WETLAND AND BIODIVERSITY ASSESSMENT FOR THE EXPANSION OF THE PIETERMARITZBURG AIRPORT

J. Gillham, C. Curry & I.P. Bredin

Institute of Natural Resources
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Wetland and Biodiversity Assessment for the Expansion of the Pietermaritzburg Airport

PREPARED FOR:	PREPARED BY:
CITY OF CHOICE PIETERMARITZBURG MSUNDUZI	Institute of Natural Resources
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Please direct any queries to:

Ian Bredin

P O Box 100396, Scottsville, 3209

Tel: 033 3460 796 E-mail: ibredin@inr.org.za

DECLARATION OF INDEPENDENCE
We declare that the Institute of Natural Resources NPC (INR) have no financial or personal interest in the proposed development, nor its developers or any of its subsidiaries, apart from the provision of a wetland and biodiversity assessment report.

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LIST OF ACRONYMS

CBA	Critical Biodiversity Area
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EDTEA	KwaZulu-Natal Department of Economic Development, Tourism & Environmental Affairs
EKZNW	Ezemvelo KwaZulu-Natal Wildlife
EIA	Environmental Impact Assessment
EIS	Ecological Importance & Sensitivity
ESIR	Environmental Scoping and Impact Report
GA	General Aviation
GIS	Global Information System
GPS	Global Positioning System
HGM	Hydro-geomorphic
INR	Institute of Natural Resources NPC
MM	Msunduzi Municipality
NEMA	National Environmental Management Act
PES	Present Ecological State
PMB	Pietermaritzburg
SA	South Africa
SDF	Sustainable Development Framework
WGS	World Geodetic System
WULA	Water Use License Application

1. INTRODUCTION

Pietermaritzburg Airport (previously known as Oribi Airport) is owned by the Msunduzi Municipality (MM) and serves the city of Pietermaritzburg and surrounds as well as the outer west suburbs of Durban. To improve the service provision and effectively meet the increasing growth in passenger and cargo volumes and air traffic movements, MM has proposed the expansion of the Pietermaritzburg Airport. Associated activities include:

- The extension of the taxiway to service an extension of the aircraft apron;
- Reconfiguration of the existing hangars and other facilities for aircraft maintenance and repair;
- Improved access via a link to Washington and/or Market Roads;
- Development of a new parking area and drop off zone;
- Development of a technology hub; and
- Site allocation for any possible future expansion of the terminal building and General Aviation (GA) areas.

In terms of the National Environmental Management Act (No. 107 of 1998) (NEMA) the proposed expansion will result in the transformation of more than 20ha of indigenous vegetation and thereby triggers the need for environmental authorisation. The MM has accordingly made application to the KwaZulu-Natal Department of Economic Development, Tourism & Environmental Affairs (EDTEA) for environmental authorisation. The application is supported by an Environmental Scoping and Impact Report (ESIR) as per the EIA Regulations of December 2014. The MM appointed the Institute of Natural Resources NPC (INR) as the Independent Environmental Assessment Practitioner to prepare the application and manage the associated EIA process. The proposed expansion will impact directly on the grassland and wetland ecosystems within the area of concern. This prompted the need for a wetland and terrestrial ecological assessment to inform the EIA process.

2. TERMS OF REFERENCE

The following was carried out during the investigation:

- Wetland Assessment:
    - The classification and delineation of the wetlands in the study area, which includes wetland habitat associated with the Blackborough Spruit directly north-east of the railway line which boarders on the northern boundary of the study area (i.e. between the railway line and Washington road);
    - A health assessment of wetlands in the study area (i.e. Wet-Health) to determine condition / likely Present Ecological State (PES);
    - An assessment of the functional value of the wetland systems in the study area (i.e. Wet-Ecoservice Assessment);
    - An assessment of the Ecological Importance & Sensitivity (EIS) of wetlands in the study area, which takes into consideration the biodiversity value of the wetlands;
    - A wetland buffer assessment to determine appropriate buffer zones to reduce the direct impact of the proposed development on the wetland systems and associated terrestrial habitat within the study area;

  - An impact assessment to determine the likely impact the proposed development / expansion will have on wetlands, both within the study area and the surrounding regulated area (i.e. consider possible cumulative impacts of the proposed development); and
  - The recommendation of mitigating measures to reduce the impacts of the proposed development.
- Biodiversity Assessment:
  - A desktop vegetation and faunal assessment;
  - A brief infield vegetation scan to gain an understanding of the habitats within the study area and the presence of any species of conservation concern;
  - The classification and mapping of habitats within the project footprint;
  - Determine the ecological (habitat and species) and ecosystem services value of the terrestrial ecosystems;
  - The assessment of possible ecological corridors (i.e. particularly possible corridors linking to the adjacent Bisley Nature Reserve);
  - Define and assess the direct, cumulative and any secondary impacts to the terrestrial ecosystems; and
  - Identify suitable mitigation measures.

3. PROJECT TEAM

The wetland and biodiversity assessment at Pietermaritzburg Airport was conducted and managed by the INR. The details of the project team are included in Table 1.

Table 1: Study team

SPECIALIST	ASPECT	QUALIFICATIONS
Ian Bredin (INR)	Project Manager Wetland and biodiversity assessment	MSc – Veterinary Science (Pretoria) *Pr.Sci.Nat.* Registered – Ecology & Zoology (Refer to Appendix A)
Christina Curry (Independent consultant)	Vegetation assessment	PhD – Botany (University of KwaZulu-Natal)
Jarryd Gillham (INR)	Assisted with the wetland and biodiversity assessment	BSc (Hons) – Geographic and Environmental Management

4. PROJECT DESCRIPTION

4.1. Location and Layout

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 (Figure 1). To assess the impact that the expansion of the airport may have on the biodiversity of the area, the Bisley Nature Reserve (located just seven kilometres from Gladys Manzi Road) was also taken into account as the development may impact on ecological corridors in the area. A precise breakdown of the proposed infrastructure and land use can be found in **Appendix B**.

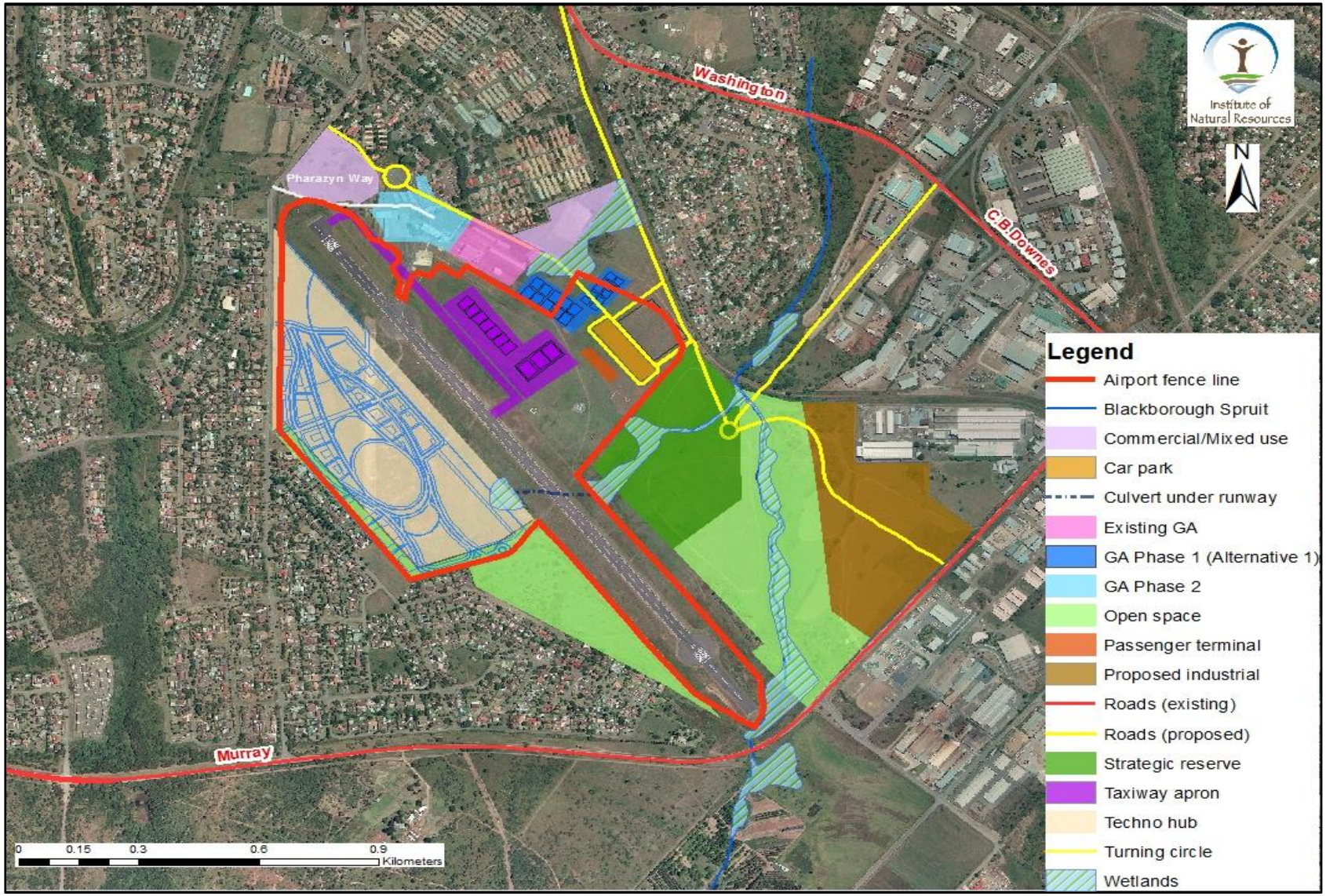


Figure 1: Overview of the proposed development

5. BIOPHYSICAL ENVIRONMENT

5.1. Climate – Regional Rainfall and Temperature

The climate of the study site is seasonal, with hot and wet summers (December to February) and warm and dry winters (June to August). Rainfall in the study area is highly seasonal, typically highest in February and lowest in June. In the region, rainfall in the last couple of years has been very low and erratic as shown in Figure 2. Temperature is less seasonal and is highest during January and February and lowest during June and July as shown for Pietermaritzburg Airport (Table 2).

Table 2: The monthly average minimum and maximum air temperature for the Pietermaritzburg Airport region for the period 2008-2016 (Source: SASRI weather web)

Temperature (°C)	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Max	27	28	27	24	24	21	21	23	25	24	24	26
Min	17	17	16	13	12	9	9	10	12	13	14	16

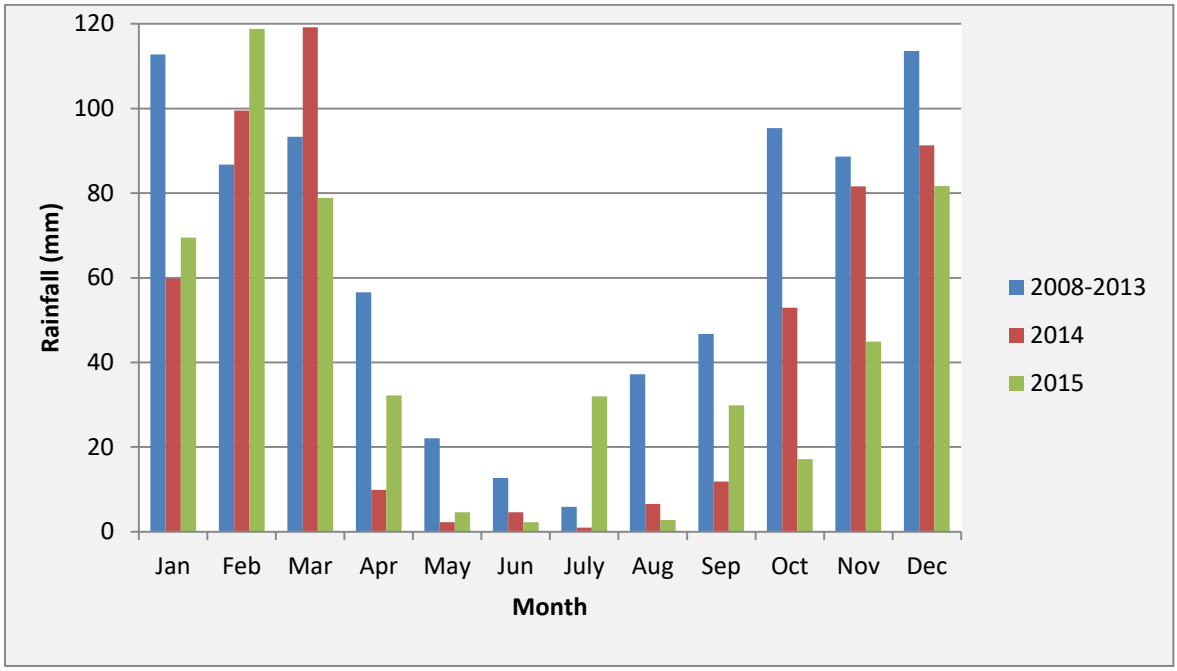


Figure 2: Average monthly total rainfall for the Pietermaritzburg Airport during 2008-2013 and 2014-2015. A noticeable decline in rainfall from 2014-2015 is discernible. (Source: SASRI weather web)

5.2. Geology and Soils

The main geology type at the study site is shale and dolerite (Figure 3). The Soil Conservation Services method for Southern Africa (SCS-SA) uses information of hydrologic soil properties to estimate surface runoff from a catchment (Schulze *et al*., 1992). The hydrological soil group that defines the catchment of the study area as either a group C or D, where:

- Group C - Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- Group D - Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

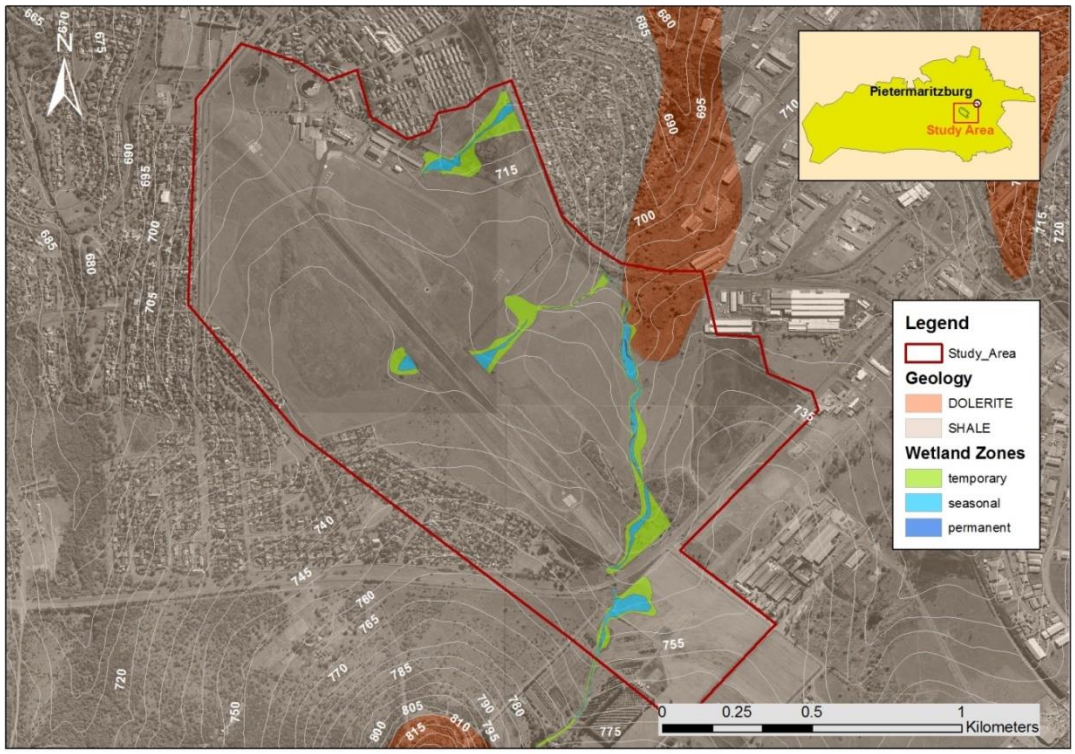


Figure 3: Geology at study site

5.3. Regional Vegetation

There is one regional vegetation type found in the study area. This is the KwaZulu-Natal Hinterland Thornveld. A Brief description of this regional vegetation types is provided below. Further information can be obtained from Mucina and Rutherford (2006).

The KwaZulu-Natal Hinterland Thornveld falls within the Savannah Biome and the vegetation is characterized by open thornveld dominated by *Acacia spp*. on undulating plains found on upper margins of river valleys. The vegetation unit is listed as vulnerable with a national conservation target of 25%. A list of characteristic species typically found at the KwaZulu-Natal Hinterland Thornveld can be seen on (Table 3).

Table 3: A list of species previously found in the KwaZulu-Natal Hinterland Thornveld (Cook, 2013)

Tree	**Scientific Name**
Sweet Thorn	*Acacia karoo*
Scented Thorn	*Acacia nilotica*
Paperbark Thorn	*Acacia sieberiana var. woodii*
Fever Tree	*Acacia xanthophloea*
Flat Crown	*Albizia adianthifolia*
Bitter-leaf Silver-oak	*Brachyleana elliptica*
Velvet Bushwillow	*Combretum molle*
Common Cabbage Tree	*Cussonia spicata*
Coast Coral Tree	*Erythrina caffra*
Shrub	**Scientific Name**
Small Bone Apple	*Coddia rudis*
Puzzle Bush	*Ehretia rigida*
Cross Berry	*Grewia occidentalis*
Karee	*Rhus lancea*
Common Crowberry	*Rhus pentheri*
Grass	**Scientific Name**
Ngongoni three-awn	*Aristida junciformis*
Pangola-Grass	*Digitaria eriantha*
Guinea Grass	*Panicum maximum*
Dog's Tooth Grass	*Cynodon dactylon*
Common Turpentine Grass	*Cymbopogon caesius*
Weeping Lovegrass	*Eragrostis curvula*
Blady Grass	*Imperata cylindrical*
Three o'clock Thatching Grass	*Hyparrhenia fillipendula*
Natal Grass	*Melinis repens*

6. METHODOLOGY

6.1. Wetland Assessment Methodology

A field investigation was initially undertaken on the 28th of July and the 1st of August 2011 by the INR, 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 demarcate the catchments of the wetlands and identify relevant activities / conditions within them. A desktop study was then undertaken to try and determine the biodiversity that may be present in the area and how the proposed development may impact on the different species present. A follow-up field investigation was undertaken on the 11th October 2016 to determine the extent of change within the wetland habitats and to assess the portion of wetland habitat downstream of the railway bridge over the Blackborough Spruit.

Methods used in the assessment of wetland resources include:

6.1.1. Wetland Delineation and Mapping

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 wetland 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.

It should be noted that 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 10.4 (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.

6.1.2. Wetland Classification

According to Ollis, *et al*. (2013), the Level 4 of the classification system allows for the identification of hydrogeomorphic (HGM) units within inland aquatic ecosystems. Seven primary HGM types are recognised for inland systems at Level 4 (Table 4).

Table 4: Wetland HGM units showing the primary HGM types at Level 4A and the sub-categories at levels 4B to 4C (adapted from Ollis, *et al*., 2013)

LEVEL 4: HGM UNIT		
HGM Type	Longitudinal zonation / landform / outflow drainage	Landform / inflow drainage
A	B	C
Channelled valley-bottom wetland	Not applicable	Not applicable
	Not applicable	Not applicable
Unchannelled valley-bottom wetland	Not applicable	Not applicable
	Not applicable	Not applicable
	Not applicable	Not applicable
	Not applicable	Not applicable
	Not applicable	Not applicable
	Not applicable	Not applicable
Floodplain wetland	Floodplain depression	Not applicable

LEVEL 4: HGM UNIT		
HGM Type	Longitudinal zonation / landform / outflow drainage	Landform / inflow drainage
A	B	C
	Floodplain flat	Not applicable
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	Not applicable	Not applicable
Wetland flat	Not applicable	Not applicable

6.1.3. Wetland Condition

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 5). 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	4 – 5.9

IMPACT CATEGORY	DESCRIPTION	SCORE
	wetland integrity has been lost.	
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 6. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table 6: 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.

6.1.4. Wetland Ecological Services

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.

6.1.5. Ecological Importance and Sensitivity

The determination of Ecological Importance and Sensitivity (EIS) enables the identification of systems that provide higher ecosystem services, biodiversity support functions or wetlands that are highly sensitive to impacts. The EIS was determined using the methodology outlined by Rountree and Kotze (2013). This method was developed using criteria from the WET-Ecoservices tool (Kotze *et al*., 2007) and a previous version of the Department of Water and Sanitation (DWS) EIS assessment tools, to propose the following three suites of importance criteria:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWS and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, which considers water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of basic human benefits – this suite of criteria consider the subsistence uses and cultural benefits of the wetland system.

