






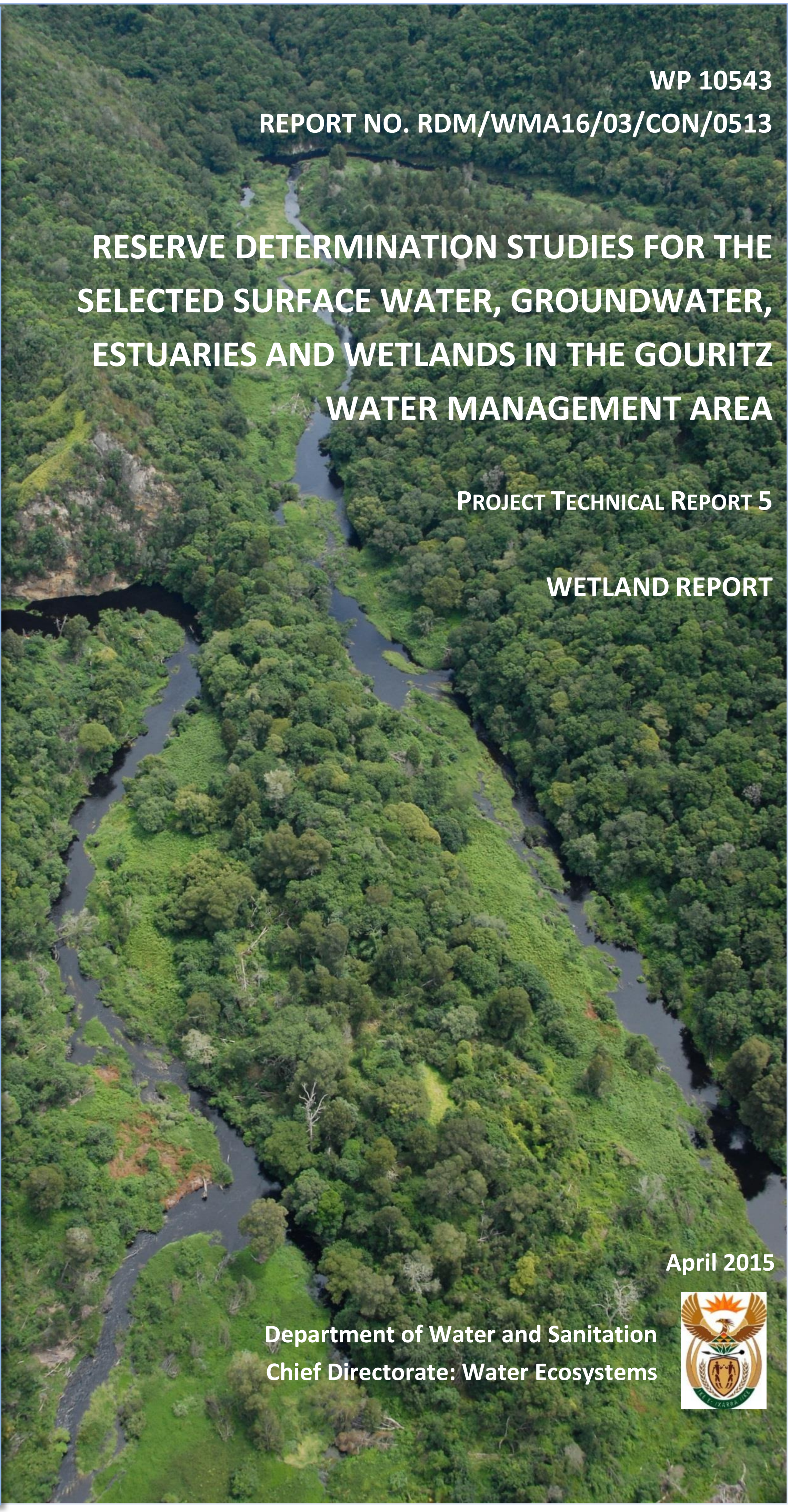

WP 10543

REPORT NO. RDM/WMA16/03/CON/0513

RESERVE DETERMINATION STUDIES FOR THE SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE GOURITZ WATER MANAGEMENT AREA

PROJECT TECHNICAL REPORT 5

WETLAND REPORT

April 2015

Department of Water and Sanitation

Chief Directorate: Water Ecosystems

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DOCUMENT INDEX

Reports as part of this project:

INDEX NUMBER	REPORT NUMBER	REPORT TITLE
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Report Number 02	RDM/WMA16/00/CON/0213	Desktop EcoClassification Report
Report Number 03, Volume 1	RDM/WMA16/00/CON/0313, Volume 1	Delineation Report, Volume 1 (Groundwater, Estuaries and Wetlands)
Report Number 03, Volume 2	RDM/WMA16/00/CON/0313, Volume 2	Delineation Report, Volume 2 (Rivers)
Report Number 04	RDM/WMA16/02/CON/0413	Groundwater Report
Report Number 05	**RDM/WMA16/03/CON/0513**	**Wetland Report**
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Report Number 12	RDM/WMA16/00/CON/1213	Monitoring Report
Report Number 13	RDM/WMA16/00/CON/1313	Main Report
Report Number 14	RDM/WMA16/00/CON/1413	Study Closure Report

Bold indicates this report.

