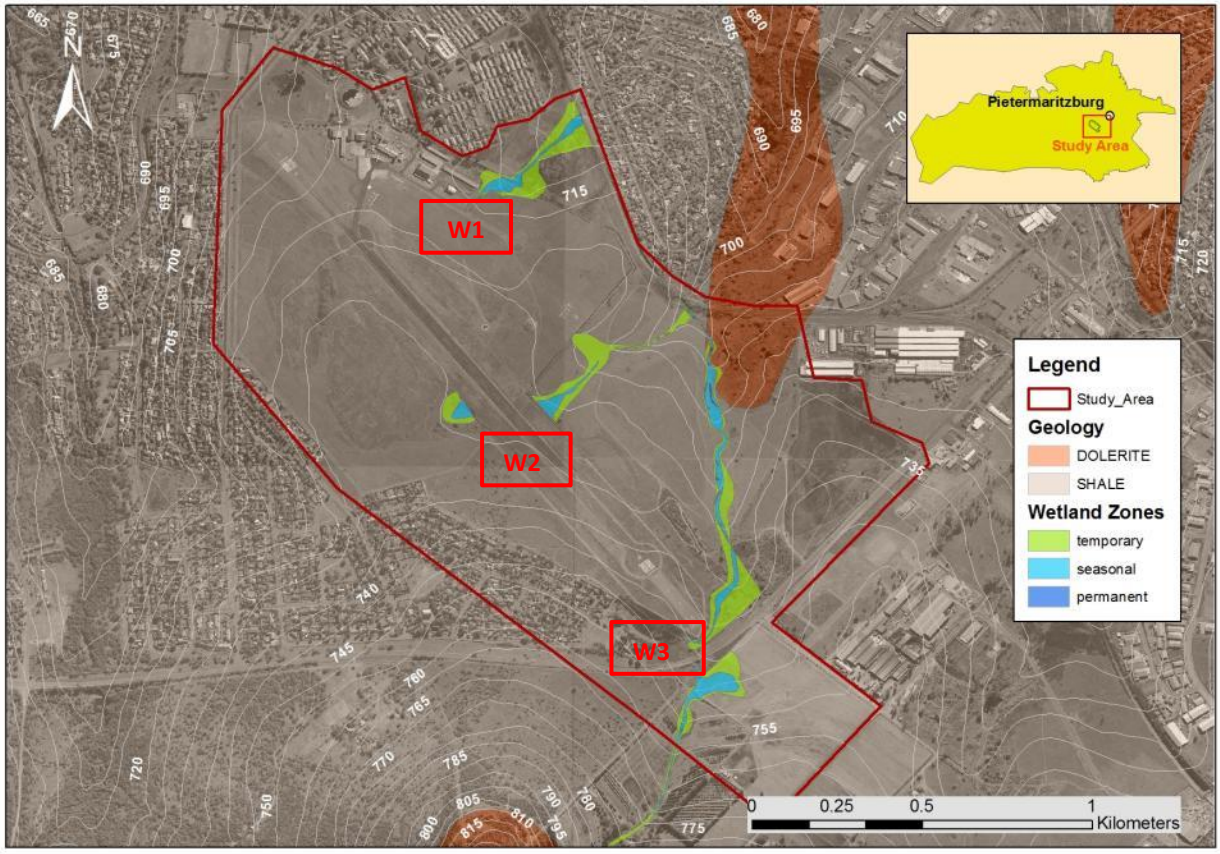


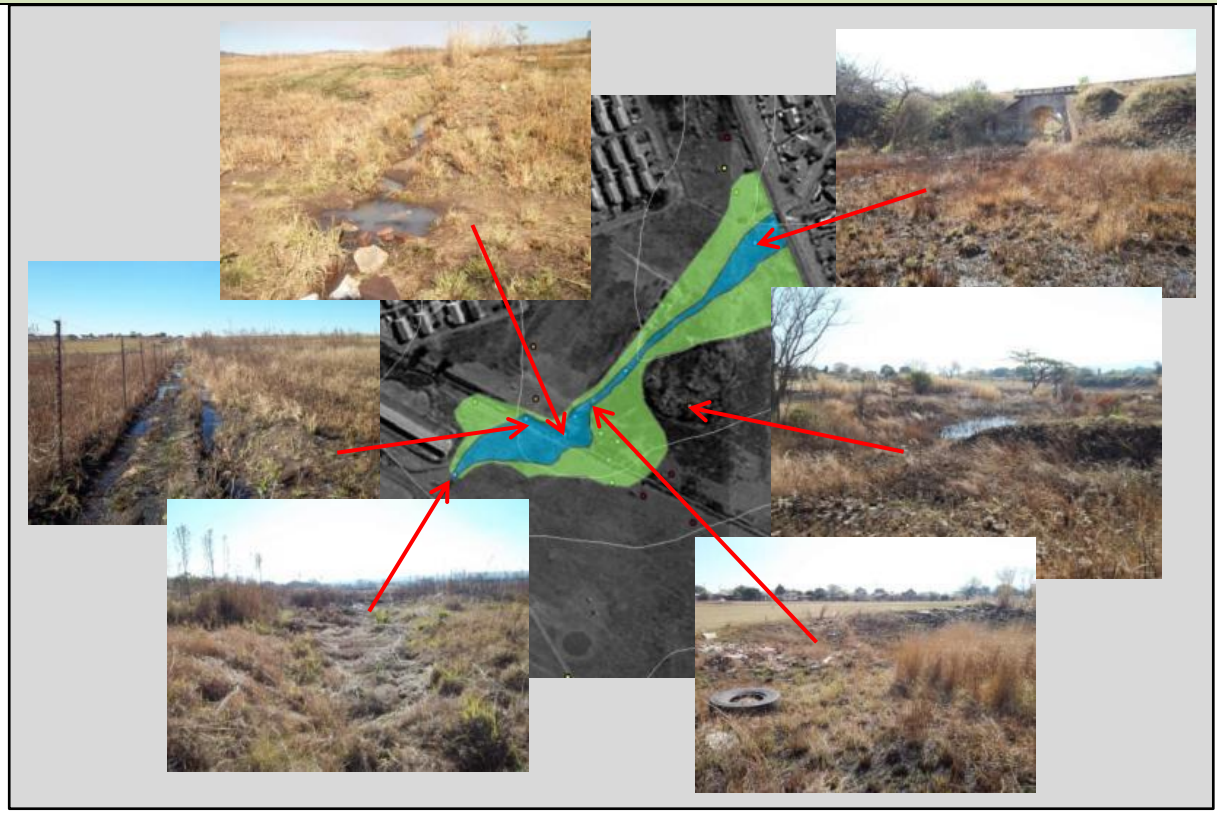
Figure 4: Geology Map

The toe of wetlands W2 and W3 are superimposed on dolerite, which in comparison to the largely shale surroundings is a much harder material and therefore more resistant to erosion. As a result the available energy is used to erode the channel systems further up the wetlands, which is likely has been the cause for the formation of gullies on both of these systems. This geological feature is enhanced by the presence of an old raised railway line directly downstream of the toe of these two wetlands, which has resulted in a 'pinch / narrowing' in the channelled system.