The highest of these three scores was used to determine the overall importance and sensitivity as described in Table 7 below.

Table 7: Ecological Importance and Sensitivity categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999)

ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORIES	RANGE OF EIS SCORES
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems 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 systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

6.2. Biodiversity Assessment Methodology

6.2.1. Biodiversity Desktop Assessment

The main focus of this assessment, as reflected in the terms of reference, was to assess and determine the impacts of the proposed development on the biodiversity in the area. A desktop study was initially undertaken to gain a better understanding of the receiving environment. This included; analysing the literature on the area (previous studies) and using Geographic Information System (GIS) to create maps of the study area and its surrounding environment, based on available spatial data. Consequently it was possible to identify potential areas of concern and to draw up a list of potential species that may be affected by the proposed development.

6.2.2. Selection of Biodiversity Features

There are two approaches when selecting biodiversity features; the coarse filters (habitat type, vegetation units, or environmental features) and fine features (which are usually species or specific plant or animal communities). Using the fine filter approach, individual occurrences of threatened species were identified and mapped to represent the known or potential occurrence of the species within the development footprint. Noss (2004) suggests that such an approach is appropriate for plants and small-bodied animals, as long as sound data is available. Although data typically is incomplete, requiring expert judgment in defining probable areas of occurrence, Noss (2004) suggests that it would be “foolhardy” to neglect areas known to be rich in biodiversity simply because the biodiversity data for the entire region is incomplete.

The objective of including coarse filters such as vegetation types is typically to protect the range of variation along environmental gradients that occur in the planning domain. Ensuring the representative samples of such areas are maintained is likely to help safeguard species, genetic variation, communities and other elements of biodiversity (e.g. pollination processes) that are unlikely to be adequately represented through fine filters. This highlights the need to include both coarse and fine filters where possible to increase the likelihood of safeguarding an appropriate suite of processes and habitats necessary to ensure the persistence of biodiversity.

6.2.3. Selection of Species

This step involved extracting a list of all recorded and potentially occurring red data and endemic plant and animal species at the Pietermaritzburg Airport site. This was done by analysing the Msunduzi Biodiversity Assessment (INR, 2008) which provided information previously gathered on red data and endemic species for the entire MM. A plethora of plant and animal species that were included in the Msunduzi Biodiversity Assessment were then excluded from occurring at the Pietermaritzburg Airport site due to their habitat requirements not being met by the habitats present within the study area. A final list of potential plant and animal species to be found within the study area was then drawn up and used as an indicator of the likely species to occur / utilize the habitats within the study area.

6.2.4. Vegetation Assessment Methodology

A site visit was conducted on the 15th and 16th October 2016 to gain an understanding of the plant species within the study area. This allowed for the mapping of the vegetation units, assessment of the general vegetation condition and to determine if there was any threatened / listed flora species present. A total of 7 sample locations were established across the study site. Purposive sampling strategy was chosen as this allowed specific sampling areas to be selected in order to get a full understanding of the study area. At each sample location, the dominant vegetation was identified using Boon (2010) for trees and various field guides for shrubs, grasses, forbs and other flowering plants (Pooley 1998, Van Oudtshoorn 2004, Henderson 2001). Unknown species were collected and pressed as vouchers and matched in the Bews Herbarium (UKZN, Pietermaritzburg), especially in cases where species were absent from field guides. Photographs were also taken at sample locations.

A combination of site species lists, field notes, photographs and Google Earth maps, was used to establish approximate boundaries for vegetation units on the property. Lists of red data plant species for the study area and its surroundings were obtained from Ezemvelo KZN Wildlife. These lists, as well as other listed plants protected and regulated under various provincial ordinances, were used to create a priority species list for the study area.

6.3. Impact Assessment Methodology

6.3.1. EIA Impact Assessment Methodology

A standard methodology was required to be applied for all specialist studies undertaken for the EIA. The methodology is detailed in **Appendix C**.

6.3.2. DWS Impact Assessment Methodology

Risk-based management is an adaptive management approach used for assessing and managing the impacts of particular water uses on a watercourse, the risks and hazards these pose and actions required to mitigate them (DWS, 2014). The recently gazetted General Authorization for Section 21 (c) and (i) water uses (No. 40229 Pg. 105 Notice 509, gazetted on the 26th August 2016, included a risk assessment matrix (Appendix D of the gazetted notice) that is required to be used during the assessment of risk and mitigation of risk. According to the matrix risk is determined after considering all listed control / mitigation measures. The DWS risk matrix was used to assess the threat to wetlands.

A risk rating was calculated based on input from the assessment. The consequence of the impact was calculated by adding scores for the severity, spatial scale and duration. Likelihood was calculated by adding scores for frequency of activity, frequency of incident, legal issues and detection. A risk rating was then determined by multiplying the scores for consequence and likelihood. The significance of the risk was based on the identified impacts and expressed qualitatively (Table 8).

Risk = Consequence (Severity + Spatial Scale + Duration) X Likelihood (Frequency of Activity + Frequency of Incident + Legal Issues + Detection)

Table 8: Risk classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	**(L) Low Risk**	**Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.**
56 – 169	**(M) Moderate Risk**	**Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.**
170 – 300	**(H) High Risk**	**Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.**

6.4. Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The faunal component of the study is based on a desktop assessment of available data. Infield trapping for a range of faunal species did not form part of this study.
- The vegetation site visit took place outside the preferred sampling period (November-April) for the province (EKZNW, 2013). Some plants were therefore unable to properly flower which made plant identification extremely difficult. This is an impression based purely on observation; not on quantitative data. In addition, the timing of the site visit and the severe drought made it difficult to comment on the condition of the vegetation. Therefore comments regarding vegetation condition are based purely on observations and not quantitative data.

- Sampling by its nature, means that not all individuals are assessed and identified. Some species and taxa may therefore have been missed during the assessment, and this was largely due to the suboptimal conditions at the time of sampling.
- Due to time constraints, only a limited time was spent sampling. Areas with similar habitat were assumed to have similar species compositions.
- Access to surrounding areas was restricted during the site visit, which limited the assessment of important sites or the potential for ecological corridors in the surrounding areas.
- When establishing the extent of wetland impacted by the mixed use development near the soccer field (Figure 1) was taken to be a commercial / mixed use development (Land use activities including retail, commercial and business).
- The assessment of impacts and mitigating measures is based on the development layout made available at the time of the assessment. Any changes made post infield assessments could only be assessed at a desktop level (e.g. road crossing points, etc.)
- Detailed information of the airport layout was only received after in field assessments had taken place thus limiting the significance of each impact to be properly assessed in field.

7. WETLAND SITE ASSESSMENT RESULTS

7.1. General Site Description

There are three primary wetlands within the study (Figure 4), 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.

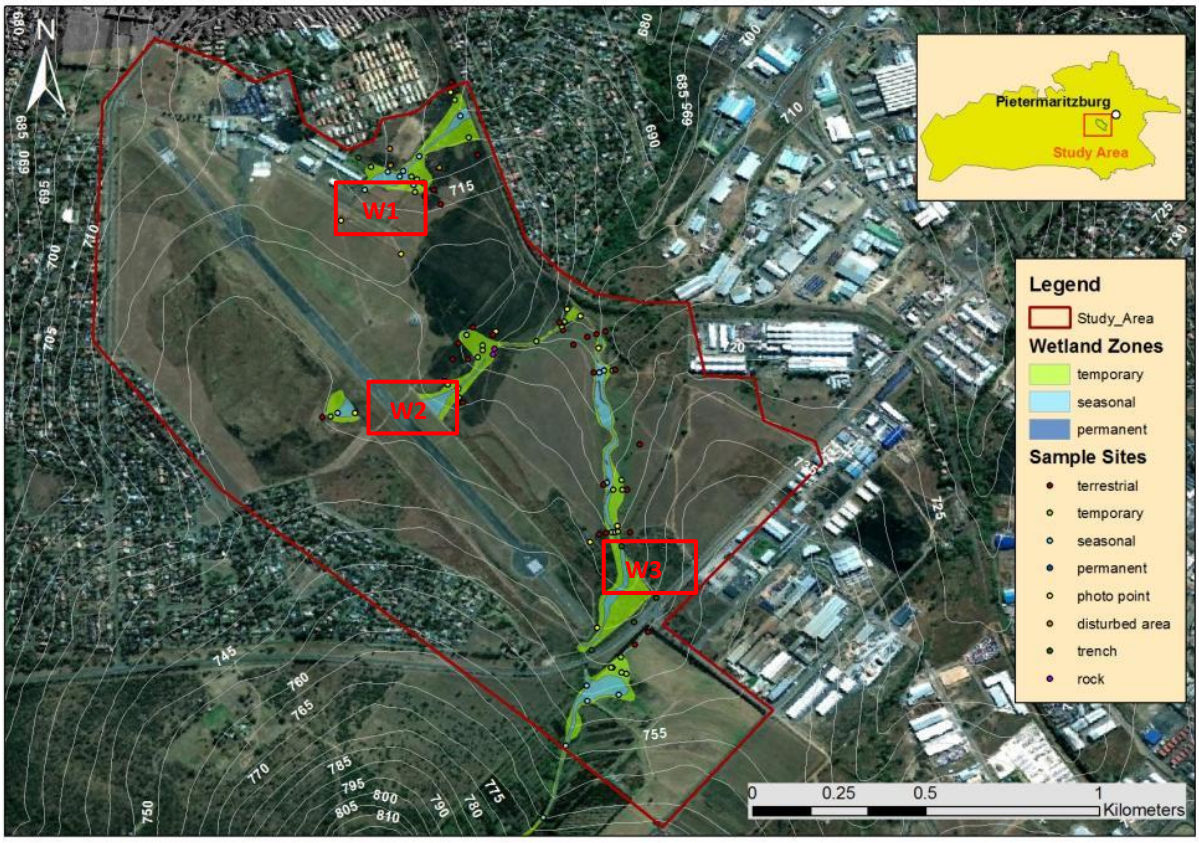


Figure 4: Wetlands within the study area

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 5 below highlights the board underlying geological features in the area.

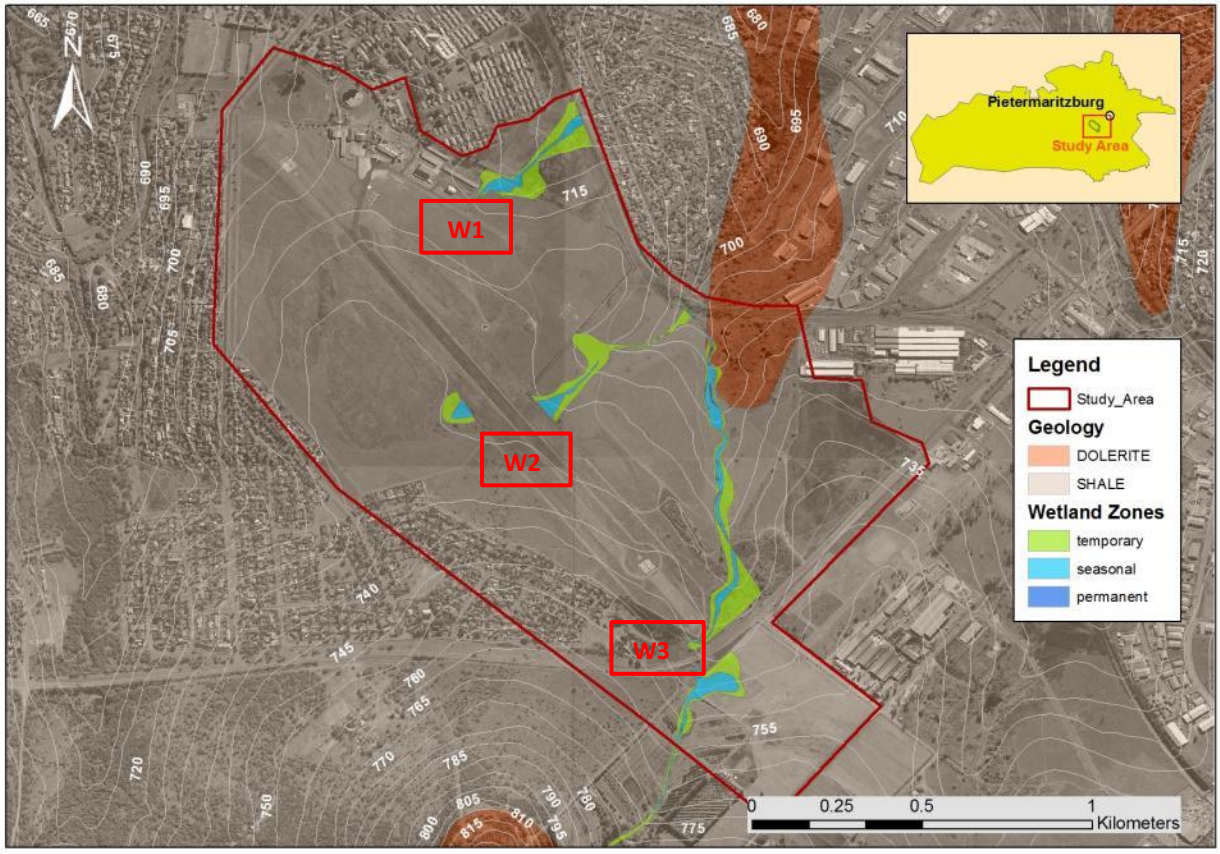


Figure 5: Board underlying geological features in reference to wetland within the study area

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 7.2*).

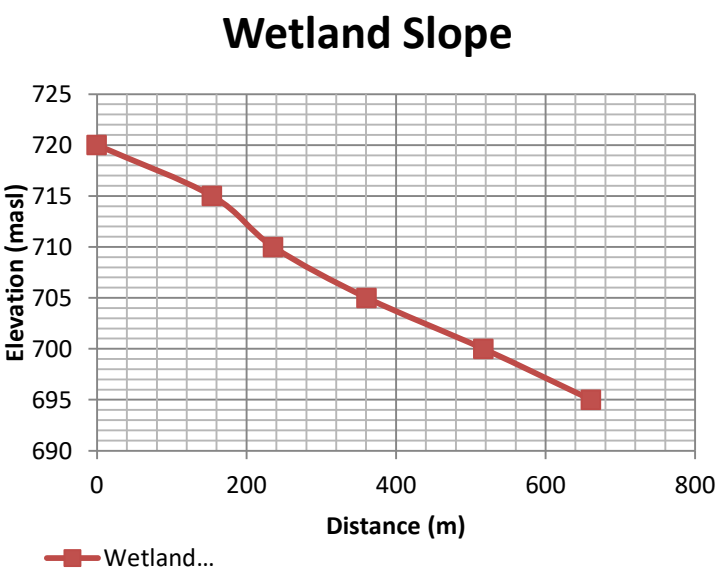
7.1. Wetland Delineation, Wet-Health, Wet-Ecoservices, and EIS Assessment for Wetland HGM Units on Site

WETLAND 1 (W1) = DISTURBED VALLEY HEAD / HILLSLOPE SEEP LINKED TO A CHANNEL

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

- The construction of the existing Pietermaritzburg Airport infrastructure and associated infrastructure (increased inputs into the wetland);
- Oribi village and sports fields at the village (portion of the wetland has been cleared for a soccer field);
- 1 - Fencing;
- 2 - Construction of channels / drains within the wetland to drain storm water 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
- 3 - 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.

WETLAND DELINEATION



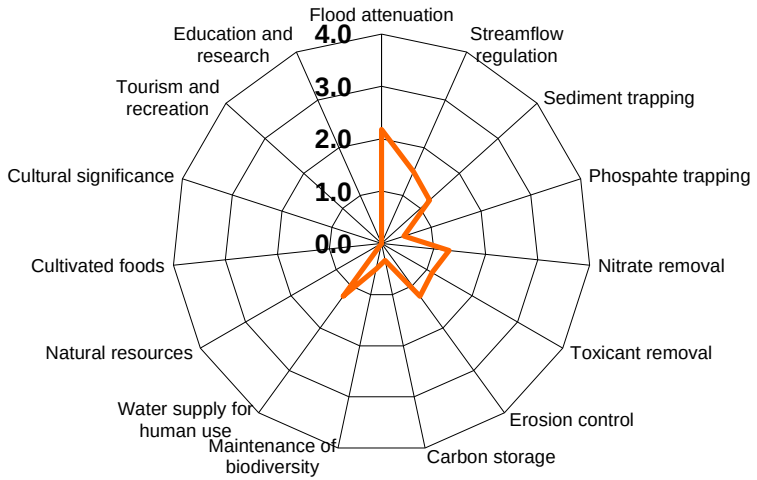
Refer to the **Appendix E** for a list of characteristics for each of the sample sites identified in the delineation map. Disturbances to the soil profile and vegetation layer restricted the accuracy of the delineation.
The slope of the wetland = 4.1%.

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 Pietermaritzburg 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 storm water 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.
% Naturalness	25%	

ECOSYSTEM SERVICES

Wetland unit 1 ecosystem services scores

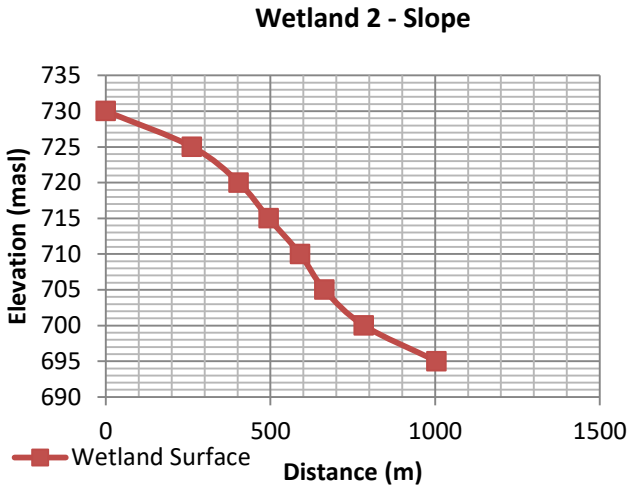


Due to extensive disturbances, wetland ecosystem services scored poorly. Hillslope / valley head seeps generally slow the movement of water through the catchment, which has a number of benefits, such as enhancing the quality of water. However, this wetland has been artificially canalized to accommodate storm water 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.

EIS

The EIS score for the wetland was determined to be less than **1**. This means that the EIS is rated as **LOW** (Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers).

WETLAND 2 (W2) = DISTURBED VALLEY HEAD / HILLSLOPE SEEP LINKED TO A CHANNEL



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

- The construction of the Pietermaritzburg Airport runway directly through the upper portion of the wetland;
- 1 and 2 - The canalization of the wetland downstream of the culverts under the runway;
- 3 - The removal of wetland soils within portions of the wetland (i.e. particularly upstream of the runway); and
- 4 - The reduction in vegetation cover through either burning and / or cutting.

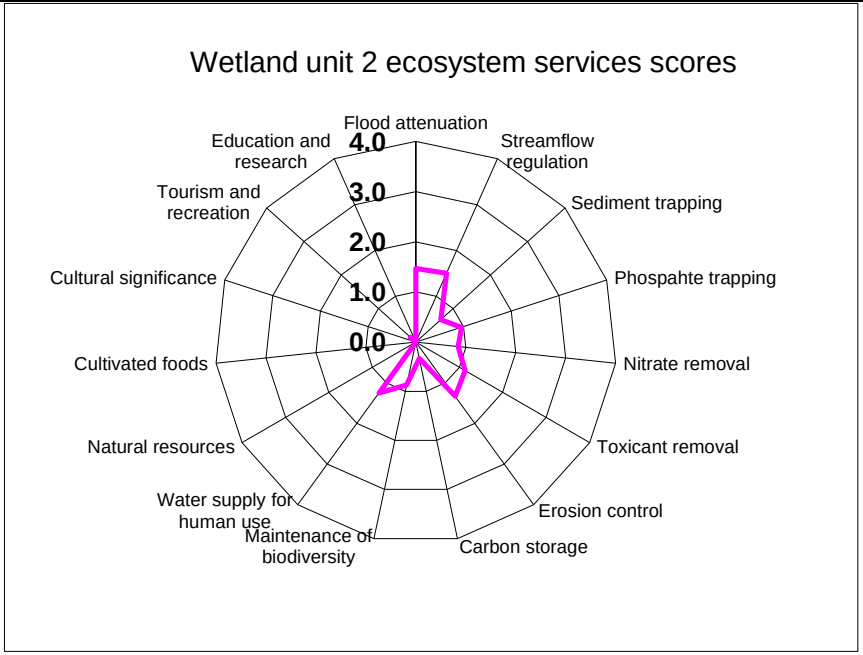
Wetland Delineation

Refer to the **Appendix E** 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.