The individual wetlands will be described and the findings of the assessments presented in the following section (*Section 5.2*).

5.2. Wetland Delineation, Functional and Ecoservices Assessment for individual Wetlands on Site

Wetland 1	W1 – Disturbed Valleyhead / Hillslope Seep linked to a Channel

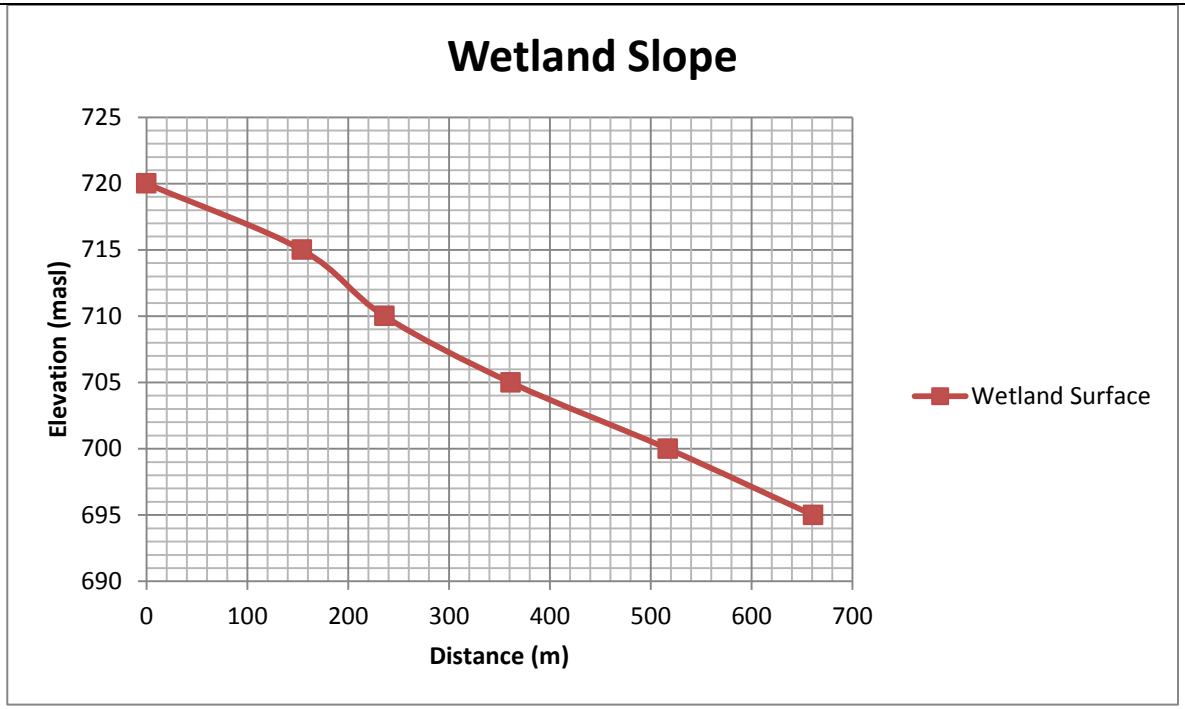


Wetland 1 is a disturbed valleyhead seepage wetland, which has been extensively transformed through anthropogenic activities, including but not limited to:

- The construction of the existing Oribi Airport infrastructure and associated infrastructure;
- Oribi village and sports fields at the village (portion of the wetland has been cleared for a soccer field);
- Fencing;
- Construction of channels / drains within the wetland to drain stormwater runoff from the airport (this includes water from the

apron and a car wash facility);

- The on-going cutting and burning of vegetation in the vicinity of the airport for safety purposes;
- The dumping of rubble and litter within the wetland;
- Alien vegetation; and
- The construction of a railway bridge, which has resulted in a 'pinch' in the wetland. It should be noted that downstream of this railway bridge is an urban area where the wetland has been largely destroyed and in some places replaced with a canal.



The slope of the wetland = 4.1%.

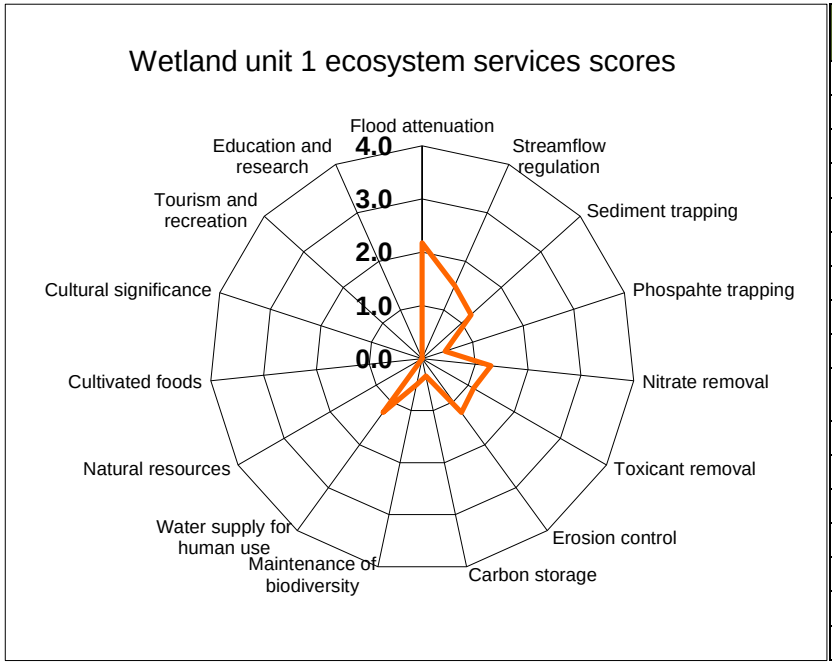
Wetland Delineation

Refer to the *Appendix* for a list of characteristics for each of the sample sites identified in the delineation map. Disturbances to the soil profile and vegetation layer restricted the accuracy of the delineation. A brief site visit will need to be conducted during optimal conditions (i.e. spring / summer) to verify the findings from this initial delineation.

Wetland Health / PES		
Indicator	**Score**	**Description**
Hydrology	9.5	Critically modified: Extensive increase in the volume of water entering the wetland through runoff from the Oribi Airport and associated infrastructure. Canalization of the wetland has resulted in an artificially modified drainage line.
Geomorphology	5.0	Largely modified: The wetland has been largely canalized to accommodate the stormwater runoff from the hardened surfaces at the existing airport. Portions of the wetland within the study site have been filled / excavated through either

		the dumping of rubble or the clearing of land for a soccer field. In addition, an old raised railway line, tracks and a fence impede the wetland.
Vegetation	7.1	Seriously modified: Vegetation is regularly burnt and / or cut reducing the surface roughness extensively (Note: The wetland was assessed after a recent burn and will be visited during spring/summer to verify the extent of the reduction in surface roughness). There were also few alien / invasive species within the wetland.
Overall Health	**7.5**	**Seriously modified**
Health Category	**E**	**The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.**
% of Naturalness	**25%**	

Ecosystem Services



Ecosystem Services	Score
Flood attenuation	2.2
Streamflow regulation	1.3
Sediment trapping	1.2
Phosphate trapping	0.5
Nitrate removal	1.3
Toxicant removal	1.1
Erosion control	1.3
Carbon storage	0.3
Maintenance of biodiversity	0.5
Water supply for human use	1.2
Natural resources	0.0
Cultivated foods	0.0
Cultural significance	0.0
Tourism and recreation	0.0
Education and research	0.0
Threats	4.0
Opportunities	0.0

Due to extensive disturbances to this wetland ecosystem services in general scored poorly. Hillslope / valleyhead seeps generally slow the movement of water through the catchment, which has a number of benefits, i.e. such as enhancing the quality of water. However, this wetland has been artificially canalized to accommodate stormwater runoff from the airport precinct. In addition the adjacent

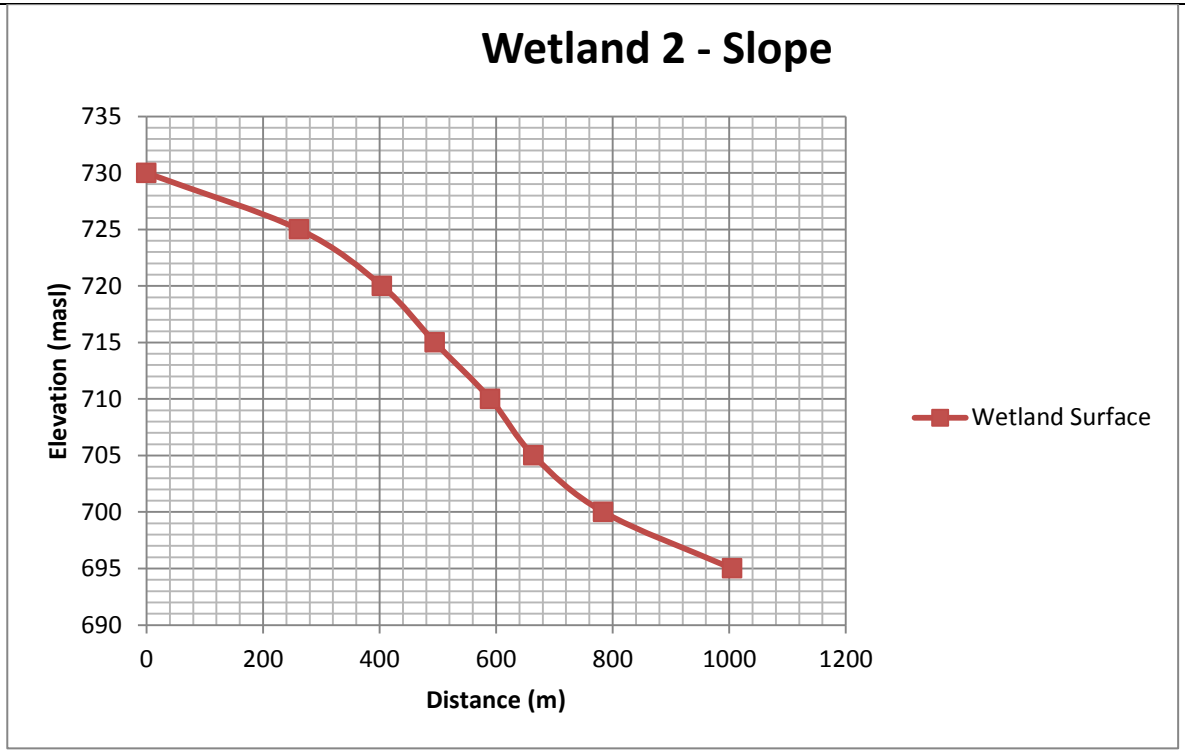
	urban area has resulted in the loss of a significant portion of the wetland, i.e. through the clearing of soil / levelling of an area for a soccer field, etc. Flood attenuation scored the highest, which is indicative of the natural functioning of a seepage wetland (particularly early in the rainy season). Limited streamflow regulation, sediment trapping, enhancing of water quality and erosion control is still provided by the small portions of remaining seepage areas (i.e. portions not canalized). Water supply for human use only scored a 'relatively' high score due to its association with streamflow regulation.

Wetland 2	**W2 – Disturbed Valleyhead / Hillslope Seep linked to a Channel**

Wetland 2 is a disturbed valleyhead / hillslope seepage wetland, which has been transformed through anthropogenic activities, including but not limited to:

- The construction of the Oribi airport runway directly through the wetland upper portion of the wetland;
- The canalization of the wetland downstream of the culverts under the runway;
- The removal of wetland soils within portions of the wetland (i.e. particularly upstream of the runway); and

- The reduction in vegetation cover through either burning and / or cutting.



The slope of the wetland = 3.8%. The reduction in the slope at an elevation of approximately 705m is indicative of the highly erosive resistant dolerite.