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



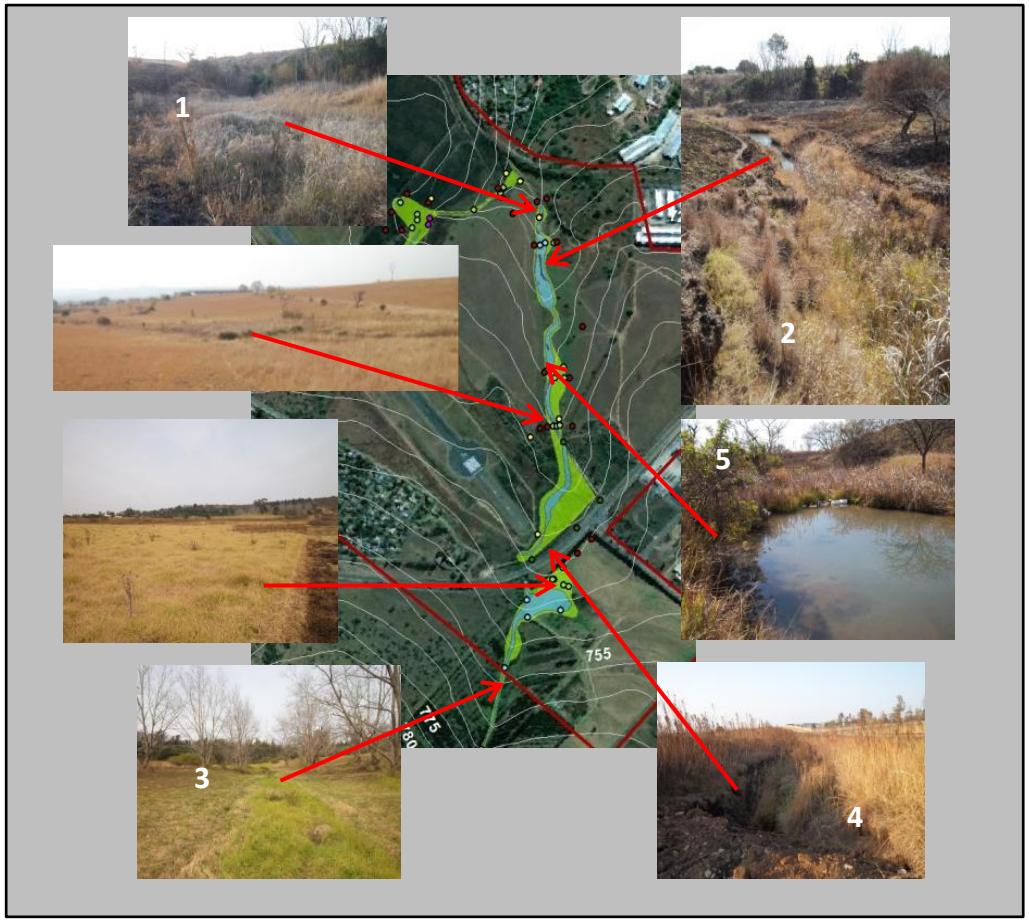
Ecosystem Services	Score
Flood attenuation	1.5
Streamflow regulation	1.5
Sediment trapping	0.7
Phosphate trapping	1.0
Nitrate removal	0.9
Toxicant removal	1.1
Erosion control	1.3
Carbon storage	0.3
Maintenance of biodiversity	0.9
Water supply for human use	1.3
Natural resources	0.0
Cultivated foods	0.0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

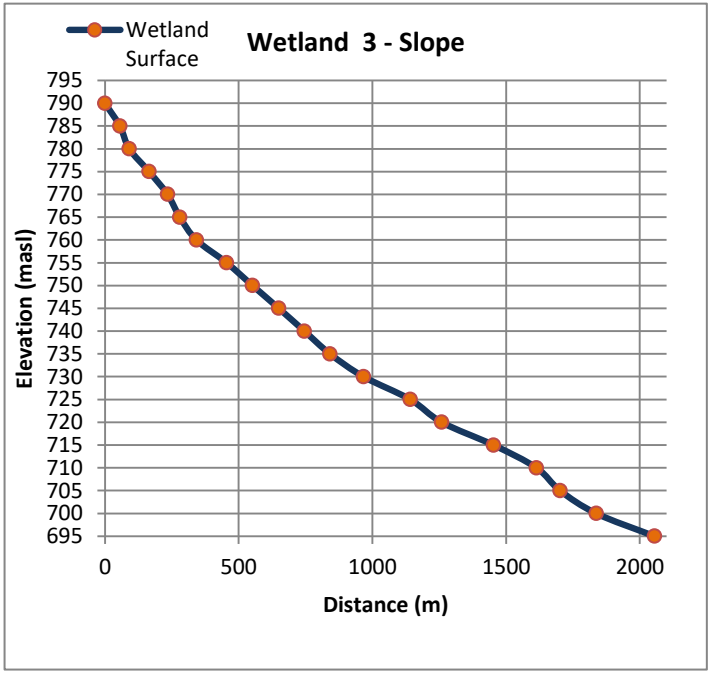
Due to the disturbances to this wetland ecosystem services in general scored poorly. Hillslope / valley head seeps generally slow the movement of water through the catchment, which has a number of benefits. However, water flows through a culvert under the runway and the wetland is largely canalized downstream 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.

EIS

The EIS score for the wetland was determined to be **1.6**. This means that the EIS is rated as **MODERATE** (Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems 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).

WETLAND 3 (W3) = VALLEY BOTTOM WITH A CHANNEL





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

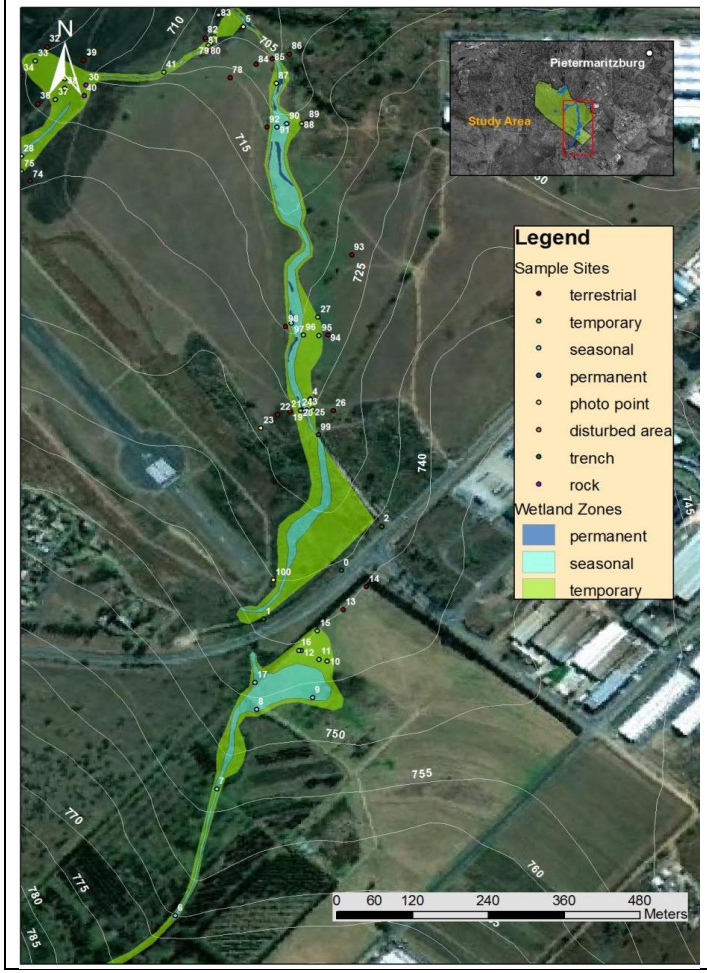
Wetland 3 is a disturbed channelled valley bottom wetland, which has been largely transformed through anthropogenic activities, including but not limited to:

- 1 - 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;
- 2 - A tarred road (Gladys Manzi), which cuts through the top portion of the wetland;
- A light industrial area within the catchment. Storm water runs directly into the wetland;
- 3 -Deep trenches have been dug for water pipelines adjacent to the Gladys Manzi 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 Gladys Manzi road;
- 4 - Earth works, i.e. trenches, directly downstream of the Gladys Manzi road;
- 5 - 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.

WETLAND DELINEATION



Wetland habitat below the railway crossing of the blackborough spruit

Culvert present, storm water discharge from adjacent industrial area, erosion and foul odour present.

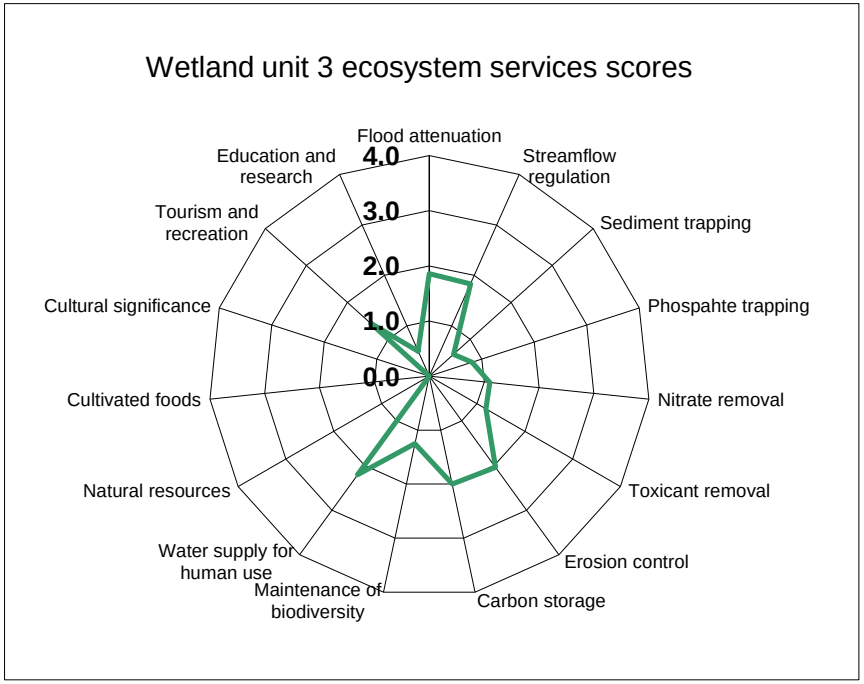
Sewage is present (broken sewer main – sewage flowing into the spruit) few metres from stream.

Stream is heavily polluted, aliens present throughout wetland

Refer to the **Appendix E** for a list of characteristics for each of the sample sites identified in the delineation maps.

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 storm water 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 completely 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.
EIS
The EIS score for the wetland was determined to be **1.6**. This means that the EIS is rated as **MODERATE** (Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers).

8. BIODIVERSITY ASSESSMENT

This desktop study has listed the potential faunal species that are of conservation concern and that may be found within the development footprint or the surrounding areas.

While the terrestrial ecosystems (i.e. primarily grassland) within the study area may not be pristine, sections are in a relatively good condition. The wetlands in the area however, are largely degraded, scoring largely modified to seriously modified on the WET-Health assessment.

As mentioned previously, the Bisley Nature Reserve is located approximately 7km away from the study site and is classified as a protected area with the reserve being owned by MM who are responsible for managing the reserve. The nature reserve was initially proclaimed to preserve and protect biodiversity and to provide recreational opportunities to Pietermaritzburg residents. Therefore it is important that the proposed development does not have an impact on the biodiversity of this protected area. This study therefore needs to take into account how the proposed development will affect the surrounding areas, particularly in terms of restricting any existing ecological corridors linking to the nature reserve.

8.1. KZN Systematic Conservation Assessment

Using data from EZKNW (2016) Sustainable Development Framework (SDF), it was possible to create a Critical Biodiversity Area (CBA) map (Figure 6). This map showed the optimal[1] and irreplaceable biodiversity areas for the study area. Irreplaceable CBA's are areas considered critical for meeting biodiversity targets and thresholds, and which are required to ensure the persistence of viable populations of species and the functionality of ecosystems. A portion of the proposed landside development/mixed use is situated in an irreplaceable CBA.

[1] Optimal CBAs are areas identified through systematic conservation planning software which represent the best localities out of a potentially larger selection of available planning units that are optimally located to meet conservation targets

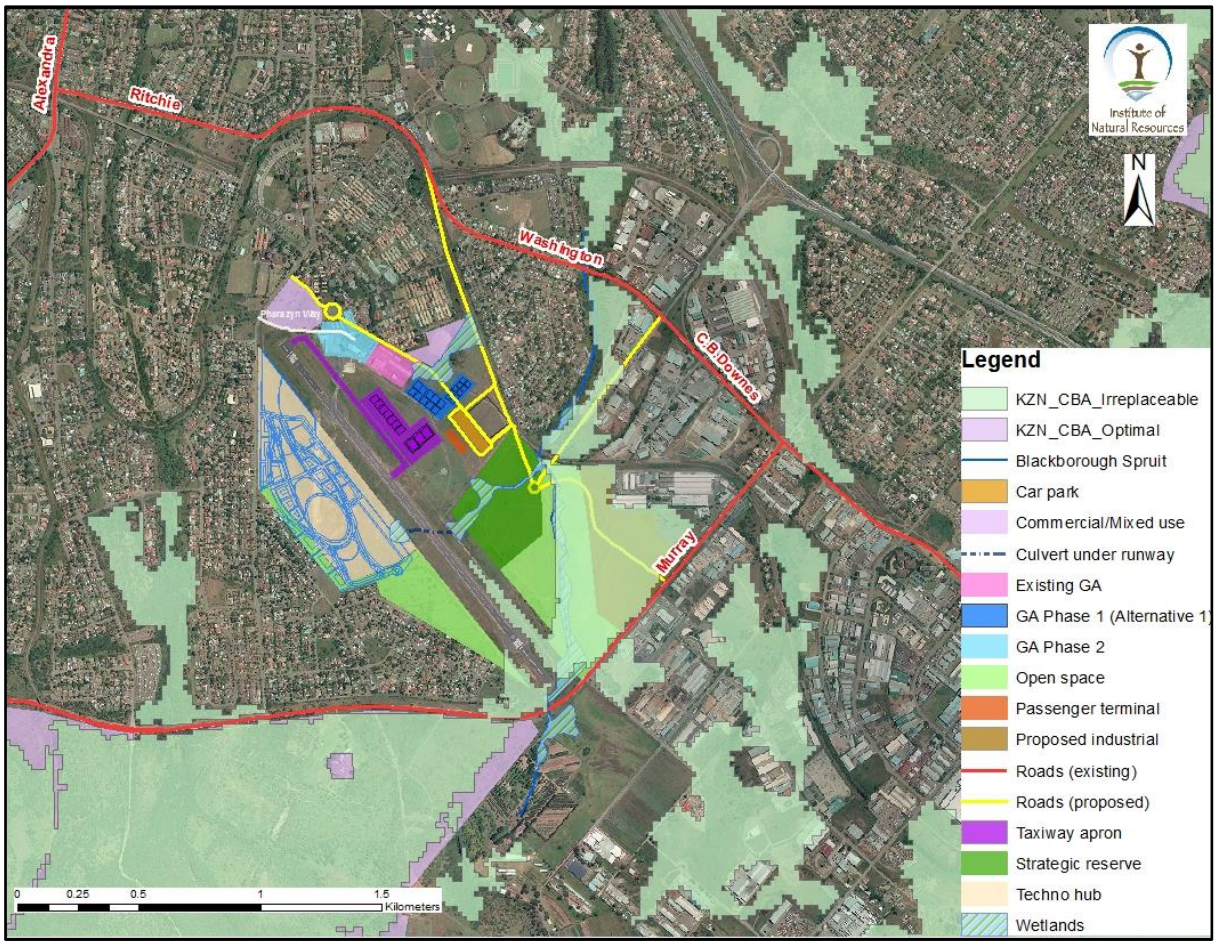


Figure 6: Map showing optimal and irreplaceable habitats

8.2. Desktop Faunal Study

This desktop study has identified seventeen potential faunal species of conservation concern that may be found within or adjacent to the study area (Table 9) (INR, 2008).

Table 3: List of faunal species with a conservation status that could potentially be within or adjacent to the study area (Pietermaritzburg Airport)

SPECIES	SCIENTIFIC NAME	STATUS	HABITAT	POTENTIAL TO OCCUR WITHIN OR ADJACENT TO THE STUDY AREA
Natal leaf folding frog	*Afrixalus spinifrons*	Vulnerable	Midlands, KZN, Inhabits marshes, dams, floodplains and river banks and also occurs in highland wetland areas.	Possibly, due to the wetlands present
Short-tailed Pipit	*Anthus brachyurus*	Vulnerable	Msunduzi Municipality, scattered, lowland grasslands	Possibly, grasslands are present but was not identified in previous bird study.
Black-headed dwarf chameleon (Endemic to KZN)	*Bradypodion melanocephalum*	Unknown	Natal Midlands, undisturbed grasslands, tall herbaceous plants. Leaf litter, or on tree	Unlikely, habitat mostly unsuitable.

SPECIES	SCIENTIFIC NAME	STATUS	HABITAT	POTENTIAL TO OCCUR WITHIN OR ADJACENT TO THE STUDY AREA
			trunk or branches.	
Lawrence's red millipede (Endemic to KZN)	*Centrobolus lawrencei*	Unknown	Narrow-range endemic (PMB & Richmond)	Possibly, is found in PMB but unclear if this includes the Airport
Corn crake	*Crex crex*	Vulnerable	Bisley Nature reserve, rank grassland and open savanna. Occurs around the edge of marshes, but seldom in areas with standing water.	Unlikely, most likely found at the Bisley Nature Reserve, the conditions at Oribi are less suitable.
Javelin flat-backed millipede (Endemic to KZN)	*Gnomeskelus jaculator*	Unknown	Bisley, In rotting logs, under rocks or logs, in leaf litter	Possibly but most likely only found at Bisley
Green giant earthworm (Endemic to KZN)	*Microchaetus papillatus*	Unknown	Narrow-range endemic, indigenous, undisturbed grasslands, small patches between bushes or agriculture fields	Possibly, due to the extent of grasslands in and around the Pietermaritzburg Airport. Rare species.
Thornville earthworm (Endemic to KZN)	*Proandricus thornvillensis*	Unknown	Narrow-range endemic, indigenous grasslands, bushes on the river banks	Possibly, due to the extent of grasslands in and around the Pietermaritzburg Airport. Rare species.
Southern African Python	*Python sebae natalensis*	Vulnerable	Very widespread distribution range, preferring rocky outcrops and moist, rocky, well wooded valleys in arid and moist savannah.	Unlikely, limited suitable habitat.
Broad-tailed Warbler	*Schoenicola brevirostris*	Near-Threatened	Widespread species inhabits marshy grassland, tall rank grassland along drainage lines and moist grassy hillsides.	Possibly, is a widespread species that inhabits grasslands.
Digger soil millipede (Endemic to KZN)	*Ulodesmus fossor*	Unknown	Pietermaritzburg Airport, in rotting logs, under rocks or logs, in leaf litter or in top 30cm soil.	Likely, has been identified at Pietermaritzburg Airport before.
Modest millipede (Endemic to KZN)	*Typhloxenus modestus*	Unknown	Bisley Nature reserve, in leaf litter, may also be found in trees on bark of trunk or branches	Unlikely, limited suitable habitat.
Shaw's earthworm	*Tritogenia shawi*	Unknown	Bisley Nature reserve, narrow range endemic	Possibly

SPECIES	SCIENTIFIC NAME	STATUS	HABITAT	POTENTIAL TO OCCUR WITHIN OR ADJACENT TO THE STUDY AREA
Boneberg's Frog/ Kloof frog	*Natalobatrachus bonebergi*	Endangered	Coastal forests and gallery forests, where it is usually found along streams, and does not survive in open areas. It breeds in streams, hanging its eggs above water on branches, and sometimes on rock faces.	Unlikely, unsuitable habitat - no forest or coastal forest.
Pietermaritzburg Giant Earthworm	*Microchaetus caementerii*	Thought to be extinct	Pristine Grassland	Unknown, not enough information available
Hairy robberfly	*Neolophonotus hirsutus*	Unknown	Unknown	Unknown, not enough information available
Wandering Black Millipede	*Doratogonus peregrinus*	Unknown	Endemic to KZN	Unknown, not enough information available
Lanner Falcon	*Falco biarmicus*	Near-Threatened in SA	Observed foraging over the grasslands	Likely to occur

All of the faunal species listed above are largely cryptic species and therefore it is difficult to determine their absence or presence. Likelihood of occurrence is based primarily on the availability of suitable habitat. Conservation of core habitat areas will be essential for ensuring suitable habitat remains for the species that are possibly or likely to occur in the area. Prior to construction commencing an entomologist should be contracted to survey the area for any species that could be relocated out of the development footprint.