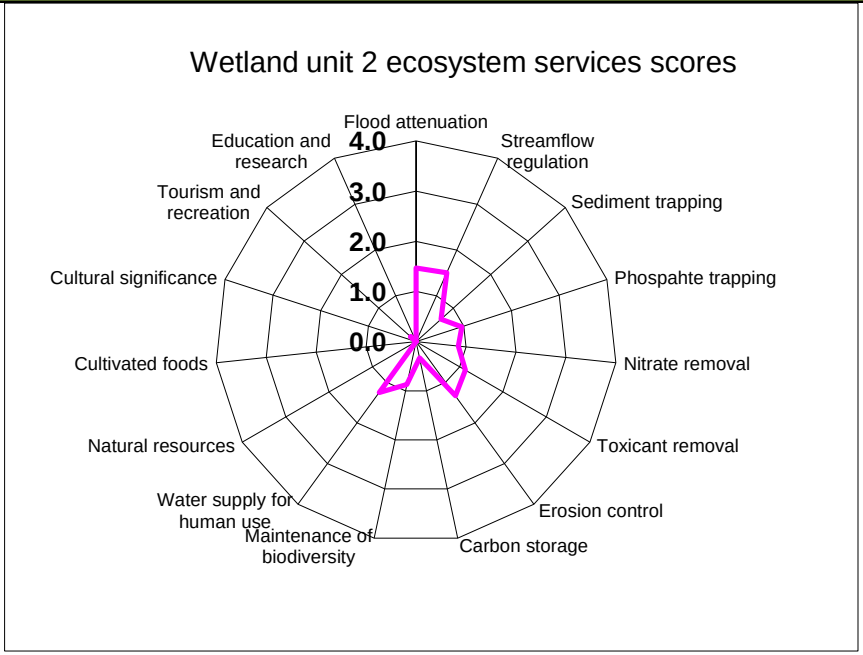
Wetland Delineation

Refer to the *Appendix* for a list of characteristics for each of the sample sites identified in the delineation map. Disturbances to the vegetation (i.e. recently burnt) restricted the accuracy of the delineation. A brief site visit will need to be conducted during optimal conditions (i.e. spring / summer) to verify the findings from this initial delineation.

Wetland Health / PES		
Indicator	**Score**	**Description**
Hydrology	7.0	Seriously modified: An increase in the volume of water entering the wetland through runoff from the runway (trenches have been dug adjacent to the runway to allow runoff to drain to the portion of wetland upstream of the runway). Canalization of the wetland has resulted in an artificially modified drainage line.

Geomorphology	4.3	Largely modified: A portion of the wetland directly downstream of the culvert under the runway has been canalized and a large area of wetland soils directly upstream of the runway have been removed (i.e. excavated). In addition to the runway cutting through the wetland, there is an old raised railway line at the toe of the wetland. Tracks and a fence also impede the wetland.
Vegetation	5.7	Largely modified: Vegetation downstream of the runway is regularly burnt and / or cut reducing the surface roughness (Note: The wetland was assessed after a recent burn, which limited the use of vegetation as a wetland indicator. The wetland will be visited during spring/summer to verify the extent of the reduction in surface roughness).
Overall health	**5.9**	**Largely modified**
Health Category	**D**	**Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.**
% of Naturalness	**41%**	

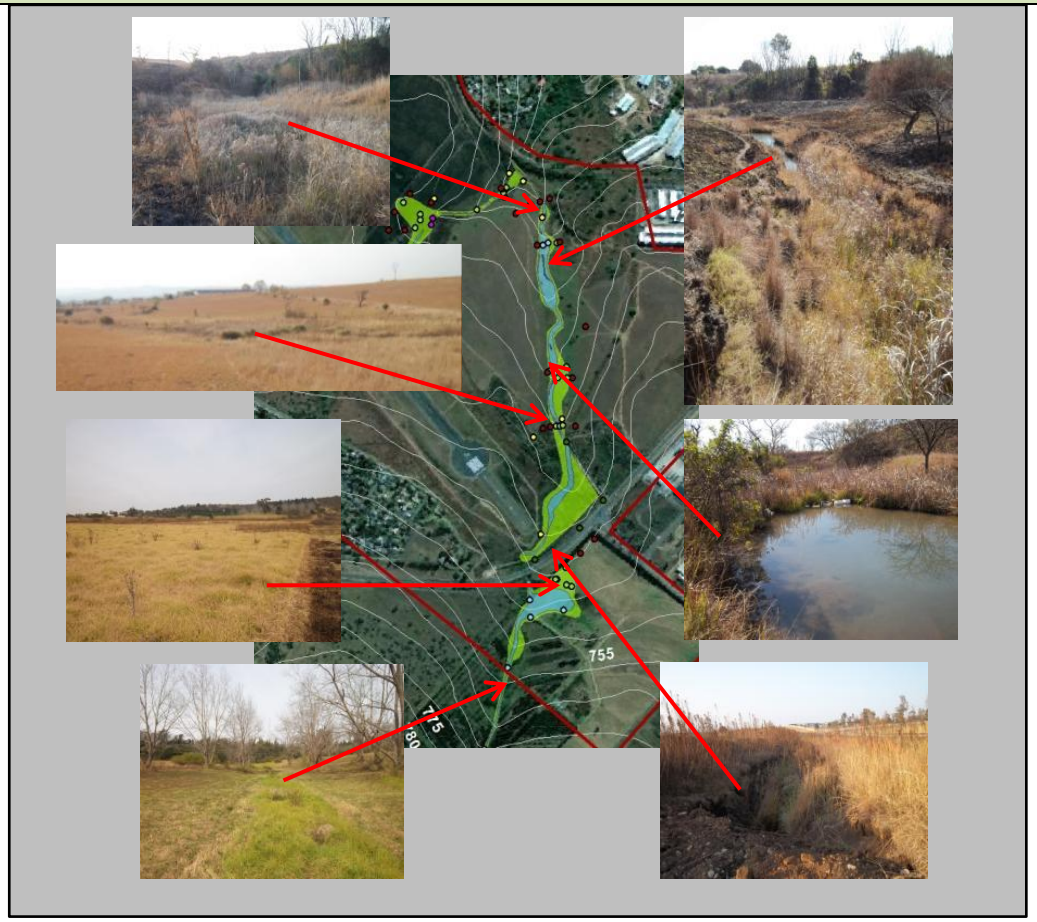
Ecosystem Services



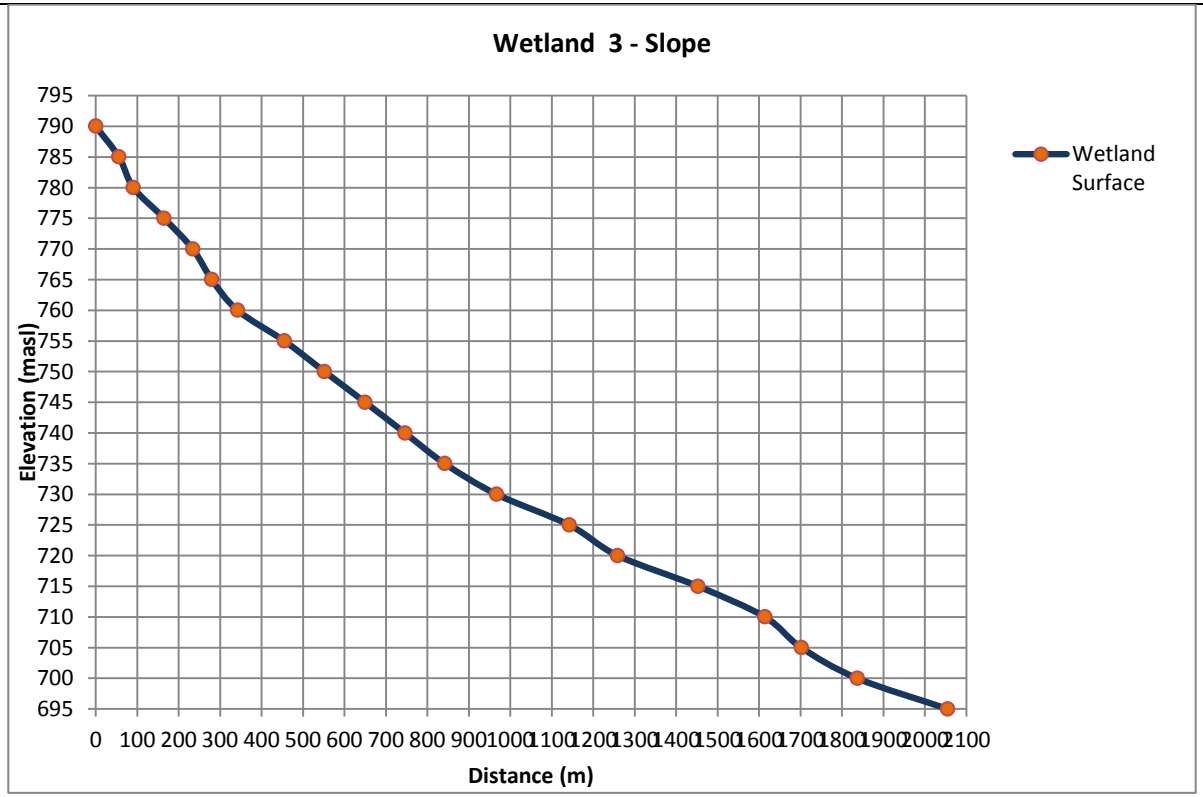
Ecosystem Services	Score
Flood attenuation	1.5
Streamflow regulation	1.5
Sediment trapping	0.7
Phosphate trapping	1.0
Nitrate removal	0.9
Toxicant removal	1.1
Erosion control	1.3
Carbon storage	0.3
Maintenance of biodiversity	0.9
Water supply for human use	1.3
Natural resources	0.0
Cultivated foods	0.0
Cultural significance	0.0
Tourism and recreation	0.1
Education and research	0.0
Threats	4.0
Opportunities	0.0

Due to the disturbances to this wetland ecosystem services in general scored poorly. Hillslope / valleyhead seeps generally slow the movement of water through the catchment, which has a number of benefits. However, water flows through a culvert under the

	runway and the wetland is largely canalized downstream of the culvert. Flood attenuation and streamflow regulation scored the highest, which is indicative of the natural functioning of a seepage wetland (particularly early in the rainy season). Limited erosion control and enhancing of water quality is still provided by the portions of remaining seepage areas. Note: Water supply for human use only scored a 'relatively' high score due to its association with streamflow regulation.

Wetland 3	**W3 – Valley bottom with a channel**
	
	Wetland 3 is a disturbed channelled valley bottom wetland, which has been largely transformed through anthropogenic activities, including but not limited to:

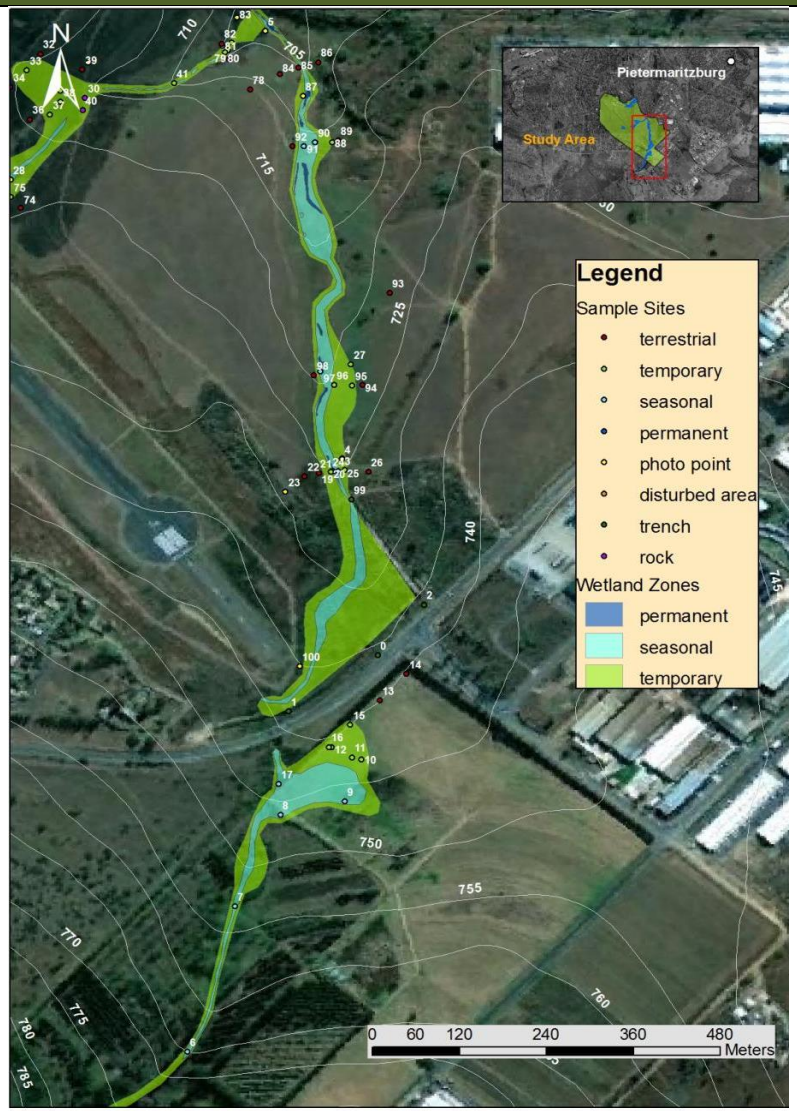
- Farming activities in the catchment and the upper reaches of the channel. These include the converting of wetland areas to pastures and clearing for the cultivation of various crops;
- A tar road (Gladys Manzi), which cuts through the top portion of the wetland;
- A light industrial area within the catchment. Stormwater runs directly into the wetland;
- Deep trenches have been dug for water pipelines adjacent to the tar road. These trenches run directly through the top portion of the wetland and also along it;
- The dumping of rubble and litter within the wetland, primarily downstream of the tar road and the trenches;
- Alien vegetation; and
- The construction of a railway bridge, which has resulted in a 'pinch' in the wetland, i.e. the toe of the wetland.