As there is very little available literature on previous biodiversity studies done at Pietermaritzburg Airport it is difficult to give a precise breakdown of all the potential faunal species. There was however a study done at Pietermaritzburg Airport by Byron and Downs (2002) looking at the bird presence of the area. In that article it is worth noting that the author's state that Pietermaritzburg Airport is one of the worst airports for birds striking aircrafts, with Hadeda Ibis (*Bostrychia hagedash*) and the Crowned Plover (*Vanellus coronatus*) the most common birds hit by aircrafts at Pietermaritzburg Airport. Of all the bird species observed only the Lanner Falcon (*Falco biarmicus*) is on the Red Data Bird List (Near-Threatened in South Africa).

8.3. Vegetation Assessment

Many areas within the study area had been burnt during the preceding year; hence flowering was good this season. This allowed a species list of 120 species to be compiled (**Appendix F**). This list only represents taxa that are apparent and/or flowering at this time of year. Major groups such as the Orchidaceae flower later in the season and have hence not been recorded. For a more complete species list, the site needs to be surveyed over one or two years, during different seasons.

Three areas were surveyed within the fenced airport zone (sites 1, 2 and 3). Four areas were surveyed in areas adjacent to the fenced-in airport zone (sites 4, 7, 8 and 9). These are indicated in Figure 7.

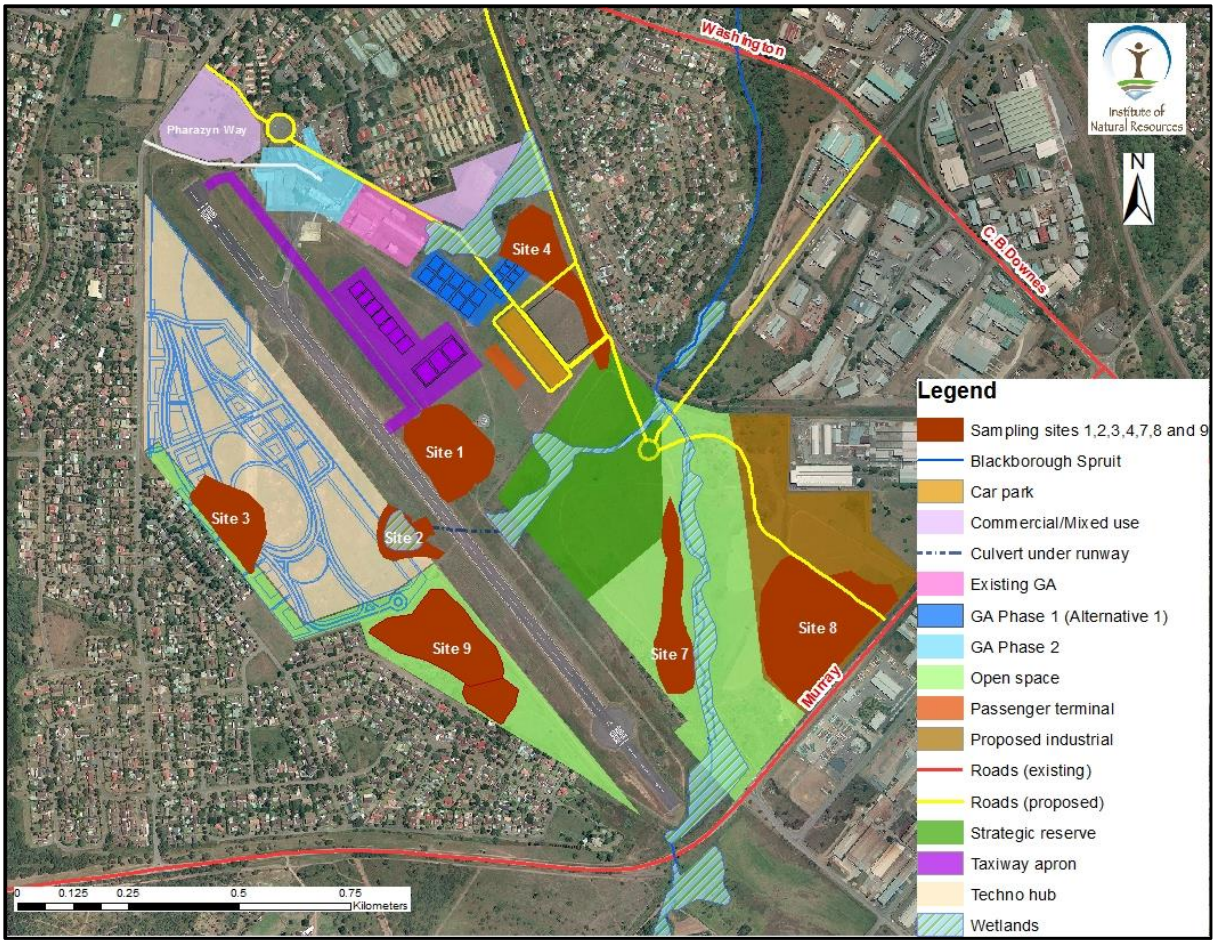


Figure 7: Vegetation sampling sites

A combined species list for the whole area was compiled (120 species), with presence recorded for each of the seven sites. If a species has not been recorded for a site, it does not necessarily mean the absence of that species. Time constraints – especially in the fenced-in airport zone – meant that only representative areas were sampled for each site.

The majority of the area is grassland in good condition (Figure 8). One section towards Murray Road is becoming degraded. The fenced-in areas appear to have not been grazed for many years and are in better condition to the grassland areas outside of the perimeter fence (Figure 8). This finding is based on the relatively good plant diversity identified at the sample sites within the fenced-in area. Other habitat types, apart from the various grasslands, included degraded bushveld and wetlands. The full notes on the botanical survey can be found in **Appendix G**.

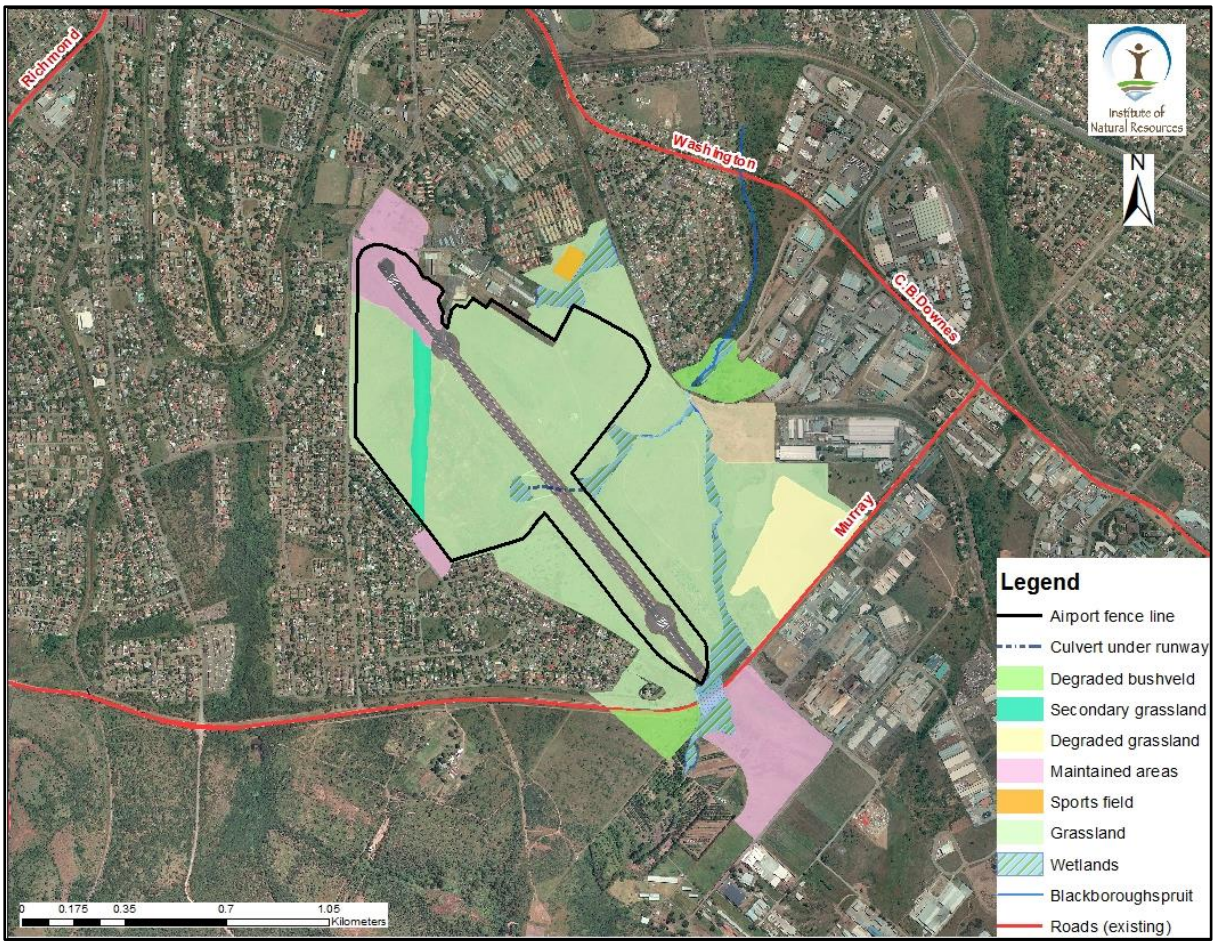


Figure 8: Map showing plant communities across the study site

8.3.1. Red Data Plant Species

Five Red List plant species were identified on site (**Appendix H**), all of them either listed as declining or vulnerable; *Boophone disticha, Brachystelma franksiae, Crinum bulbispermum, Hypoxis hemerocallidea and Woodia verruculosa.*

Boophone disticha is a species in the declining category of the Redlist of SA plants. It is an attractive, deciduous bulbous plant with a thick covering of dry scales above the ground. The colour of flowers varies from shades of pink to red and is sweetly scented. The plant has many medical uses but the bulb is very poisonous.

Brachystelma franksiae is a narrow range endemic in KwaZulu-Natal where it is usually found in grassland. It is in the vulnerable category of the Redlist of SA plants. It is a herb comprised of 1-2 stems and grows up to 300mm. The leaves are approximately 50mm long with a broad base tapering to sharply pointed tips. One to three hanging flowers are produced between September and February.

Crinum bulbispermum is a species in the declining category of the Redlist of SA plants and it occurs naturally mainly on the highveld areas of the eastern hinterland. It is a large bulbous plant up to 1m high, which produces attractive grey green gracefully arching leaves during the summer months. Has

a tall stem bearing large, hanging, lily-type flowers which are white with a pink to red stripe in each petal, is produced early in the growing season

Hypoxis hemerocallideais is a species in the declining category of the Redlist of SA plants and is usually found in grasslands and is characterized by straplike leaves and yellow star-shaped flowers. The leaves are up to 400mm long, with the lower surface of the leaves being densely hairy with white hairs. Leaves appear above ground in spring before the flowers appear.

Woodia verruculosa is in the vulnerable category of the Redlist of SA plants. It is a perennial herb. Found in mistbelt and Ngongoni Grassland, Midlands and southern Zululand and is mostly recorded between Howick and Eston. The stem is between 15-25mm tall and the leaves are broad, rough with 4-7 pairs.

8.3.2. Invasive Alien Plant Species

The un-mowed, unburnt areas in the airport are being invaded by alien invasive woody plant species. *Lantana camara*, *Solanum mauritianum* (Bugweed), *Litsea sebifera*, *Melia azedarach* (Syringa), *Gleditsea triacanthos* (Honey locust) and *Tecoma stans* (Yellow bells) are species that require an active alien invasive control programme in this area. Other alien species are present throughout the study area with a full list of alien species being found in **Appendix H**.

8.3.3 Important Medicinal Plant Species

Boophone disticha is a very poisonous plant that has medicinal value with parts of the plant being used by certain African tribes and also by some Europeans to cure various ailments. The outer covering of the bulb is applied to boils and abscesses. Fresh leaves are used to stop bleeding of wounds.

Crinum bulbispermum is used in traditional healing as a cure for common colds, rheumatism, varicose veins. It is also used to reduce the swelling and the treatment of septic sores. It also has superstitious values as many rural areas use it to protect their homes from evil.

Hypoxis hemerocallideais has been used in traditional medicine in South Africa for many years. The tuberous rootstock is traditionally used to treat a wide variety of ailments and is used against tuberculosis and cancer. It is also used to build up the immune system of patients suffering from cancer and HIV. Different compounds are created from it that have medicinal purposes.

8.4. Ecological corridors

An ecological corridor connects within and between ecosystems in the landscape and is well recognized as contributing significantly to biodiversity conservation, particularly in highly transformed landscapes (Bennett, 1998, 2003). Corridors allow an increase in migration of species to habitats, thus increasing the species richness of that habitat (Bennett, 1998, 2003). Increased movement of species also allows for genetic mixing and reduces or prevents inbreeding (*Williams et al*., 2005). For many semi-aquatic reptile species connectivity between aquatic habitats is regarded

as vital as these species often cross land in order to find suitable hibernating spots or patches of permanent water in the dry season (Cowan, 1995). Although fine scale corridors enable short distance or regional movements, they also play a role in sustaining long distance migrations.

Ecological corridors also have a range of reported disadvantages. These include; facilitating the spread of unwanted species, diseases and abiotic disturbances, increasing the exposure of animals to: predators, hunting or poaching by humans, and high management costs of these corridors that may reduce funds available for alternative conservation actions. It is worth noting that many of these would apply equally to large intact landscapes.

The grassland and wetland habitat at the Pietermaritzburg Airport study site is home to a diverse array of species. The proposed developments may potentially hinder the movement of species to the different habitats. To ensure that the movement of species are not completely hindered, a core habitat / corridor will be considered as part of the final buffer to allow movement of species during the construction and operation phase of the development.

9. BUFFER ZONES

9.1. Aquatic Impact Buffers

Buffer zones play a vital role in mitigating anthropogenic impacts on aquatic ecosystems with some of their functions including: maintaining basic aquatic processes, services and values, reducing impacts from upstream and adjacent activities and land uses, and providing habitat for terrestrial species. The general approach to buffer zones has been to apply a standard buffer distance regardless of taking into account the specific characteristics of the ecosystem in question or the attributes of the actual buffer zone (i.e. slope, topography, vegetation, soil). Macfarlane et al. (2014) developed an approach for determining buffer zones, and the current Water Research Commission guideline document that is available is “The Preliminary guideline for the determination of buffer zones around wetlands, rivers and estuaries”. This approach has been identified by the DWS as a preferred method for determining buffer zones. It advocates for the assessment of key attributes rather than the use of a standard distance buffer zone. The following criteria are considered for determining buffer zones:

- The threats associated with the development;
- Climatic conditions in the general area (i.e. mean annual precipitation and rainfall intensity);
- The sensitivity of the wetland, riparian areas and drainage lines (i.e. in terms of the water resource and biodiversity); and
- Site specific characteristics of the proposed buffer zone (i.e. slope, vegetation density (during construction and operational phases of the development), soil characteristics, etc.).

The buffer zones of the wetlands were assessed using the Preliminary guideline for the determination of buffer zones around wetlands, rivers and estuaries (Macfarlane et al., 2014). It is also our understanding that the delineation of the buffer zones also informed the final selection of some of the infrastructure for the proposed development.

Taking a conservative approach, an aquatic impact buffer width of 43 meters was determined for Wetland 1, 25 meters for Wetland 2 and 26 metres for Wetland 3 (Figure 9). These aquatic impact buffer sizes are sufficient to mitigate lateral impacts through diffuse surface runoff into the wetland (i.e. such as sediment deposition, diffuse storm water runoff, etc.).

An aquatic impact buffer width of 25 metres for Wetland 1 is appropriate for the proposed landside development/mixed use as it has a potential to impact the wetland through an increase in sediment input and turbidity into the wetland and through potentially altering the patterns of flow in the wetland (increased flood peaks).

An aquatic impact buffer width of 26 metres was determined for the bottom segment of Wetland 2, where the proposed techno hub will be. A buffer of this distance is necessary because of the potential high impacts of an increase in sediment input and turbidity into the wetland and potentially altering the patterns of flow in the wetland (increased flood peaks). A buffer of 45 metres was deemed necessary for the top section of Wetland 2, situated in the area of the proposed car park. The wetland surrounding area has a fair cover of vegetation, has a dominantly uniform topography and has soils that are not well drained.

An aquatic impact buffer of 26 metres was determined for Wetland 3 where the proposed landside development will be. A buffer of this distance was deemed necessary because of the potential high impacts of an increase in sediment input and turbidity into the wetland and potentially altering the patterns of flow in the wetland (increased flood peaks).

The aquatic buffer width recommended is only applicable for this development. In addition, alternative mitigating measures, e.g. sediment trapping devices (sediment filters) and appropriate storm water management structures may well be more effective at limiting certain impacts to the wetland.

The proposed roads and turning circle are set to occur inside the wetland and therefore a buffer is not going to mitigate the impact of the roads and turning circle.

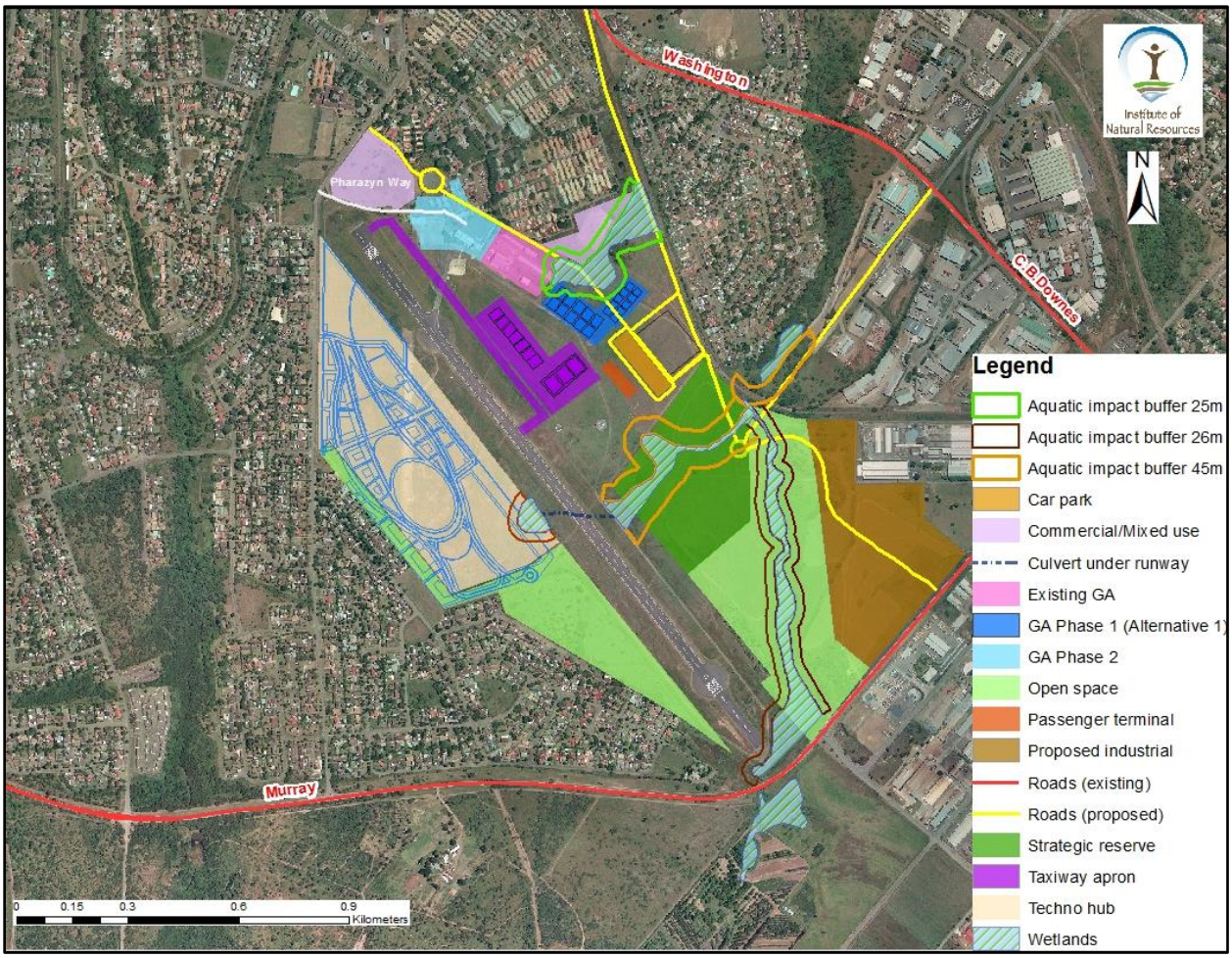


Figure 9: Recommended Aquatic Impact buffer zones

9.2. Biodiversity Buffer Requirements

In addition to the aquatic impact buffer requirements, consideration was also given to the threatened habitat types and habitat requirements of threatened species. The biodiversity assessment highlighted that a significant portion of the study site was grassland in relatively good condition. Many threatened and near threatened vegetation species are located in the grassland areas which include species such as *Brachystelma franksiae* which was identified in the proposed study site and is a vulnerable vegetation species that is endemic to the KZN midlands. This particular vegetation species struggles to relocate and is sensitive when handled. It is thus recommended that development is limited in the study area as much as possible. In consultation with Dr. Curry, sections of the Airport study sited should be deemed 'Core Habitat' areas[2] (Figure 10) and are of special concern and any form of development in these areas is argued against. Other sections of the study

[2] Core Habitat = The area of natural habitat essential for long term persistence of a species in its current distribution range.

area fall under 'Prime Habitat' areas[3] although not as critical as a 'Core Habitat' these areas are still of concern, and it is our recommendation that development be limited as much as possible in these areas. Limiting development implies, where practically possible, limiting the footprint of proposed infrastructure and incorporating the remaining grassland in the primary habitat areas into the landscaping around the development.