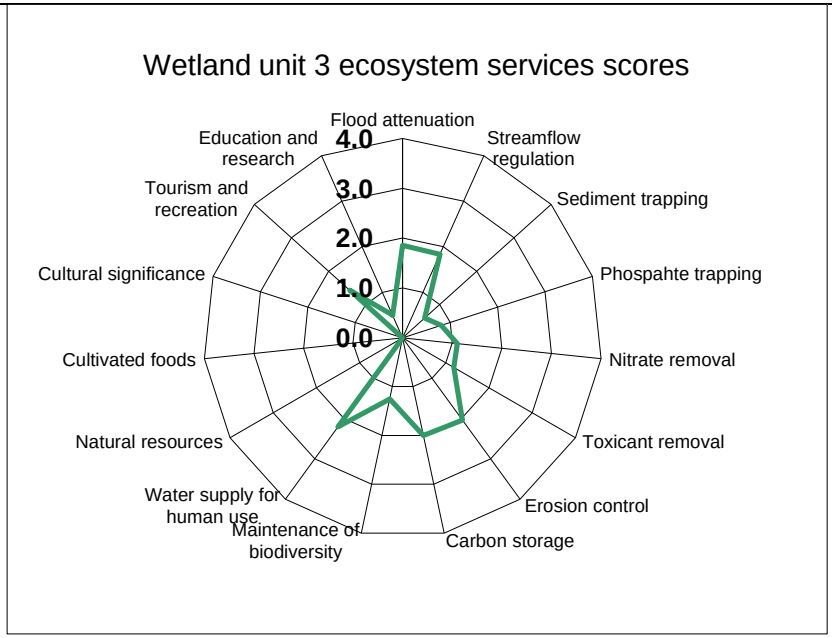
The slope of the wetland = 4.9%. The reduction in the slope at an elevation of approximately 710m is indicative of the underlying

	dolerite.

Wetland Delineation



Refer to the *Appendix* for a list of characteristics for each of the sample sites identified in the delineation map.		
Wetland Health / PES		
Indicator	**Score**	**Description**
Hydrology	9.5	Critically modified: The volume of water entering the wetland has been significantly increase through inter catchment transfer of water to irrigate at Ukulinga farm, which is at the state of the system. There is also extensive stormwater runoff from harden surfaces in the catchment, i.e. primarily the light industrial area and the tar road. Water flow is restricted to culverts running under Gladys Manzi road.
Geomorphology	6.6	Seriously modified: The complete width of the wetland directly downstream of Gladys Manzi road has been trenched. A portion of the eastern boundary of the wetland, directly downstream of the road has also been trenched. These trenches have modified the movement of water and sediment through the system.
Vegetation	6.8	Seriously modified: wetland vegetation upstream of the road is complete transformed. Alien and invasive species dominate within the disturbed area directly downstream of the road. Further downstream vegetation is regularly burnt and / or cut.
Overall health	**7.9**	**Seriously modified**
Health Category	**E**	**The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.**
% of Naturalness	**21%**	
Ecosystem Services		



Ecosystem Services	Overall score
Flood attenuation	1.9
Streamflow regulation	1.8
Sediment trapping	0.6
Phosphate trapping	0.8
Nitrate removal	1.1
Toxicant removal	1.2
Erosion control	2.0
Carbon storage	2.0
Maintenance of biodiversity	1.3
Water supply for human use	2.2
Natural resources	0.0
Cultivated foods	0.0
Cultural significance	0.0
Tourism and recreation	1.4
Education and research	0.5
Threats	4.0
Opportunities	1.0

Due to the existing disturbances to this wetland ecosystem services in general scored poorly. Water supply for human use scored the highest, which was due to the presence of all three wetland zones and limited use for agricultural purposes, i.e. water from the wetland is not used for irrigation purposes but crops and pastures within and adjacent to the wetland still benefit from the moist conditions. There is a level of erosion control in the upper portion of the wetland, where the vegetation cover is largely intact, however, directly above the toe of the wetland gullies have formed, which is likely due to the underlying geology and the 'pinch' in the system where the railway crossing was constructed. Carbon storage also scored relatively high, which is likely due to the presence of all three wetlands zones, although permanent zones are limited. As indicative of a channelled system there is some provision for flood attenuation and streamflow regulation.

6. DEVELOPMENT GUIDELINES

As the proposed expansion of the Oribi Airport is still very much in its planning phase the following interim norms and standards for urban / infrastructural development (DAEA, 2002) will provide guidance when considering areas to be developed:

1. Infilling, excavation, drainage and hardened surfaces (including buildings and asphalt) should not be located in any of the wetland zones (i.e. permanent, seasonal or temporary).
2. Hardened surfaces should be located at least 15 m outside of the outer boundary of the seasonal/permanent wetland zone.
3. Stormwater outflows should not enter directly into the wetland. A predominantly vegetated buffer area at least 20 m wide should be included between the stormwater outflow and the outer boundary of the wetland, with mechanisms for dissipating water energy and spreading and slowing water flow and preventing erosion.
4. Where the wetland has a particularly high biodiversity value, further buffering and linkages to other natural areas are likely to be required, the width of which would depend on the specific requirements of the biota. Ezemvelo KZN Wildlife's guidelines for buffering wetland systems (EKZNW, 2010) will be applied once areas for development have been identified.
5. Roads should ideally not be allowed to traverse a wetland, however, should a route be identified within a portion of a wetland then it should be ensured that the road has minimal effect on the flow of water through the wetland (e.g. by using a bridge or box culverts rather than pipes). No excavation of the wetland or any stream passing through the wetland (i.e. lowering of the base level) should be permitted. Ensure an adequate buffer is present to deal with run-off from the road. During construction, minimize disturbance of the wetland at, and adjacent to, the road crossing site.
6. Where development (e.g. hardened surfaces, infilling and drainage) in a wetland is unavoidable then the resulting impacts must be mitigated.
7. Stringent controls should be put in place to prevent any unnecessary disturbance or compaction of wetland soils. Where any disturbance of the soil takes place in a wetland, these areas must be stabilized and any alien plants which establish should be cleared and follow up undertaken for at least 2 years thereafter and preferably longer. Where compaction results, remedial measures must be taken (e.g. "ripping" the affected area).
8. Any development must comply with the requirements of the National Water Act. Through the concept of the "ecological reserve", this act makes provision for ensuring water of acceptable quantity and quality for maintaining the ecological functioning of wetlands and river systems. In addition, relevant water use licenses will need to be obtained.

7. CONCLUSION AND RECOMMENDATIONS

All three of the wetlands identified within the study area are affected by existing disturbances. These disturbances have resulted in a marked reduction of the functioning of the systems, with Wetland 1 being 'Seriously Modified', Wetland 2 'Largely Modified' and Wetland 3 'Seriously Modified'. The poor health of the wetlands is evident in the low scores achieved when considering ecosystem services. However, even though these systems are seriously or largely modified their remaining functional abilities and provision of ecosystem services cannot be ignored when considering areas

for development for the Oribi Airport expansion. The boundaries of the wetlands delineated should be used to guide development and every effort should be made to avoid the wetlands within the study sites. As mentioned in the findings, the delineation was largely undertaken without the use of vegetation indicators because of a recent fire and therefore the findings from this delineation will be verified in the coming spring months (i.e. this should allow sufficient time for the vegetation to recover). This verification process will not delay the planning of the expansion as it will predominantly be to confirm the extent of the various wetland zones and not the actual wetland boundary already delineated. Buffers for the wetlands will be provided once plans for the expansion have been formalized. However, to aid in the planning process buffer / development guidelines have been provided (Section 6).

This is an interim wetland assessment, which was undertaken to identify the wetlands on site, assess their present ecological state (PES), and determine the level of ecosystem services provided. Impacts and mitigating measures relevant for the EIA process will be identified and discussed once plans have been formulated.

8. REFERENCES

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9. APPENDIX

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
0	-29.65563124	30.40600746	trench				Cuts through wetland
1	-29.65634814	30.40489719	trench				Cuts through wetland
2	-29.65499061	30.40657994	trench				Cuts through wetland
3	-29.65312799	30.40556146	photo point				
4	-29.65313033	30.40556548	photo point				
5	-29.64768209	30.40460886	photo point				
6	-29.66068620	30.40364183	seasonal	• Greyish matrix • Many mottles • Chroma = 1	• *Typha capensis* • *Cyperus sexangularis*		Reduced to a narrow channel in an orchard. Lots of Kikuyu grass
7	-29.65883388	30.40423242	seasonal	• Greyish matrix • Many mottles • Chroma = 1	• Dominated by kikuyu grass		Reduced to a narrow channel in an orchard. Lots of Kikuyu grass
8	-29.65766477	30.40479560	seasonal	• Brownish / Grey matrix • Many mottles • Chroma = 2	• Stand of *Phragmites australis* along a fence (i.e. planted) • *Cyperus sexangularis*		Water visible in track crossing the drainage line

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
9	-29.65749881	30.40559515	seasonal	• Many mottles • Chroma = 2			Pasture field
10	-29.65695977	30.40580068	temporary	• Few mottles • Chroma = 2 • Matrix brownish			Pasture field
11	-29.65693454	30.40568383	temporary	• Very few mottles • Dark brown / greyish matrix • Chroma = 2	• *Centella asiatica*		Pasture field
12	-29.65680873	30.40543322	temporary	• Greyish brown matrix • Very few mottles • Chroma = 1	• *Centella asiatica*		Pasture field. Water collected in the auger hole.
13	-29.65620523	30.40602565	terrestrial	• Light brown / reddish matrix			Pasture field
14	-29.65587289	30.40636101	terrestrial	• Light brown / reddish matrix			Pasture field
15	-29.65652031	30.40566321	temporary	• Greyish brown matrix • Chroma = 1 • High clay content			Pasture field
16	-29.65680236	30.40539801	temporary	• Very few mottles • Moist clay soils • Matrix greyish			

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
				brown • Chroma = 1			
17	-29.65727384	30.40477381	seasonal		• *Cyperus sexangularis*		Artificial channel
18	-29.66149698	30.40258270	photo point				
19	-29.65329135	30.40544721	permanent	• Shallow soils • Greyish matrix • No mottles	• Number of sedge species • *Typha capensis* • Rush species		
20	-29.65329914	30.40542089	temporary	• Slight mottling • Chroma = 1 • Matrix brown to grey			No obvious veg indicators a few meters off the main channel
21	-29.65331281	30.40527882	terrestrial	• No mottling • Light brown to brown matrix			No obvious veg indicators a few meters off the main channel
22	-29.65335136	30.40509735	terrestrial	• No mottling • Light brown to brown matrix			No obvious veg indicators a few meters off the main channel
23	-29.65354884	30.40485897	photo point				
24	-29.65328976	30.40550899	seasonal	• Shallow soils • Flowing water • No gleying	• Number of sedge species		Edge of channel, *Verbena spp*.

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
25	-29.65327484	30.40559306	temporary	• Slight mottling • Dark grey matrix	• *Cyperus sexangularis*		*Verbena spp*.
26	-29.65329998	30.40588793	terrestrial	• Light brown to brown matrix			Edge of mowed grass
27	-29.65192669	30.40567009	temporary	• Chroma = 2	• *Cyperus sexangularis*		Looks like a levy?
28	-29.64957054	30.40145114	photo point		• *Typha capensis*		Wetland has been channelled below culvert (Artificial channel). *Typha capensis* and sedge species growing in soil cleared from the channel
29	-29.64808359	30.40241439	photo point				
30	-29.64853277	30.40237533	rock				Bed rock
31	-29.64844150	30.40206771	temporary	• Clear mottling • Brown to grey brown matrix • Chroma = 2			
32	-29.64797060	30.40182003	terrestrial	• Chroma > 2 • No mottles			Recently burnt veg

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
33	-29.64817738	30.40165130	temporary	• Chroma = 2 • Few mottles			Recently burnt veg
34	-29.64839204	30.40144603	terrestrial	• Shallow soils • Gravel in soil samples			
35	-29.64879949	30.40129398	terrestrial				
36	-29.64880745	30.40168768	terrestrial	• Shallow soils			
37	-29.64874886	30.40194073	temporary	• Shallow moist soils	• *Centella asiatica*		
38	-29.64857879	30.40206998	temporary	• Some mottling • Grey brown matrix • Shallow soils			Recently burnt veg
39	-29.64817311	30.40234113	terrestrial				Very rocky area
40	-29.64868608	30.40234348	rock				
41	-29.64834385	30.40347680	temporary	• Chroma = 2 • Very slight mottling			Veg recently burnt.
42	-29.64792500	30.40414651	photo point				
43	-29.64782425	30.40419655	temporary	• Slight mottling • Chroma = 2			