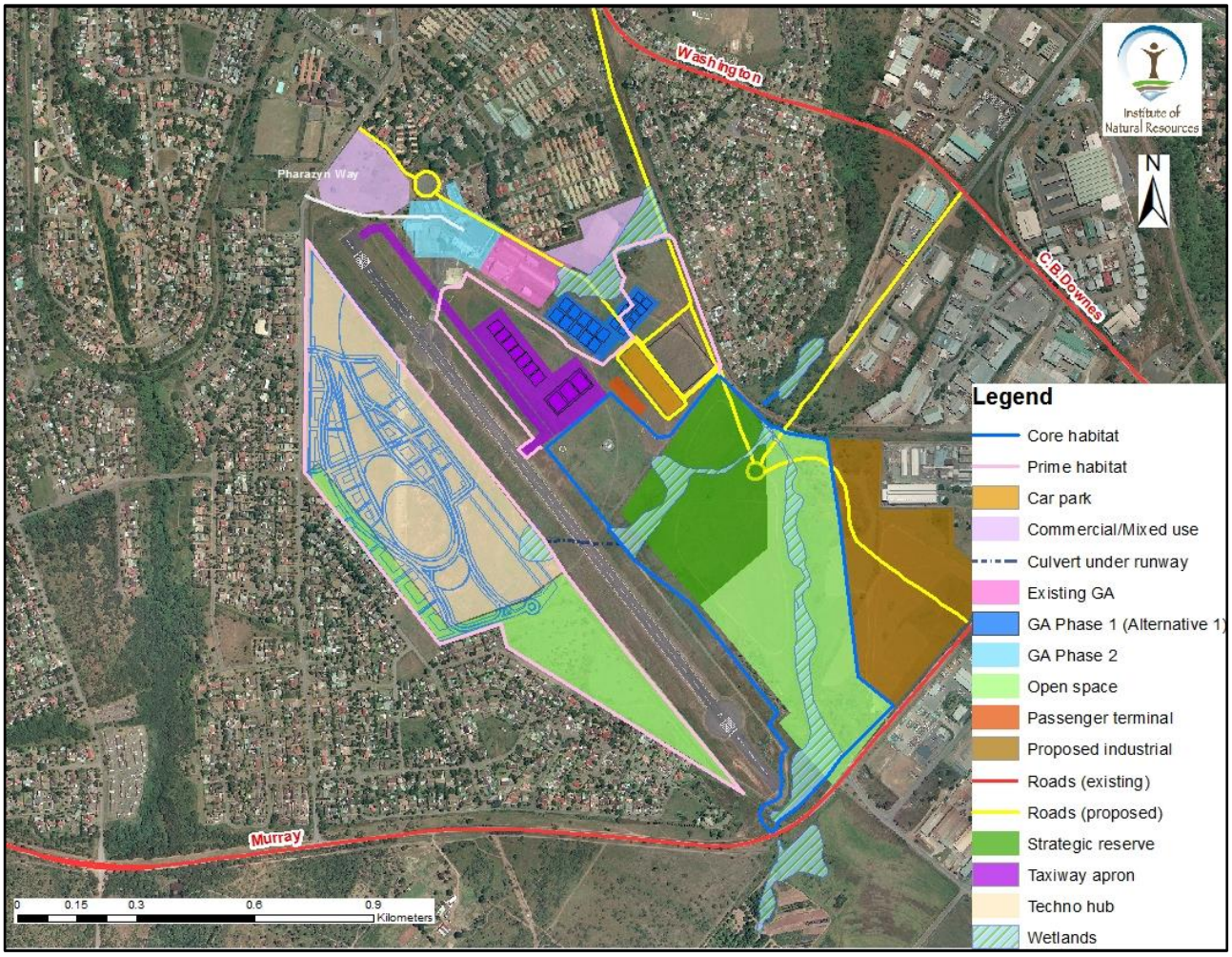


Figure 10: Map showing the core and prime habitats

A final buffer was established, taking into account the aquatic impact buffer zones and the 'Core Habitat' areas (Figure 11). The final buffer is also set outside the Pietermaritzburg Airport fence line, in the grassland, thus ensuring the protection of the biodiversity in this area from the proposed development. It is important to note that these grassland areas do occur in the Pietermaritzburg Airport property with certain parts earmarked for development. Again it is stressed that development in this area be limited and the footprint of the proposed development be minimal to

[3] Prime Habitat = The area of natural habitat, in addition to core habitat areas that contribute to the persistence of a species in its current distribution range. Essentially these areas are representative of habitat in a relative good condition that should be conserved where practically possible.

protect the biodiversity of the area. The buffer region outside the fence line will allow for species to migrate between the different wetland systems without being affected by the development.

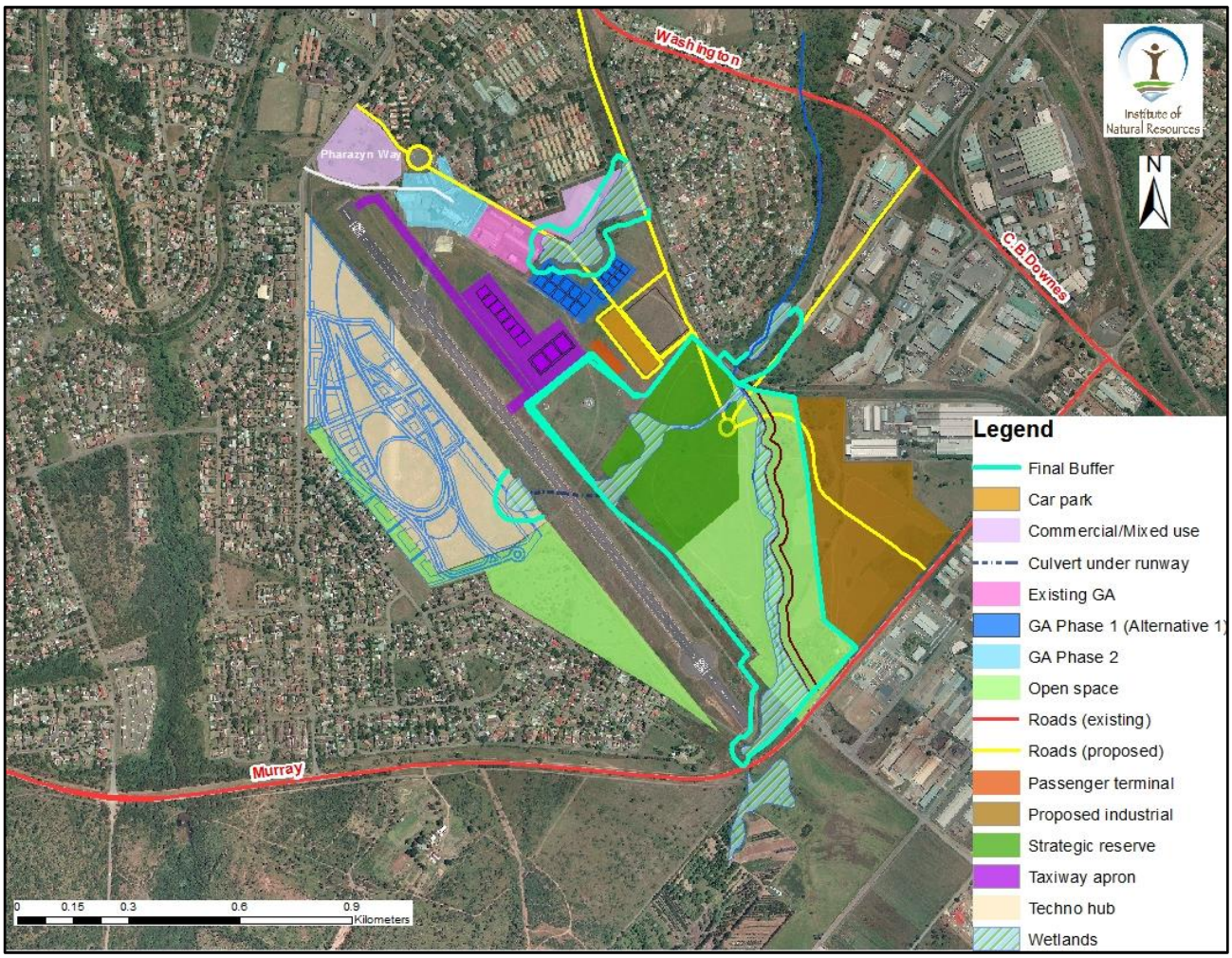


Figure 2: Recommended final buffer zones

10. IMPACTS AND MITIGATION MEASURES

10.1. Existing Impacts

The aquatic ecosystems within and directly adjacent to the study area have been extensively transformed through anthropogenic impacts over an extended period. The wetland habitats in particular have been transformed through a wide range of land use activities in the catchment and are all in poor environmental condition.

There are multiple existing impacts in the study site. Major soil erosion is present at the top side of wetland 2, with gullies forming in the landscape. There are smaller levels of soil erosion scattered throughout the study area. Alien invasive species are present throughout the study site and are prevalent in the different wetland ecosystems and grasslands. Sewage and storm water discharges are entering into the wetlands and the Blackborough Spruit. There has been the construction of channels/drains within wetlands to drain the storm water runoff from the airport. Dumping of

rubble and litter has taken place within some of the wetlands. The reductions in vegetation cover through either burning and / or cutting.

10.2 Potential Impacts to Wetland and Terrestrial Habitats

10.2.1 EIA Impact Assessment

The proposed expansion of Pietermaritzburg Airport and associated developments (Figure 1) will result in certain infrastructure being positioned within and directly adjacent to wetland and grassland in relatively good condition (Table 10).

Table 10: Estimated area of loss and the likely cause for the loss

Vegetation Type	Area (Ha)	Estimated Area Loss (%)	Cause for Area Loss
Wetland 1	3,01	4	Proposed road, Commercial mixed use, GA Phase 1
Wetland 2	2,33	26	Techno hub, small stretch of proposed road, car park, passenger terminal
Wetland 3	5,70	1	Small patches of road, GA Phase 1, Industrial area
Grassland Inside fence line	69,53	50	Techno hub, Taxiway apron, passenger terminal, GA Phase 1, Car park, proposed roads
Grassland Outside fence line	45,38	11	Techno hub, Industrial area, Commercial mixed/use, GA Phase 1, proposed roads
Secondary Grassland	3,07	100	Techno hub
Maintained Areas	21,36	16	Commercial Mixed Use, Taxiway apron
Sports field	0,68	100	Commercial Mixed Use
Degraded grassland	10,47	87	Proposed Industrial and proposed road
Degraded Bushveld	6,48	3	Proposed Road
Wooded Grassland	4,68	46	Proposed Industrial and proposed road

The development will result in the direct loss of wetland and grassland habitat and a small portion of degraded bushveld, even if the final buffer zone is implemented and effectively managed (Table 10). Impacts from the adjacent developments may result through diffuse surface inputs or point source discharges. These impacts will need to be taken into consideration, as these types of impacts may result in a further loss of functionality or area of ecosystems. Impacts include (refer to the impact tables):

- Loss of wetland/stream habitat (habitat and buffer) – construction phase.
- Loss of Grassland habitat – construction.
- Loss of Red Listed Species.
- Pollution of Wetlands and Blackborough Spruit – during construction from construction activities and substances (cement, steel, rubble, etc.) and sediment, from disturbed areas.

- Increased infestation by Alien invasive plant species in wetland and grassland - construction/operational phase.
- Pollution and erosion of wetland and stream habitat– (operational phase) from uncontrolled storm water.

In addition to the potential onsite impacts, particular concern should be given to the likely cumulative impact of the proposed development. There were sightings of red list vegetation species in a short survey time and there is the possibility that there may be more of these species in the area. The proposed location of the techno hub is positioned on grassland in good condition relative the grassland outside of the fenced area. This grassland was considered prime habitat. The proposed development will also transform the landscape. Coupled with the existing impacts from activities in the catchment the developments are likely to have a measurable cumulative impact on the aquatic ecosystems adjacent and downstream to the development footprints. While the impact on wetlands on site and directly adjacent to the site are anticipated to be moderate, it is the impact on the instream and riparian environment which is likely to be more significant.

The following tables list the main impacts associated with the development and assesses the significance of each impact to the environment. The tables also assess possible mitigation measures that can be put in place to address the impacts and to determine if there is a reduction in the significance of the impacts. These assessment can then be compared to a 'no go' option (a scenario if the development did not take place) to try and determine the significance on the environment if the development did not take place.

Impact Assessment of the General Aviation Phases

General Aviation (GA) Phase 1 is positioned inside the aquatic impact buffer zone of Wetland 1. If realigned outside the buffer zone it is anticipated that the impact of GA Phase 1 is likely to be reduced. General Aviation Phase 2 is unlikely to have any direct significant ecological impact to the wetlands or grasslands.

Impact:	**Loss of wetland/stream habitat**								
Description	The development of proposed infrastructure for the airport is anticipated to result in the loss of approximately 0.7ha of wetland habitat.								
Causes	Proposed road, Commercial mixed use, GA Phase 1, Techno hub, small stretch of proposed road, car park, passenger terminal, Small patches of road, GA Phase 1, Industrial area								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Pre-mitigation significance	Direct	-ve	On site	Permanent	Low	Minor	Definite	Moderate	Medium
Mitigation measures	**Develop and implement a wetland rehabilitation and management plan - Rehabilitation of entire remaining wetland systems, which will need to include rehabilitation activities such as clearing aliens, replanting of veg, clearing rubble, erosion control, etc. Amend final design of infrastructure to limit wetland and buffer area lost.**								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Post-mitigation significance	Direct	+ve	On site	Permanent	Low	Minor	Likely	Minor	Medium

No go Option

Impact:	**Loss of wetland/stream habitat**								
Description	No development								
Causes	**The development does not go ahead so portions of wetland and stream habitat are not lost. This would be a positive impact. However, the loss of opportunity to rehabilitate the wetland systems outweighs this minor positive impact. Overall the no-go option will likely result in a negative impact to wetlands.**								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
No-go significance	Direct	-ve	Local	Long Term	Medium	Moderate	Likely	Minor	Medium

Impact:	**Loss of grassland and bushveld habitat and Red Listed Species**								
Description	The development of proposed infrastructure for the airport, will lead to the permanent loss of about 41.3% of grassland habitat, which is home to several red list species on site, and 3% of degraded bushveld.								
Causes	Techno hub, taxiway apron, passenger terminal, GA Phase 1, car park, proposed roads								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Pre-mitigation significance	Direct	-ve	On site	Permanent	Medium	Moderate	Definite	Moderate	Medium
Mitigation measures	**Realignment of final designs to limit area of impact to grassland habitat (particularly prime and core habitat areas). Develop and implement a grassland management plan. Search and rescue prior to construction.**								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Pre-mitigation significance	Direct	-ve	On site	Permanent	Medium	Moderate	Definite	Moderate	Medium

No go Option

Impact:	**Loss of grassland habitat and Red Listed Species**								
Description	No development								
Causes	**The no-go option would result in there being no loss of grasslands which are in relatively good condition, within the fenced precinct. The grasslands within the fenced area are also likely to be managed in a similar manner to how they are currently being managed, thus maintained in their current state. The grasslands outside of the fenced area would also remain. The conditions of these are unlikely to change significantly.**								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
No-go significance	Direct	+ve	Local	Long Term	Medium	Moderate	Likely	Moderate	Medium

Impact:	**Pollution of Wetlands and Blackborough spruit**								
Description	Pollution from the proposed infrastructure through direct sources such as the dumping of rubbish or point source discharges, or through diffuse surface flow, etc.								
Causes	Proposed infrastructure and land uses								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Pre-mitigation significance	Direct	-ve	On site	Short Term	Low	Minor	Likely	Minor	Medium
Mitigation measures	**Standard pollution control measures and sediment control measures/systems. E.g. use of sediment curtains, limit activities within wetlands, reduce footprint of activities, etc.**								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Post-mitigation significance	Direct	-ve	On site	Short Term	Low	Minor	Likely	Minor	Medium

No go Option

Impact:	**Pollution of Wetlands and Blackborough spruit**								
Description	No development								
Causes	The no-go option would mean that no development would occur in the wetlands or the Blackborough spruit, meaning that the amount of pollution going into these areas would be significantly reduced.								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
No-go significance	Indirect	+ve	Local	Long Term	Medium	Moderate	Likely	Minor	Medium

Impact:	**Increased infestation by Alien invasive plant species in wetland, bushveld and grassland habitat**								
Description	The disturbance of these areas through construction and development, may potentially allow alien invasives to spread in these areas and reduce the areas ecological state								
Causes	Proposed road, industrial areas, commercial mixed/use, Taxway apron, GA Phase 1								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Pre-mitigation significance	Indirect	-ve	On site	Long Term	Low	Minor	Likely	Moderate	Medium
Mitigation measures	**Develop and implement an invasive plant management plan.**								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Post-mitigation significance	Indirect	-ve	On site	Long Term	Low	Minor	Likely	Minor	Medium

No go Option

Impact:	**Increased infestation by Alien invasive plant species in wetland and grassland**								
Description	No development								
Causes	If the development does not go ahead there is less disturbance and less chance of an infestation into the wetland, bushveld and grassland habitats. However, the opportunity to manage existing invasive plant species will be lost								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
No-go significance	Indirect	+ve	Local	Long Term	Medium	Moderate	Likely	Negligible	Medium

Impact:	**Pollution and erosion of wetland and stream habitat from uncontrolled storm water**								
Description	The Storm water from the developments may contain a variety of nutrients that can alter the health of the wetland and stream. The increased storm water also means more water to erode the wetland habitats and stream banks								
Causes	Proposed road, Commercial mixed use, GA Phase 1, Techno hub, small stretch of proposed road, car park, passenger terminal, Small patches of road, GA Phase 1, Industrial area								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
Pre-mitigation significance	Indirect	-ve	Local	Long Term	Medium	Moderate	Likely	Moderate	Medium
Mitigation measures	**Realignment of the proposed infrastructure to accommodate the recommended buffer zone. Storm water management plan applying sustainable urban storm water design principles. Storm water discharges points should not be placed within wetlands or the associated buffer zone.**								
Impact assessment	**Type**	**Status**	**Exteb vnt**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
	Indirect	-ve	Local	Long Term	Medium	Moderate	Likely	Moderate	Medium

No go Option

Impact:	**Pollution and erosion of wetland and stream habitat from uncontrolled storm water**								
Description	The development does not go ahead so the wetland and stream habitats are not impacted by uncontrolled storm water								
Causes	With the development not going ahead, it would mean no uncontrolled storm water which can cause erosion and pollute sensitive habitats such as wetlands and streams								
Impact assessment	**Type**	**Status**	**Extent**	**Duration**	**Intensity**	**Magnitude**	**Likelihood**	**Significance**	**Confidence**
No-go significance	Indirect	+ve	Local	Long Term	Medium	Moderate	Likely	Moderate	Medium

10.2.2. DWS Risk-based Management Assessment

The risk-based management approach developed by the DWS is required to be undertaken to determine if a Water Use License Application (WULA) is required. The approach was used to assess potential impacts on wetland habitats. The approach takes into consideration control / mitigation measures when scoring the significance of the potential impact (i.e. post mitigation). All impacts assessed warrant the application of a water use licence. A summary of the assessment is provided in Table 11.

Table 4: Summary of the Risk Matrix (refer to **Appendix D**)

Activity	Aspect	Impact	Consequence (*Severity + Spatial Scale + Duration*)	Likelihood (*Frequency of Activity + Frequency of Incident + Legal Issues + Detection*)	Risk Score	Risk Rating	Control Measures
Wetland 1: Proposed road, Commercial mixed use, GA Phase 1	Clearing of vegetation and digging to lay foundations within and adjacent to a wetland. Plus other associated construction activities	Wetland loss, veg loss, reduced functionality, increase runoff, increase sediment and nutrient input.	**8**	**14**	**112**	**M**	Construction phase: • Implementation of the recommended buffer zone for the wetland. • The use of sediment curtains. • For all road crossing, it should be ensured that the road has minimal effect on the flow of water through the wetland. Crossings points should be kept to a minimum and be ideally be located at existing crossing points / disturbance points. No excavation of the wetland should be permitted (Roads should ideally not be allowed to traverse a wetland). • The development and implementation of a wetland rehabilitation and management plan. The plan should be completed prior to construction commencing. Operational phase: • Limit access to wetland habitat and surrounding grassland. Implement the wetland management plan.
	Increased activity in the area, pollution, litter	Litter, soil compaction, possible oil spills and waste into the wetland areas	**7,25**	**11**	**79,75**	**M**	
Wetland 2: Techno hub, small stretch of proposed road, car park, passenger terminal	Clearing of vegetation and digging to lay foundations within and adjacent to a wetland. Plus other associated construction activities	Wetland loss, veg loss, reduce functionality, increased runoff, increased sediment and nutrient input	**8,25**	**14**	**115,5**	**M**	
	Increased activity in the area, crossing points through the wetland	Litter, pollution, increased runoff with sediments and contaminates	**6,75**	**11**	**74,25**	**M**	
Wetland 3: Access roads, GA Phase 1, Industrial area	Clearing of vegetation and digging to lay foundations within a wetland. Plus other associated construction activities	Direct loss of a wetland, veg loss, reduce functionality, increase runoff, increase sediment and nutrient input, habitat loss to red list species	8,5	**15**	**127,5**	**M**	
	Industry operating adjacent to a wetland, potential discharge of waste and pollution, litter, contaminates	Litter, pollution, increased runoff with sediments and contaminates	9,25	**10**	**92,5**	**M**	

10.3. Recommended Mitigating Measures

The following measures should be taken into consideration for identifying possible options for reducing the impact of the proposed development:

- ***The implementation of the recommended final buffer zones***

  The implementation of the recommended final buffer zones during the construction and operational phases will significantly reduce the likelihood of the development impacting the adjacent aquatic ecosystems through diffuse surface runoff. In order for the buffer zones to function effectively sediment curtains must be used throughout the construction phase. The sediment curtains will need to be placed outside of the buffer zone and constructed parallel to the edge of the buffer.

  The sediment curtains in conjunction with the recommended final buffers zones are anticipated to effectively mitigate the increase in sedimentation during the construction phase. The buffer zones are also expected to mitigate other possible inputs, such as nutrients and toxic contaminants, during the operational phase. However, this will be dependent on effective management of the buffer areas. Appropriate management measures include:

  - The implementation of an alien invasive vegetation clearing programme;
  - Clearing of all debris and / or litter from the buffer areas and aquatic ecosystems on a regular basis; and
  - The focus of maintaining the buffer area as a strip of natural vegetation (i.e. focus should be on achieving the best possible basal cover for the buffer areas).
  - In the grassland areas, no gardens should be created, mowing needs to be kept to a minimum.

  It is important to highlight that the buffers will only be effective at mitigating diffuse surface runoff from adjacent activities and not adjacent point sources discharges or direct impacts in the buffer and/or aquatic ecosystem. Should there be anticipated impacts of this nature, then alternative mitigation measures will need to be investigated.

- ***Develop and implement a wetland and grassland rehabilitation and management plan***

  Rehabilitation of entire remaining wetland systems, which will need to include rehabilitation activities such as clearing aliens, replanting of veg, clearing rubble, erosion control, etc. Given the extent of the loss of wetland habitat it is anticipated that rehabilitation, and not offsets, will sufficiently mitigate the impacts of the proposed development. Therefore, a detailed rehabilitation and management plan is required to be developed, prior to construction, to determine the hectare equivalents of the wetland habitat lost and the appropriate rehabilitation and management measures required to mitigate the impacts. A grassland management plan will also need to be developed prior to construction, as a considerable area of grassland in relative good condition will be lost as a result of the development. Thus the plan is important to ensure that the core grassland habitat within the recommended final buffer zone, and remaining portions of prime grassland habitat, are managed as conservation areas. It is important to note

that a portion of the core habitat identified incorporates Irreplaceable CBA areas, which are considered critical for meeting biodiversity targets and thresholds, and which are required to ensure the persistence of viable populations of species and the functionality of ecosystems.

- ***Amendment of the final design of infrastructure to limit the loss of wetland and grassland habitat***

  The final designs for the development need to be amended, where practically possible, to limit the impact to wetlands and grassland. An ecologist needs to be contracted prior to contraction, and during the appropriate season (e.g. spring/summer), to undertake a search and rescue operation for floral species that are able to be relocated (this will also provide an opportunity to document additional populations of red list species).

  For example: the layout of the hangers and commercial / mixed use development currently within a portion of Wetland 1 should be realigned, if practically possible, to exclude the wetland and buffer zone. In addition, crossing points should be kept to a minimum and be ideally be located at existing crossing points / disturbance points. No excavation of the wetland should be permitted (Roads should ideally not be allowed to traverse a wetland).

- ***Standard pollution control measures and sediment control measures/systems***
  Sediment curtains should be used during construction. These should be placed outside of the recommended buffer zones. Activities within wetlands should be limited. The footprint of activities should be reduced.

- ***Develop and implement an invasive plant management plan***
  The plan should cover all habitats throughout the study area and should be developed for the different phases of the development (i.e. construction and operation).

- ***Develop and implement a storm water management plan***
  Develop and implement a storm water management plan that applies sustainable urban storm water design principles.

- ***Buffer zone management***
  The following management measures must be implemented to reduce the impact of the development and enhance the functionality of the buffer zones.
  - Demarcate the recommended buffer zones (e.g. with the use of clearly visible pegs / markers, placed along the edge of the final buffer zones). The buffer areas, other than dedicated crossing points, should be considered 'no go' areas during the construction phase.
  - The buffer zones should be managed throughout the construction and operational phases as strips of natural vegetation. Maintaining good basal cover must be the primary focus. Therefore, it is recommended that an alien invasive vegetation clearing programme be implemented to ensure the buffer areas do not become overrun by invasive species, which would likely reduce the basal cover.
  - The municipality should assign responsibility for the maintenance of the buffer areas to ensure they can function effectively throughout the construction and operational phase.

This would include refuse / litter removal on a regular basis, alien plant control, mowing, controlled burning, etc.

11. CONCLUSION AND RECOMMENDATIONS

The three wetland systems within the study area have been transformed due to existing anthropogenic activities. The wetland habitats were assessed to determine extent, condition, service provision, and ecological importance and sensitivity. It was determined that the wetlands have all been extensively transformed / degraded, to the point that the ecosystems are either largely/ or seriously modified. The proposed development will have an impact on portions of the different wetlands. However, only a small percentage of each of the wetlands is anticipated to be directly lost through encroachment of the development. While this would lead to further deterioration of the wetland systems it could provide an opportunity for the remaining portions of the wetlands to be rehabilitated and managed, and thereby improve the current functional value and condition of the wetland systems. As a result a wetland rehabilitation and management plan needs to be developed and implemented. The plan should be developed prior to construction. The recommended buffer zone, which includes a core habitat area, will need to be managed throughout the construction and operational phases to ensure these ecosystems continue to provide the relevant ecosystem services.

A vegetation assessment was undertaken to determine the vegetation presence at Pietermaritzburg Airport. The majority of the grassland habitat throughout the study area is in a relatively good condition, particularly the grassland areas within the fenced airport precinct. Five Red List plant species were identified in the study area or surrounding areas, all of them either listed as declining or vulnerable; *Boophone disticha, Brachystelma franksiae, Crinum bulbispermum, Hypoxis hemerocallidea and Woodia verruculosa.* The layout of the development will result in the loss of grassland, with approximate 50% of the grassland within the fenced area being lost largely due to the development of the techno hub (Table 10). While the importance of the development for the city and municipality is acknowledged, the loss of a sizeable area of grassland in relatively good condition will result in the loss of habitat for red list species. To mitigate this loss it is important that the remaining areas of prime habitat and core habitats be managed for conservation throughout the construction and operation phases of the development. There should be no unnecessary development in theses grasslands, with it being recommended that any unnecessary mowing, tarred surfaces and/or gardening be avoided. Before any development occurs, a survey to collect any Red List species found in the proposed developed areas should be undertaken so an attempt can be made to relocate them to a safe area. An entomologist should also be contracted to survey the final footprint area for any faunal species of conservation concern, which could be relocated to adjacent core habitats. A grassland management plan, including an alien invasive management plan needs to be developed and implemented.

Certain infrastructure is proposed inside the delineated wetland areas. Realignment of the development layout within these areas, where practically possible, is required to avoid the relevant wetland and buffer zone areas. Where realignment is not feasible, the rehabilitation plan will need

to address how to mitigate the loss of wetland habitat and functional value. This may be sufficient to mitigate direct loss of wetland habitat.

The final buffer zone incorporates aquatic impact buffers and conservation areas (core habitats / local corridors). The final buffer zone does not include a section of the area identified as a CBA: irreplaceable area. This corresponds to the area adjacent to Murray Road proposed for landside development/mixed use. The primary reason for excluding this area from the final buffer zone was because it was largely degraded grassland.

The implementation of the recommended final buffer zones will provide effective mitigation from diffuse surface runoff carrying sediments, nutrients and other possible pollutants (e.g. toxic contaminants). The biodiversity buffer requirements, i.e. core habitat areas, are important for conserving grasslands in relatively good condition that provide habitat for a host of threatened species. All additional areas outside of the final buffer zone, i.e. prime habitat areas, should be maintained as grassland areas adjacent to the proposed development within these specific areas (i.e. incorporated as open spaces adjacent to development and not replaced with manicured gardens.

The development would negatively impact on the environment through removal of grassland and wetlands, pollution and erosion of the wetlands and stream habitat and the possible infestation of alien invasives into the grassland and wetland ecosystem. Mitigation measures can be put in place to address the impacts of the development and limit the amount of damage to the environment. The 'no-go' option assesses the impacts if the development did not go ahead and the results highlight the positive impact it would have on the grasslands that are in relatively good condition which are home to red listed species, but it also prevents the wetlands that are all in poor health to be properly rehabilitated.

Management of the final buffer zones and additional open space areas needs to be detailed in a rehabilitation and management plan for the proposed development. The aim would be to manage the grasslands similarly to how the existing areas of grassland habitat within the fence area are managed (i.e. maintaining these areas as strips of natural vegetation, which will allow for refuge for species in the area). Wetlands need to be rehabilitated and managed to maintain or even improve the function they prove in the landscape.

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APPENDICES

Appendix A: Ian Bredin Curriculum Vitae

CURRICULUM VITAE

Ian Bredin (*MSc, Pr.Sci.Nat*) **– Principal Scientist**

Ian is a Principal Scientist at the Institute of Natural Resources NPC (INR) with over eleven years' experience. He manages the INR's Ecosystem Theme. His qualifications include a BSc Honours Degree in Zoology from the University of KwaZulu-Natal and an MSc Degree in Veterinary Science from the University of Pretoria. He is a registered Professional Natural Scientist in the fields of Ecological and Zoological Science. His primary interest is in wetland science, where he has gained extensive experience in the assessment, management and monitoring of wetlands. He also has a keen interest in biodiversity, ecosystem services and natural resource management, with sound experience in biodiversity assessments (both terrestrial and aquatic ecological assessments), integrated water resource management, integrated catchment management, sustainable land management, and community-based natural resource management. He has worked on projects across southern and east Africa. Ian has authored and co-authored over fifty consultancy reports, which include research reports, information booklets and peer reviewed publications. He has also presented at a host of national and international conferences.

PERSONAL DETAILS

Date of Birth	27 December 1976	*Marital Status*	Married
Nationality	South African	*Driver's License*	EB
Home Language	English	*Email Address*	Ian.bredin@mweb.co.za
Other Language	Afrikaans	*Contact Number*	0824421424

QUALIFICATIONS

Institution	Qualification	Year
University of Pretoria, Onderstepoort	MSc (Veterinary Science)	2006
University of KwaZulu-Natal (Pietermaritzburg)	BSc Hons (Zoology)	2004
University of Natal, Pietermaritzburg	BSc	2003
Institute of Marketing Management, Pietermaritzburg	Graduate Diploma in Marketing and Business Management	1997

RECORD OF EMPLOYMENT

Year(s)	***Position***	***Organization***
2014 - present	Principal Scientist	Institute of Natural Resources
2011 - 2014	Senior Scientist	Institute of Natural Resources
2010 - 2011	Scientist	Institute of Natural Resources

Year(s)	***Position***	***Organization***
2008 - 2010	Senior Environmental Scientist	Natural Scientific Services
2006 - 2008	Junior Environmental Scientist	Natural Scientific Services
2005 - 2006	Researcher / Field Assistant: Assisted with Buffalo Tuberculosis Research in the Kruger National Park	University of Pretoria, Onderstepoort

RELEVANT PROJECT EXPERIENCE (i.e. examples of projects, not a complete list)

Wetland Projects:

- The development of a refined procedure for determining wetland Resource Quality Objectives (RQOs), and the development of a wetland RQOs implementation manual (WRC Project, K5/2547).
- Testing the preliminary guidelines for the determination of buffer zones for rivers, wetlands and estuaries (WRC Project, K5/2463).
- The development of RQOs for wetlands in the upper and lower Vaal catchment for the DWS.
- The development of national guidelines for determining appropriate buffer zones for wetlands, rivers and estuaries (WRC project, K5/ 2200).
- Prioritisation and preliminary planning of offsets for Spring Grove Dam: Assessment to determine the current condition and potential impacts to wetland habitats in reaches of the Hlatikulu and Mooi Rivers.
- An assessment of in excess of twenty wetlands for the Richards Bay Zulti South mineral lease area, KZN.
- A wetland management and rehabilitation plan for the Richards Bay Zulti South mineral lease area, KZN.
- Wetland functional and ecosystem service assessment of the Mount Moreland wetlands, KZN.
- Wetland delineation, functional and ecosystem service assessment for the expansion of the Oribi Airport, KZN.
- Wetland delineation, functional and ecosystem service assessment for the Mafutha project in the Lephalale area, Limpopo.

Biodiversity and Natural Resource Management Plans:

- An integrated catchment management plan for the Letseng-la-Letsie catchment (Lesotho's Ramsar wetland).

Terrestrial and Aquatic Ecological Assessment Projects:

- Aquatic baseline assessment for the Richards Bay Zulti South mineral lease area, KZN.
- Ecological baseline assessment for the Makhathini Sugar Cane Project on the Makhathini flats, KZN.

Integrated Environmental Management Projects:

- Technical support for the Lesotho component of the USAID Southern Africa funded Project titled "A Water Secure Future for Southern Africa- Applying the Ecosystem Approach in the Orange-Senqu Basin".
- Identifying climate change adaptation strategies and building capacity for adaptation in the Lesotho highlands mountain catchments to improve the resilience of livelihoods and ecosystem services (USAID Southern Africa funded project).

PROFESSIONAL REGISTRATION AND MEMBERSHIP

- Registered with the South African Council for Natural Scientific Professions (SACNASP) as a Professional Natural Scientist (*Pr.Sci.Nat*.) in the fields of Ecology and Zoology (400162/08).
- **Chairman of the KwaZulu-Natal Wetland Forum.**
- Member of the Southern African Society of Aquatic Scientists.
- Steering Committee member for four WRC projects.

CONFERENCE PRESENTATIONS, PUBLICATIONS AND CONSULTANCY REPORTS

- **Pringle, C., Bredin, I., McCosh, J., Dini, J., Zunckel, K., Jewitt, G., Hughes, C., de Winnaar, G. and M. Mander. 2015. 'An Investment Plan for securing ecological infrastructure to enhance water security in the uMngeni River catchment', Green Fund, Development Bank of Southern Africa, Midrand.**
- **Jewitt, G., Zunckel, K., Dini, J., Hughes, C., de Winnaar, G., Mander, M., Hay, D., Pringle, C., McCosh, J., and Bredin, I. (eds.). 2015. 'Investing in ecological infrastructure to enhance water security in the uMngeni River catchment, Green Economy Research Report No. 1, Green Fund, Development Bank of Southern Africa, Midrand.**
- **Macfarlane, D.M., Bredin, I.P., Adams, J.B., Zungu, M.M., Bate, G.C. and Dickens, C.W.S. 2014. Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries. Final Consolidated Report. WRC Report No TT 610/14, Water Research Commission, Pretoria.**
- Invited to present at the WRC's research development and innovation symposium on the 'Buffer Project' in September 2015.
- Invited to present at the WRC's ecosystems research and innovation symposium on the 'Buffer Project' in February 2015.
- Presented at the International Association for Impact Assessment Conference in 2015.
- Presented and hosted workshops at the SASAQS Conference in 2013 and 2014, the National Wetland Indaba in 2014 and 2015, and the SANBI Biodiversity Planning Forum in 2013.
- Ian has authored / co-authored in excess of 50 consultancy reports and associated documents during his years in the field of practice.

Appendix B: Proposed Infrastructure and Land-use

The project involves the expansion or addition of the following components which are detailed below:

- **Airside Infrastructure:** Extension of the taxiway to service an extension of the aircraft apron.
- **General Aviation:** Reconfiguration of existing hangars, and expanded facilities for aircraft maintenance and repair.
- **Terminal Building:** Site allocated for future expansion of the terminal building.
- **Landside Infrastructure:** Improved access via a link to Washington and/or Market Roads, new parking area and drop off zone, an industrial zone, and mixed commercial zones.
- **Technology Hub:** Located between the runway and western boundary of the airport (Oribi Road) that provides for the following zones: special sports, mixed use/commercial, mixed use residential/hotel, aviation hub, education/techno-hub, and light industrial.
- **Open Space/Conservation:** Assigned to sensitive riparian systems and open space.

Airside Infrastructure
The airside infrastructure consists of the following elements shown in Figure 9.

Runway
No extensions to the existing runway are required. The total length of the existing runway is 1597m with a stop way of 190m; the classification of the runway will therefore remain an ICAO Code 2C runway; however the length does cater for certain code 3C aircraft to be able to operate at this airport. The runway is adequate to serve the aircraft mix within Phase 1.

Taxiways
For planning purposes the taxiway infrastructure including the relevant clearances have been laid out for full ICAO Code C aircraft (up to 36 m wingspan), this to cater for the possible long term future introduction of this aircraft category. An initial parallel Taxi Way will be developed to serve the extended apron.

Aprons
The new apron will be parallel to the runway on the eastern side. This phase incorporates a flexible extension of the existing apron where the indicated area allows for several parking configurations to be determined and implemented as per actual demand. However, for planning purposes six ICAO Code B aircraft stands and three ICAO Code C (e.g four AVRO RJ 85) stands have been provided. It will have an area of 14 000m^2 (200m wide and 70m deep). It is noted that currently the airport is used by smaller code C aircraft with a wingspan of around 26 m only. The indicated parking arrangement is therefore indicative. The proposed modular arrangement can be easily extended in future if demand dictates so. Between the several apron stands associated apron taxi lanes have been planned, further land reservation has been made for apron service roads.

Navigation Aids
Navigation aids will be upgraded and implemented concurrent with the terminal building, runway and taxiway system extensions to be compliant with ICAO's and CAA's standards.

Visual Aids and Signage

With the extension of the taxiway system and the new terminal building, the visual aids and signage need to be upgraded to be compliant with ICAO's and CAA's standards.

The table below lists the land use facilities including a brief description of the function served by Airside facilities.