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
44	-29.64392315	30.40001524	seasonal	• Some gleying • Many mottles • Chroma = 1	• Veg indicators appear to be present (i.e. Phragmites) but areas was recently burnt.		Wetland has been channelled. Lots of disturbance.
45	-29.64406229	30.40022629	temporary	• Few mottles • Chroma = 1 • Grey to brown matrix			Veg recently burnt
46	-29.64413362	30.40036904	temporary	• Few mottles • Chroma = 1 • Grey brown matrix			Veg recently burnt
47	-29.64423135	30.40053751	temporary	• Few mottles • Chroma = 2 • Brown to greyish brown matrix			Veg recently burnt
48	-29.64440435	30.40080800	terrestrial	• No mottles • Reddish brown matrix • Chroma > 2			Veg recently burnt
49	-29.65019415	30.39877413	photo point				
50	-29.65020773	30.39831019	seasonal	• Greyish matrix • Many mottles • Chroma = 1	• Sedge species		Most of the seasonal zone has been clear (i.e. soil removed)
51	-29.65028023	30.39812537	temporary	• Few mottles • Chroma = 2	• No indicator species		

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
				• Matrix brown to greyish brown			
52	-29.65030898	30.39791071	terrestrial	• No mottles	• No indicator species		
53	-29.64606875	30.39995816	photo point				
54	-29.64520876	30.39840080	photo point				
55	-29.64440376	30.39902215	seasonal	• Moist soils	• Veg recently cut • Few sedge species present		In artificial channel draining the seepage area
56	-29.64447157	30.40032227	temporary	• Few mottles • Chroma = 2 • Greyish brown matrix	• No veg indicators		Veg cut short / burnt
57	-29.64458272	30.40057942	terrestrial	• No mottles • More of a brownish matrix			Veg cut short / burnt
58	-29.64479780	30.40098879	terrestrial	• No mottles, gravel in soil			Veg cut short / burnt
59	-29.64428457	30.40029368	seasonal	• Standing water • Greyish soils • Chroma = 1			
60	-29.64406958	30.39992966	seasonal	• Standing water but not gleying • Mottles			Veg burnt
61	-29.64394209	30.39961265	seasonal	• Greyish matrix • Some mottles • Chroma = 1			Veg burnt
62	-29.64380555	30.39918870	temporary	• Shallow moist soils	• Sedge species		Disturbed soil profile and alien veg
63	-29.64358167	30.39885200	trench				Run off from airport

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
64	-29.64377982	30.39969170	disturbed area				Veg and soil profile disturbed
65	-29.64334647	30.39967158	disturbed area				Veg and soil profile disturbed
66	-29.64354889	30.40043257	seasonal	• Flow water • Greyish matrix			Veg and soil profile disturbed
67	-29.64383681	30.40096273	disturbed area	• Rubble	• Alien veg		Veg and soil profile disturbed
68	-29.64350070	30.40195146	terrestrial				
69	-29.64306216	30.40172154	temporary	• Few mottles • Brownish grey matrix • Chroma = 2	• Burnt veg		
70	-29.64249219	30.40150286	seasonal	• Standing water • Greyish brown matrix • Mottles not very clear	• Burnt veg		Veg and soil profile disturbed
71	-29.64207594	30.40134838	temporary	• Few mottles in top 10cm	• Cleared veg		
72	-29.64187914	30.40124855	photo point				
73	-29.64163003	30.40126741	terrestrial	• Shallow soils • No mottles			
74	-29.64993314	30.40157788	terrestrial	• Shallow soils, gravel in soil at 10cm • No mottles	• Burnt veg		Overlying shale

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
75	-29.64979794	30.40145483	temporary	• Shallow soils • Greyish brown matrix • Some Mottles			
76	-29.64945772	30.40116942	temporary	• Few mottles • Greyish brown matrix	• Burnt veg		
77	-29.64935864	30.40107714	terrestrial				
78	-29.64842733	30.40441926	terrestrial				
79	-29.64804277	30.40416327	terrestrial	• Dark soil profile • No mottles	• No veg indicator species		
80	-29.64794973	30.40411080	temporary	• Few mottles in top 10cm • Chroma = 3 • Moist soils	• Burnt veg		
81	-29.64787136	30.40407711	temporary	• Few mottles in top 10cm	• Burnt veg		
82	-29.64783976	30.40406805	terrestrial	• Dry brownish soils • Not mottles			
83	-29.64750364	30.40425690	photo point				
84	-29.64822834	30.40478739	terrestrial				
85	-29.64814612	30.40501823	terrestrial				
86	-29.64807730	30.40526558	terrestrial				
87	-29.64850805	30.40507765	photo point				
88	-29.64909897	30.40543531	temporary	• Few mottles in top	• Burnt veg		Gully

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
				10cm • Greyish brown matrix			
89	-29.64907567	30.40551326	terrestrial	• Reddish soils • No mottles			
90	-29.64909721	30.40522903	seasonal	• Many mottles • Greyish brown soil matrix • Chroma = 2	• Burnt veg		Between channels
91	-29.64914943	30.40508855	seasonal	• Many mottles • Greyish brown soil matrix • Chroma = 2	• Burnt veg		2nd channel
92	-29.64915060	30.40494665	terrestrial	• Reddish brown soils • No mottles			
93	-29.65101600	30.40615054	terrestrial	• Reddish brown soils • No mottles			
94	-29.65219164	30.40581367	terrestrial	• Reddish brown soils • No mottles			
95	-29.65219701	30.40568643	temporary	• Few mottles in top 10cm • Chroma = 2 • Brown to greyish matrix	• Sedge species		Levy / dry channel
96	-29.65218770	30.40546104	temporary	• Some mottles • Dark soil profile	• No veg indicator species		Edge of channel
97	-29.65201512	30.40529265	seasonal	• Shallow soils in channel	• Many sedge species		
98	-29.65206985	30.40521244	terrestrial				

Sample No.	Coordinates		Wetland Zone / Points of Interest	Soil Wetness Characteristics	Vegetation - Key Species	Sample photos of soil samples and veg indicators	Notes
	Latitude	Longitude					
99	-29.65364942	30.40567394	trench				Large trench
100	-29.65577331	30.40503885	photo point				