Description of the airside infrastructure

Main Category	Typical Facility Type	General Description
Airside Infrastructure	Runway Infrastructure	Asphalt runway pavements and associated pavement marking, Airfield Ground Lighting elements, ducting and manholes, special airport systems equipment, metrological equipment and storm water drainage elements. Intended use: Aircraft, controlled access.
	Taxiway Infrastructure	Asphalt taxiway pavements, associated pavement marking graded (grass) taxiway strips, airfield ground lighting elements, ducting and manholes, storm water drainage elements: Intended use: Aircrafts, controlled access.
	Apron Infrastructure	Concrete or asphalt pavements, associated markings, floodlighting masts, ducting and manholes, drainage elements. Intended use: Aircraft, Airport Service Vehicles, passengers, restricted access.

General Aviation

The expansion of the GA facilities will take place within two phases, within the overall phase 1 expansion.

- The first phase will involve the existing GA hangar facilities (indicated in pink in Figure 9) will be reconfigured and the area optimised in order to accommodate the growing demand for GA operations. In addition, the GA infrastructure will be developed adjacent the existing area (shown in blue in Figure 9).
- Once the terminal building and parking area moves to the new location indicated in Figure 9, the existing terminal facilities can be reconfigured for use by private and business aviation as well. **Error! Reference source not found.** lists the land use facilities for including a brief description of the function served by the GA facilities.

Description of the General Aviation infrastructure

Main Category	Typical Facility Type	General Description
General Aviation	Aircraft Hangars	Hangars to be used for parking of privately owned aircraft. Building heights for hangers are up to 8m for code B and 15m for Code C.
	Aircraft Maintenance and Repair facilities	Aircraft Maintenance and Repair activities are assumed to be mostly related to General Aviation although if scheduled flights intensify at some stage limited routine line maintenance services might be provided for by the airlines. MRO facilities are assumed to be located in the areas indicated for GA. These facilities will consist of hangars with workshops and warehousing for storage of equipment and parts.
	Aero Club facilities / Flight School	The current PZB Aero Club has facilities on the existing airport, During the development of the airport activities of the Aero club and Private Pilot Training Activities are assumed to continue and expand. Facilities like a club house, instruction rooms and hangars are assumed to be located within the areas indicated for GA.

Landside Infrastructure

Mixed-Commercial Use

Mixed use area reservations are proposed on the northern end of the airport. A 75-125 room Hotel is proposed for the area between Oribi Road and the existing Airport entrance. The hotel buildings will be a maximum of two storeys supported by parking facilities for guests and staff. A second mixed use/commercial zone is proposed in the area adjacent immediately adjacent Oribi Village along the proposed new access road that links into Washington Road.

Industrial Zone

The first phase will accommodate a new industrial zone of approximately 17 hectares which will accommodate land uses and activities similar to those in the existing and adjacent industrial estate (i.e. manufacturing, logistics, warehousing).

Airport Access

The current airport access road (Pharazyn Way) off Oribi Road will be retained as an access point to the General Aviation portion of the airport once the other access routes are established. The following additional airport access is proposed:

i. A new access road off Oribi-Road. This will run along the boundary with Oribi Village and extend to the new parking area and terminal building once they are established.
ii. A new road that links the new access off Oribi Road to Washington Road providing a 'loop' system'.
iii. A new access road connecting the airport directly with the N3 via Market Road. This road (Market Road extension) will also provide access to the light industrial area off Gladys Manzi (Murray) Road.

Three new intersections are proposed off Oribi Road to access to the Techno-hub. These will be opposite existing access roads off Oribi road to the residential area.

Parking

A new parking area is proposed adjacent to the proposed position for the new passenger terminal building. This parking area will be used for staff, passenger and VIP parking. The car rental offices can also be relocated to this location. A section of the existing parking area will remain as such for this phase which could provide additional parking dedicated for the GA related facilities and airport staff. It should be noted that Servest, who manage the parking area have a contract until 2024 with an option to extend by 5 years. In terms of this contract they have an agreement with the Municipality to extend the parking area by approximately 12 800m^2 towards Pharazyn Way and adjacent the water reservoir in the area identified for the hotel. This area is shown in the following diagram and the extension is likely to commence in the short term.

The timing of a move for the parking area to the new site adjacent the new terminal building shown in Figure 2 is dependent on when alternative access is developed and the terminal building needs to move. These options are described further under the section dealing with alternatives.

Figure 3: New parking site

Drop-off / public transport curbs Public Parking

At the main access road a loop is to be provided to maintain flow of traffic, while parking and drop-off zones remain connected. Terminal frontage roads with kerb for drop-off and pickup of passengers will be provided here with a bypass.

Car hire facilities

Car rental parking and offices are located in the parking area. The timing and design would be undertaken in collaboration with the holders of this concession and in terms of their lease agreement.

The table below lists the land use facilities including a brief description of the function served by the land-side Infrastructure

Description of the landside Infrastructure

Main Category	Typical Facility Type	General Description
Landside infrastructure	Access roads and circulation roads	Dual lane (bi-directional) airport access roads (asphalt) and single lane circulation roads (one direction). Street furniture and street lighting elements, storm water drainage elements. Intended use: Secondary arterial classification.
	Passenger and Staff Parking	Ground level, passenger car parking, asphalt or concrete block parking pavements, walkways, street furniture, gate house, drainage elements and street lighting.
	Drop-off/public transport curbs	Terminal frontage roads with kerb for drop-off and pickup of passengers.
	Car hire facilities	Car rental parking and offices

- Considered planning of the mixed uses should encourage movement of people as well as innovation through potential synergies.
- Buildings embody the aspirations of businesses as world leaders and innovators through their architectural expression and forms.
- The human mind is encouraged to test perceived boundaries through “creative space”.
- Traditional office typologies with confined or restrained spaces are to be avoided. Generous natural lighting, ventilation, form, colour, and open spaces are to be encouraged.
- In terms of energy efficiency and design, buildings should as a minimum comply with the requirements of SANS 204.
- Green Star and LEED certification of buildings are to be encouraged.
- Sources of renewable energy should be investigated and integrated in the planning of the hubs.

Passenger Terminal Building

The passenger terminal building currently provides an acceptable service level but is at capacity and will need to be expanded if passenger traffic further grows. It is assumed that in the first phase an increase in passenger traffic is initially accommodated by (temporary) expansion of the existing terminal. At some stage however a new passenger terminal development more centrally located around the expanded airside facilities is envisaged. This new position will also provide an opportunity to improve the landside road accessibility to the airport. The new terminal building is assumed to be a first phase of a modular extendable terminal to meet further growth in demand. The table below lists the passenger terminal building facilities for including a brief description of the function served by the passenger terminal building.

Description of the passenger terminal facilities

Main Category	Typical Facility Type	General Description
Passenger Terminal Facilities	Passenger Terminal Building	Passenger Terminal Building where passengers board and alight flights. Consisting of: a central arrival/departure hall, commercial concessions (bars/restaurants shops) check in area, waiting lounges, airport and airline offices, and ablution facilities. A two storey passenger building is envisaged.

Electricity

For Phase 1, the supply will remain to the terminal building, however, it may need to be augmented should the power required exceed the existing capacity. Further reticulation will be required for apron lighting and for the proposed GA area. Sufficient capacity should be provided to allow for future phases of the GA facilities.

Water Supply

The nearest bulk reservoir is adjacent to the existing passenger terminal. It is understood that the bulk water system has sufficient capacity; however, pressure is a concern due to the relative elevations of the airport and reservoir. Additionally a bulk water main runs diagonally under the primary runway and an engineering assessment should be undertaken to determine the suitability of this configuration in the long-term. For Phase 1 the reticulation to the terminal should be upgraded to meet the additional requirements and address the current issues relating to the existing infrastructure. Additionally, a new supply will be required for the GA area, which is anticipated to be connected from the adjacent residential network.

Wastewater

The Municipality has indicated that sufficient bulk supply is in place (or at least planned) in terms of wastewater trunk mains and treatment capacity. For Phase 1, the existing supply to the terminal will need to be upgraded to meet the additional demand. Reticulation will need to be provided for the GA areas.

Storm Water

For Phase 1, improvements to the current storm water arrangements are recommended. The passenger terminal and fire station often experience flooding due to the slopes of the adjacent taxiway and aprons. A cut-off drain will be required. Storm water management will also be required for the new GA areas. A storm water management plan will form part of the Environmental management plan and requirements.

Technology Hub

The definition of Technology Hub is" Am enterprise associated with Research, development, design and related activities in the high-technology sector which is accommodated in a park-type environment which is specifically created for the industrial needs of the enterprises concerned" .

From an environmental perspective, to note is the institution design incorporating environmental principles into the design process, to reduce the overall human health and environmental impact that may arise across the techno hub`s life cycle. These include:

- Large areas of green space are retained for the benefit and recreation of the employees and building occupants.
- Public spaces become informal outdoor boardrooms where networking and socialisation takes place.
- Provision of services, entertainment and recreation facilities, and proximity to accommodation can make hubs self-contained micro cities.
- Full integration with universities, tertiary institutions, and research institutes encourage growth in research and development.
- Research and development rich environments attract businesses investment in the hub through linkages with learning institutions.

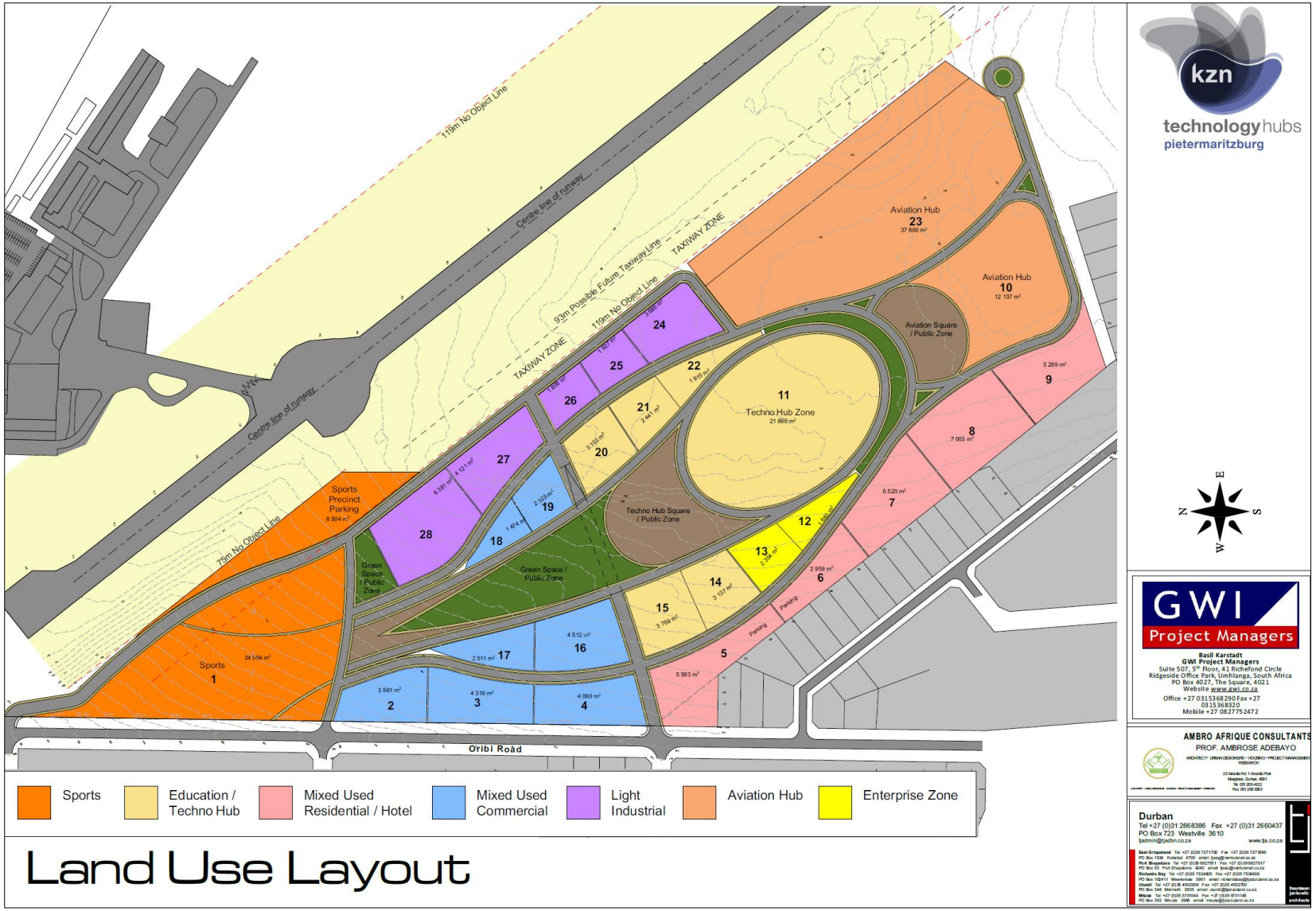
The site set aside for the Technology hub is about 25 ha. The table below depicts the conceptual zones envisaged for the technology hub of Msunduzi. This plan is based on a specific model formulated for this hub. The concept involves six specific zones, each with a sub zone. The six zones and sub zones are tabulated below with related functions

Summary of uses within the techno-hub zones

Zone	**Sub-zone**		**Function**
Mind Zone	Education	Research Zone	Laboratories (analytical, science and computer)
	Education	Student Zone	Studios (for Master and PHD students) and an interpretation centre which could be used by schools as a part of science education to instil an innovation culture in school children
Innovation Zone	Light Industrial	Testing Zone	Experimentation, materials and products testing for innovations designed
	Light Industrial	Development Zone	Laboratories for simulation, CAD, CFD, IT and product design
	Light Industrial	Engineering Zone	Consists of a learning factory for rapid prototyping, workshops and CNC Machining as well as product development
	Light Industrial	Data Zone	LAN lab with Computational Capacity and Product Testing and a server farm with unlimited connectivity and bandwidth.
Enterprise Zone	Enterprise Zone	Business Support Zone	Hub Management & Marketing/Branding is to be located in this zone and is the heart of the daily operations of the entire technology hub. Functions include: 1. Business Management & Marketing 2. Business Development & Planning 3. Consulting 4. Enterprise Finance a. Venture Capital b. Training and Mentoring

			5. Skills Transfer 6. International and national business networking and linkages between research centres, industries, international technology parks, are created by the management body. 7. Property management function It also serves as the interface for the Mind/Innovation/Business zones.
	Enterprise Zone	Start-up Zone	The start-up zone consists of the following services: 1. Start-up Incubator 2. Innovator/Entrepreneur Development Program 3. Central Services a. Reception & Secretarial b. Boardrooms c. Video Conferencing d. Meeting Spaces e. Computer Lab f. IT Services g. Telecommunications 4. Studios a. Hot Desk (for ICT services) b. Small Tenants c. Medium Tenants
Public Zone	Mixed use Commercial	Convention Zone	The convention sub zone is equipped to involve a multi-functional space for: 1. Skills transfer 2. Information & Knowledge Dissemination 3. Multifunctional Conference Spaces 4. Exhibition Space 5. 300+ Seat Auditoria / Cinema
	Mixed use Commercial	Life Zone	The life sub zone consists of the following retail support services for tenants and employees: 1. Cafes & Restaurants 2. Retail Services a. Convenience Store b. Banking & Post c. Hair & Beauty
	Sports	Body Zone	The body sub zone includes the following in order to create a multifunctional and mixed use environment servicing the everyday needs of people. 1. Gym 2. Sports & Recreation
	Mixed use/Residential/Hotel	Accommodation	• Short to Long Stay (hotels) • Spa
Business Zone	Mixed use commercial	Multi-tenanted Buildings	This sub zone allows for office or other space to be taken up by small to medium existing enterprise

	Mixed use commercial	Single-tenanted Buildings	This sub zone allows for office or other space to be taken up by medium to large existing enterprise.
Energy Zone		Solar Roof Zone	• Roof Mounted Solar Panel Farm
		Solar Terrestrial Zone	• Ground Based Solar Panel Farm • Energy Capacity • Power Security
Other	The spatial concept allows for parking, landscaping and interactive open spaces including a lake. A transport zone for shuttle services and taxi and bus drop offs is also compensated for within this plan.		



Layout of the proposed land-use within the Techno hub

Open Space

Like any development well-managed open space protects the natural green infrastructure, preserving important environmental and ecological functions such as storm-water runoff, amelioration of water quality issues, and erosion control. The Msunduzi Municipality Environmental Management Framework (EMF) identifies conservation priorities throughout the municipality, and wetland areas are regarded as sensitive areas which have to be preserved protected and free from intensive development.

Conservation Zones and Buffer zones

Conservation zones relating to sensitive areas and habitats have been identified for protection. In addition buffer zones between residential and airport related land uses have been provided. A significant portion of the land parcel with the wetlands has been set aside as strategic reservation in order to ensure the protection of a healthy system. An open space buffer of 30m has been assigned, primarily to protect the sensitive riparian systems and open land. The reserve is primarily an important riparian corridor along, and around the water bodies. It serves as a physical link to and between significant sources of biodiversity (from the Bisley nature reserve south of the airport extending all the way up to Msunduzi River past the Hayfields reserve) to prevent local species extinctions in the Msunduzi Municipal Area. This indicative buffer will be refined through specialist investigations in the EIA process.

Appendix C: Assessment criteria for the rating of impacts

Impact Assessment Methodology

To determine and evaluate the significance of potential impacts on identified resources and receptors, impact assessment and mitigation is applied in accordance with define assessment criteria. The purpose of this method is to develop and describe measures to be applied in order enhance the potential benefits, and to minimize or avoid any potential harmful effects.

Definition of Key Terminology

- **Project**: The collection of activities and components for which authorization is being applied for, which includes all associated facilities that are required for the Project to proceed.
- **Project Site:** The operational area/s of the project activities, including private transport corridors (those exclusively dedicated for the project activities during its operation).
- **Project Footprint**: The area within and surround the project site that is anticipated to be physically influenced/affected by the activities of the project in all phases. This includes areas used temporarily (i.e. land and roads used during the construction phase, as well as private and public areas along transport corridors that are disturbed)

Impact Types and Definitions

Any change to a receptor or resource as a result of a component of the project (or a related project activity) is considered impact. By evaluating baseline data as a platform for assessment, it provides the information required to evaluate and describe the affects that project is likely to have on the socio-economic and biophysical environment. They type/nature of each impact can be categorized as positive, negative, indirect, direct or cumulative, as defined in the table below

Impact Nature and Type

Nature or Type	Definition
Positive	A positive change or improvement on the baseline.
Negative	A negative or adverse change from the baseline, or the introduction of an undesirable new aspect.
Direct impact	Resulting from the direct interaction between the project's activities and the receiving environment.
Indirect impact	Resulting from other activities that are expected to occur as an effect of the project.
Cumulative impact	Impacts which act jointly with others to affect the same components (receptors and/or resources) of the project. This includes impacts from simultaneous and/or planned future impending third party activities).

Assessing Significance

Impacts need to be determined in terms of their 'significance', which is a defined by the impacts' **magnitude** and its' **likelihood** of occurring. 'Magnitude' is defined by the **extent**, **duration** and **intensity** of the impact, and sometime referred to as the 'severity' of the impact. To determine the magnitude of an impact, a set of criteria is used as per table below

Also defined in the table is a scale of 'likelihood' to be used in determining its significance.

Significance Criteria

Impact Magnitude	
Extent	– **On-site:** Within (limited to) the boundary of the projects' development site – **Local:** Affect an area that is within a 20km radius of the projects' development site – **Regional:** Experience at a regional scale (as determined bit administrative boundaries, habitat type/ecosystem) or affect regionally important resources/receptors

	– **National**: Affect an area and/or resources/receptors that are of national importance or have macro-economic implications.
Duration	– **Temporary:** Intermittent/occasional or brief duration – **Short-term:** Only occurring within the construction phase of the project – **Long-term:** Occurring throughout the life of the project, but ceases upon the projects termination (when it stops operating) – **Permanent:** Result in permanent change to the receiving environment that continues beyond the life span of the project (after it stops operating)
Intensity	**Biophysical Receiving Environment** *The sensitivity of the biophysical resource/receptor determines the intensity of the impact* – **Negligible:** Non-measureable impact – **Low: D**oes not affect the natural processes and functions – **Medium:** Alters the environment but natural processes and functions endure (although in a modified manor) – **High:** Alters natural processes and functions to the extent that they will cease (either temporarily or permanently) *National and/or international standards and limits should be applied, where appropriate, to determine/measure the impact. Quantification of the magnitude of impact and the accompanying rational should be attempted in the specialist studies.* **Socio-Economic Receiving Environment** *The ability of the communities/people affected to adapt their livelihoods to the changes brought about by the project, determines the intensity of the impact.* – **Negligible:** No noticeable change to livelihoods – **Low:** Ability to adapt livelihoods with relative ease and maintain baseline conditions – **Medium:** Ability to adapt livelihoods with some difficulty and maintain baseline conditions with a degree of support – **High:** Affect does not enable livelihoods to adapt to changes or maintain baseline conditions
Likelihood - the likelihood that an impact will occur	
Unlikely	The impact is **unlikely** to occur.
Likely	The impact is **likely to occur under most conditions**.
Definite	The impact **will** occur.

The significance rating matrix is adopted after defining the magnitude and likelihood of the impact, as a means of determining the significance of the impact. The significance colour scale is adopted to provide a visual representation of the magnitude of negative and positive ratings.

Significance Rating Matrix

Significance				
Magnitude		**Likelihood**		
		Unlikely	**Likely**	**Definite**
	Negligible	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Significance Colour Scale

Negative Ratings	Positive Ratings
Negligible	Negligible
Minor	Minor
Moderate	Moderate
Major	Major

Significance Definitions

Significance Definitions	
Negligible significance	No effect on the receiving environment (resource/receptor/people) imposed by an activity of the project, or where the anticipated effect indistinguishable from the baseline or is considered to be insignificant (negligible or unnoticeable).
Minor significance	Evidence of an effect with a sufficiently small magnitude (with or without mitigation) that is within the accepted standards and/or the receiving environment is of low value/sensitivity.
Moderate significance	An effect that is within the accepted standards and limits. Emphasis must be placed on demonstrating that the significance of the impact has been reduced, as far as reasonably possible. 'Moderate' impacts do not necessarily need to be reduced to 'minor' impacts, but rather be managed efficiently and effectively as 'moderate' impacts.
Major significance	An impact that exceeds accepted limits or standards, or where large magnitude impacts affect components of the receiving environment that are highly valuable/sensitive. The intention of the EIA process is avoid major residual impacts, particularly such impacts which are long-term or cover an extensive area. However, such impacts may not be able to be mitigated even after all reasonable options have been exhausted, in which case such negative factors need to be weighed against positive factors in order to make a decision.

A statement of the **degree of confidence** in the assessment must be qualified once the significant of the impact has been determined. The degree of confidence is expressed as 'low', 'medium', or 'high' as determined based on the associated uncertainties (whether or not there is sufficient information to adequately assess the impact).

Mitigation Measures and Residual Impacts

The EIA process is required to identify feasible and practical mitigation measures where significant impacts are evident. Mitigation measures are implemented through compliance with the Environmental Management Programme report (EMPr). After the initial determination of an impact's significance, the significance is re-determined taking into consideration the effective implementation of the mitigation measure, resulting in a significance rating for the residual impact.

Identification of Mitigation Measures

Identified feasible and practical mitigation measures need to be incorporated into the project design as a means of avoiding/reducing negative impacts or enhancing positive impacts as a result of the project activities. Such mitigation measure need to be agreed upon with the client as they are likely form the basis of any conditions of approval defined by the competent authority.

Appendix D: Risk Assessment Matrix (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+ Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level
1	Construction	Wetland 1: Proposed road, Commercial mixed use, GA Phase 1	Clearing of vegetation and digging to lay foundations within and adjacent to a wetland. Plus other associated construction activities	Wetland loss, veg loss, reduce functionality, increase runoff, increase sediment and nutrient input.	3	3	4	2	3	1	4	8	5	2	5	2	14	112	M	80
	Operation		Increased activity in the area, pollution, litter	Litter, soil compaction, possible oil spills and waste into the wetland areas	2	3	2	2	2,25	1	4	7,25	5	1	1	4	11	79,75	M	80
2	Construction	Wetland 2: Techno hub, small stretch of proposed road, car park, passenger terminal	Clearing of vegetation and digging to lay foundations within and adjacent to a wetland. Plus other associated construction activities	Wetland loss, veg loss, reduce functionality, increased runoff, increased sediment and nutrient input	3	4	4	2	3,25	1	4	8,25	5	2	5	2	14	115,5	M	75
	Operation		Increased activity in the area, crossing points through the wetland	Litter, pollution, increased runoff with sediments and contaminates	1	2	2	2	1,75	1	4	6,75	5	1	1	4	11	74,25	M	90
3	Construction	Wetland 3: Access roads, GA Phase 1, Industrial area	Clearing of vegetation and digging to lay foundations within a wetland. Plus other associated construction activities	Direct loss of a wetland, veg loss, reduce functionality, increase runoff, increase sediment and nutrient input, habitat loss to red list species	4	3	4	3	3,5	1	4	8,5	5	3	5	2	15	127,5	M	80
	Operation		Industry operating adjacent to a wetland, potential discharge of waste and pollution, litter, contaminates	Litter, pollution, increased runoff with sediments and contaminates	4	5	4	4	4,25	1	4	9,25	5	2	1	2	10	92,5	M	80

Appendix E: Wetland sample site characteristics

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

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					
16	-29.65680236	30.40539801	temporary	• Very few mottles • Moist clay soils • Matrix greyish 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	• Number of sedge		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					
				• Flowing water • No gleying	species		
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			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					
				• No mottles			
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)

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					
51	-29.65028023	30.39812537	temporary	• Few mottles • Chroma = 2 • Matrix brown to greyish brown	• No indicator species		
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			Veg burnt

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					
				• Some mottles • Chroma = 1			
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
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

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					
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
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			

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					
				• 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 10cm • Greyish brown matrix	• Burnt veg		Gully
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			

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					
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				
99	-29.65364942	30.40567394	trench				Large trench
100	-29.65577331	30.40503885	photo point				

Appendix F: Vegetation species list at Pietermaritzburg Airport

PLANT SPECIES	FAMILY	RED LIST	ENDEMISM
Blepharis maderaspatensis (L.) Roth	ACANTHACEAE		
Crabbea sp.	ACANTHACEAE		
Dyschoriste burchellii (Nees) Kuntze	ACANTHACEAE		
Ruellia sp.	ACANTHACEAE		
Thunbergia atriplicifolia E.Mey. ex Nees	ACANTHACEAE		
Agavaceae sp.	AGAVACEAE		Alien
Tulbaghia acutiloba Harv.	ALLIACEAE		
***Boophone disticha* (L.f.) Herb.**	**AMARYLLIDACEAE**	**Declining**	
***Crinum bulbispermum* (Burm.f.) Milne-Redh. & Schweick.**	**AMARYLLIDACEAE**	**Declining**	
Cyrtanthus contractus N.E.Br.	AMARYLLIDACEAE		
Schinus terebinthifolius Raddi	ANACARDIACEAE		Alien
Centella asiatica (L.) Urb.	APIACEAE		
Brachystelma franksiae* N.E.Br. subsp. *franksiae	**APOCYNACEAE**	**Vulnerable**	**KZN Midlands**
Periglossum mackenii Harv.	APOCYNACEAE		
***Woodia verruculosa* Schltr.**	**APOCYNACEAE**	**Vulnerable**	**KZN Midlands**
Xysmalobium undulatum (L.) Aiton f.	APOCYNACEAE		
Stylochaeton natalensis Schott	ARACEAE		
Asparagus africanus Lam.	ASPARAGACEAE		
Aloe maculata All.	ASPHODELACEAE		
Aloe sp . (or hybrid) - not in flower	ASPHODELACEAE		
Bulbine asphodeloides (L.) Spreng.	ASPHODELACEAE		
Trachyandra asperata Kunth	ASPHODELACEAE		
Afroaster hispida (Thunb.) J.C.Manning & Goldblatt	ASTERACEAE		
Berkheya umbellata DC.	ASTERACEAE		SA
Bidens pilosa L.	ASTERACEAE		Alien
Macledium zeyheri (Sond.) S.Ortíz	ASTERACEAE		
Euryops laxus (Harv.) Burtt Davy	ASTERACEAE		
Gazania krebsiana Less.	ASTERACEAE		
Gerbera ambigua (Cass.) Sch.Bip.	ASTERACEAE		
Helichrysum nudifolium (L.) Less.	ASTERACEAE		
Helichrysum pallidum DC.	ASTERACEAE		
Helichrysum ruderale Hilliard & B.L.Burtt	ASTERACEAE		SA (KZN)
Hilliardiella aristata (DC.) H.Rob.	ASTERACEAE		
Senecio coronatus (Thunb.) Harv.	ASTERACEAE		
Senecio cf. *madagascariensis* Poir.	ASTERACEAE		
Senecio glaberrimus DC.	ASTERACEAE		
Tagetes minuta L.	ASTERACEAE		Alien
Jacaranda mimosifolia D.Don	BIGNONIACEAE		Alien
Tecoma stans (L.) Juss. ex Kunth var. *stans*	BIGNONIACEAE		Alien
Sisymbrium sp.	BRASSICACEAE		Alien
Wahlenbergia undulata (L.f.) A.DC.	CAMPANULACEAE		

PLANT SPECIES	FAMILY	RED LIST	ENDEMISM
Cucumis hirsutus Sond.	CUCURBITACEAE		
Abildgaardia ovata (Burm.f.) Kral	CYPERACEAE		
Cyperus rupestris Kunth	CYPERACEAE		
Cyperus pseudovestitus (C.B.Clarke) Kük.A64	CYPERACEAE		
Cyperaceae sp.	CYPERACEAE		
Cyperus pulcher Thunb.	CYPERACEAE		
Cyperus sexangularis Nees	CYPERACEAE		
Cyperus obtusiflorus Vahl	CYPERACEAE		
Cyperus denudatus L.f.	CYPERACEAE		
Eriospermum mackenii (Hook.f.) Baker	ERIOSPERMACEAE		
Acalypha angustata Sond.	EUPHORBIACEAE		
Acalypha punctata Meisn.	EUPHORBIACEAE		
cf. *Jatropha natalensis* Müll.Arg.	EUPHORBIACEAE		SA (KZN)
Manihot sp.	EUPHORBIACEAE		Alien
Acacia sieberiana DC. var. *woodii* (Burtt Davy) Keay & Brenan	FABACEAE		
Argyrolobium humile E.Phillips	FABACEAE		SA
Gleditsia triacanthos L.	FABACEAE		Alien
Indigofera dimidiata Vogel ex Walp.	FABACEAE		
Indigofera hedyantha Eckl. & Zeyh.	FABACEAE		
Rhynchosia totta (Thunb.) DC.	FABACEAE		
Rhynchosia cooperi (Harv. ex Baker f.) Burtt Davy	FABACEAE		
Vigna vexillata (L.) A.Rich.	FABACEAE		
Eriosema cordatum E.Mey.	FABACEAE		
Monsonia cf. *angustifolia* E. Mey. ex A. Rich.	GERANIACEAE		
Pelargonium alchemilloides (L.) L'Hér.	GERANIACEAE		
Pelargonium luridum (Andrews) Sweet	GERANIACEAE		
Albuca cf. setosa Jacq.	HYACINTHACEAE		
Drimia cf. *multisetosa* (Baker) Jessop	HYACINTHACEAE		
Ledebouria ovatifolia (Baker) Jessop	HYACINTHACEAE		SA
Ornithogalum cf. *tenuifolium* F.Delaroche	HYACINTHACEAE		
Schizocarphus nervosus (Burch.) van der Merwe	HYACINTHACEAE		
Hypericum aethiopicum Thunb.	HYPERICACEAE		
Hypoxis acuminata Baker	HYPOXIDACEAE		
Hypoxis argentea Harv. ex Baker	HYPOXIDACEAE		
Hypoxis colchicifolia Baker	HYPOXIDACEAE		SA
***Hypoxis hemerocallidea* Fisch., C.A.Mey. & Avé-Lall.**	**HYPOXIDACEAE**	**Declining**	
Tritonia gladiolaris (Lam.) Goldblatt & J.C.Manning	IRIDACEAE		
Ocimum obovatum E.Mey. ex Benth.	LAMIACEAE		
Orthosiphon suffrutescens (Thonn.) J.K.Morton	LAMIACEAE		
Litsea sebifera Pers.	LAYRACEAE		Alien
Corchorus asplenifolius Burch.	MALVACEAE		
Grewia hispida Harv.	MALVACEAE		
Hermannia depressa N.E. Br.	MALVACEAE		

PLANT SPECIES	FAMILY	RED LIST	ENDEMISM
Hermannia grandistipula (Buchinger ex Hochst.) K.Schum.	MALVACEAE		
Hermannia parviflora Eckl. & Zeyh.	MALVACEAE		
Hibiscus aethiopicus L.	MALVACEAE		
Sida dregei Burtt Davy	MALVACEAE		
Melia azedarach L.	MELIACEAE		Alien
Oxalis corniculata L.	OXALIDACEAE		Alien
Passiflora subpeltata Ortega	PASSIFLORACEAE		Alien
Mimulus gracilis R.Br.	PHRYMACEAE		
Alloteropsis semialata (R.Br.) Hitchc.	POACEAE		
Arundo donax L.	POACEAE		Alien
Cymbopogon caesius (Hook. & Arn.) Stapf	POACEAE		
Eragrostis capensis (Thunb.) Trin.	POACEAE		
Eragrostis curvula (Schrad.) Nees	POACEAE		
Eragrostis racemosa (Thunb.) Steud.	POACEAE		
Eustachys paspaloides (Vahl) Lanza & Mattei	POACEAE		
Heteropogon contortus (L.) Roem. & Schult.	POACEAE		
Melinis nerviglumis (Franch.) Zizka	POACEAE		
Panicum natalense Hochst.	POACEAE		
Setaria cf. *sphacelata* (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss	POACEAE		
Sporobolus pectinatus Hack.	POACEAE		SA
Themeda triandra Forssk.	POACEAE		
Tristachya leucothrix Trin. ex Nees	POACEAE		
Cheilanthes viridis (Forssk.) Sw.	PTERIDACEAE		
Rubus rigidus Sm.	ROSACEAE		
Kohautia amatymbica Eckl. & Zeyh.	RUBIACEAE		
Dovyalis zeyheri (Sond.) Warb.	SALICACEAE		
Thesium costatum A.W.Hill	SANTALACEAE		
Physalis viscosa L.	SOLANACEAE		Alien
Raphionacme hirsuta (E.Mey.) R.A.Dyer	SOLANACEAE		
Solanum mauritianum Scop.	SOLANACEAE		Alien
Solanum campylacanthum Hochst. ex A.Rich. subsp. *panduriforme* (Drège ex Dunal) J.Samuels	SOLANACEAE		
Solanum chenopodioides Lam.	SOLANACEAE		Alien
Gnidia kraussiana Meisn.	THYMELAEACEAE		
Lantana camara L.	VERBENACEAE		Alien
Verbena brasiliensis Vell.	VERBENACEAE		Alien
Verbena rigida Spreng.	VERBENACEAE		Alien

Appendix G: Notes on a Botanical Survey of Pietermaritzburg Airport and adjacent areas

Date: October 2016

By Christina Curry (nee Potgieter), PhD (Botany)

Plant collection fieldwork was conducted on 15 and 16 October 2016.

Many areas had been burnt during the preceding year; hence flowering was good this season. This allowed a species list of 120 species to be compiled.

This list only represents taxa that are apparent and/or flowering at this time of year. Major groups such as the Orchidaceae flower later in the season and have hence not been recorded. For a more complete species list the site needs to be surveyed over one or two years, during different seasons.
Three areas were surveyed within the fenced airport zone (sites 1, 2 and 3). Four areas were surveyed in areas adjacent to the fenced-in airport zone (sites 4, 7, 8 and 9). These are indicated on a map.

A combined species list for the whole area was compiled (120 species), with presence recorded for each of the seven sites. If a species has not been recorded for a site, it does not necessarily mean the absence of that species. Time constraints – especially in the fenced-in airport zone – meant that only representative areas were sampled for each site.

The majority of the area is grassland in good to very good condition. One section towards Murray Road is becoming degraded. The fenced-in areas have not been grazed for many years and are in very good condition, with good plant diversity.

Site 1
This site is on the airport terminal building side of the runway. The grassland vegetation in areas adjacent to the runway are kept short for operational reasons. Further away there is taller grass and associated forbs. Vegetation cover is good, and good stands of *Themeda triandra* are present.

A Red-listed plant species, *Brachystelma franksiae* subspecies *franksiae*, was found flowering in this site. It is currently listed as Vulnerable on the Redlist for South African plants. Another subspecies is limited to the Eastern Cape. *Brachystelma franksiae* subspecies *franksiae* was previously listed as Endangered but the discovery of a few more localities resulted in the listing being changed. The sub-species is endemic to the area from Pietermaritzburg to Camperdown and is threatened by urban and industrial expansion and land use change. This species does not transplant well, which means that ex situ conservation or relocation efforts are not feasible options for mitigation, should this site be developed. The few remaining patches of untransformed land where this species occurs are essential for the long-term survival of the species.

Boophone disticha, a species in the Declining category of the Redlist of SA plants, was present. This category tends to highlight species that have the potential for decline due to over-harvesting for medicinal use.

Site 2

This site is on the opposite side of the runway and incorporates part of a wetland that is traversed by the runway. The area around the wetland is moribund, likely from a lack of fire, but there was evidence of moving near the runway. The un-mowed, unburnt areas are being invaded by alien invasive woody plant species. *Lantana camara*, *Solanum mauritianum* (Bugweed), *Litsea sebifera*, *Melia azedarach* (Syringa), *Gleditsea triacanthos* (Honey locust) and *Tecoma stans* (Yellow bells) are species that require an active alien invasive control programme in this area.

On the slope leading from the runway to the drainage line there is a dense aloe population that was not in flower. From the vegetative characteristics it was not possible to identify, but it does not resemble the species that is common in surrounding areas – *Aloe maculata*. The population has variable leaf characteristics, which suggests a possible hybrid origin. This unusual population will need to be surveyed from time to time until flowering is observed, to make a positive identification.

Site 3

This site is similar in condition and composition to site 1. Good post-burn, spring flowering was seen on previously untransformed grassland areas. The Vulnerable *Brachystelma franksiae* subspecies *franksiae* was not observed during the quick survey, but it is extremely likely that this species occurs on this site as well. It is a very inconspicuous, small species, which needs dedicated searches to locate it. The untransformed areas have good plant diversity and cover, with extensive areas of *Themeda triandra*.

There is evidence of disturbance in some areas (for example, a pipeline), but a lush cover of grassland species has established again. Scattered *Tecoma stans* invasive alien trees are a concern and need to be controlled.

Site 4

This site incorporates a wetland area and open grassland adjacent to the fenced airport area on the passenger terminal / Oribi village side. The cover is moderate, but worse than on the adjacent fenced-in airport area. The plant species diversity is good and *Boophone disticha* (Declining on the Redlist) was present. *Periglossum mackenii*, although not listed on the Redlist, is a species of biodiversity interest. Towards the Murray Road side similar species composition was present, with many similarities to that of the fenced-in adjacent area.

Site 7

This site is adjacent to the wetland and runway on the Murray Road side. The plant diversity and cover is good, and *Woodia verruculosa* was an important find. This species is listed as Vulnerable on the Redlist for SA plants. It has only been recorded at four sites between Howick and Eston and, like *Brachystelma franksiae*, does not transplant well, hence relocation is not a viable option for

conservation. The option of no development and proper grassland management is the best conservation option for this species.

It is highly likely that *Woodia verruculosa* also occurs on the other good grassland sites in the airport area and, similarly, *Brachystelma franksiae* may very likely be present on this site.
This site borders an area of wooded grassland, where *Acacia sieberiana*, other medium-sized trees and some invasive trees (e.g. Jacaranda) are present.

Site 8

This site is closest to Murray Road and shows some evidence of degradation. Cover and plant diversity is moderate, but not as good as sites closer to the airport. Some dumping of rubble and refuse was seen in the grassland, and there was evidence of cattle.

Site 9

This site borders the suburb towards Bisley and is flanked by the end of the runway; it is not far from site2. Goats were seen grazing in one section and there was evidence of mowing in some areas (possibly for dog walking). Recently burnt areas showed a good flush of spring flowering, while other areas were moribund. Cover is good. If managed properly, this area could recover to a grassland of good diversity. *Crinum bulbispermum*, a Declining species on the Redlist, was flowering in a drainage area. The Declining *Boophone disticha* is also present. A woody component was present in this site (e.g. *Acacia sieberiana*).

Appendix H: Red list vegetation identified at Pietermaritzburg Airport

SPECIES	IMAGE	SOURCE
Boophone disticha		http://www.plantzafrica.com/plantab/boophdist.htm
Brachystelma franksiae		http://redlist.sanbi.org/species.php?species=2640-34
Crinium bulbispermum		http://www.plantzafrica.com/plantcd/crinumbulbisp.htm
Hypoxis hemerocallideais		http://www.plantzafrica.com/planthij/hypoxishemero.htm
Woodia verruculosa		http://www.midlandsconservancies.org.za/threatenedplants/woodia%20verruculosa.php