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Version	Date
First draft	April 2015
Second draft	July 2015
Final report	October 2015

EXECUTIVE SUMMARY

BACKGROUND

This wetland report builds upon the earlier work undertaken in selected coastal catchments of the study area (DWA, 2010) and aims to provide a description of the types of wetlands within the area; a baseline status quo desktop assessment of wetlands within key catchments, and a rapid Ecostatus assessment of select priority wetlands within the study area. In addition, the wetlands have been grouped into Wetland Resource Units (WRUs) to enable the development of management recommendations and identification of recommended ecological specifications.

APPROACH

Individual priority wetlands in the study area were identified from the literature, desktop sources and in conjunction with the local wetland forum. Two of the highest high priority wetlands were assessed in the field to provide information on Ecostatus and management recommendations necessary to achieve the Recommended Ecological Category (REC).

Across the entire study area however, there are thousands of wetlands and it was not possible to assess each wetland individually. A baseline assessment of wetland Ecological Importance and Sensitivity (EIS) and average Present Ecological State (PES) at the quaternary catchment scale was undertaken across the Water Management Area (WMA). Quaternary catchments with more than 0.5% by area of wetlands were assessed. Recommended Ecological Categories (RECs) for these key catchments were determined from the baseline Ecostatus data.

In order to develop a catchment understanding of wetland types and processes, Wetland Resource Units, which denote large areas with similar wetland types within them, were delineated. Wetland types, processes, management concerns and recommended Ecological Specifications for the different WRUs, and for individual key quaternary catchments, were generated from available desktop information, baseline Ecostatus information and field experience of the area.

BASELINE ASSESSMENT OF WETLANDS: QUATERNARY CATCHMENT SCALE

There is a very low density of wetlands in the drier interior – most catchments have less than 0.5% wetlands by area compared with typically at least ten times that proportion in the coastal catchments. Quaternary catchments with 0.5% area or more of wetlands within them were identified using available wetland maps. The average Ecological Importance and Sensitivity (EIS) and PES for wetlands within these catchments were estimated using a desktop assessment tool.

Wetland Ecological Importance and Sensitivity

*Moderate EIS scores (**Figure I**) dominate the study area. The high rainfall coastal zone of the study area is characterised by catchments with Moderate, High and Very High EIS wetlands (**Figure II**). These catchments include the 1300 ha Wilderness Lakes, an internationally designated Ramsar wetland, as well as Groenvlei Lake and the Knysna lagoon. These are located in quaternary catchments K30 and K40D. Although there are comparatively few wetlands in the more arid, low rainfall interior of the catchment, wetlands here do provide important grazing resources, as well as trapping flood flows, and can play an important role in water table recharge functions.*

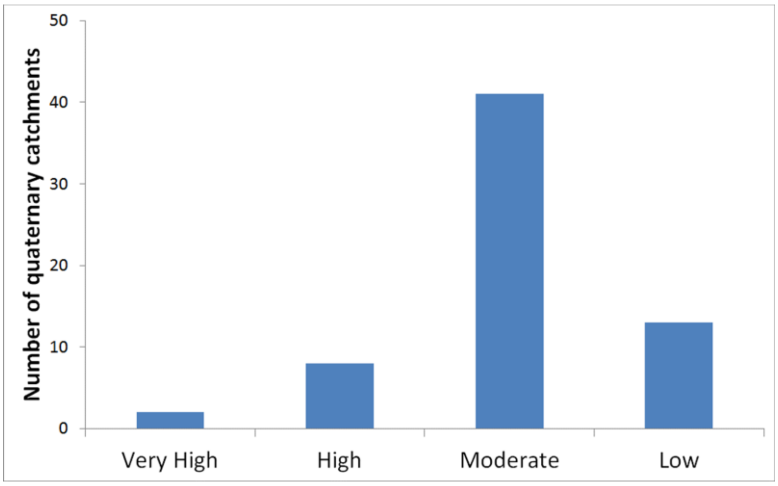

Figure I Summary of the EIS scores for the assessed quaternary catchments

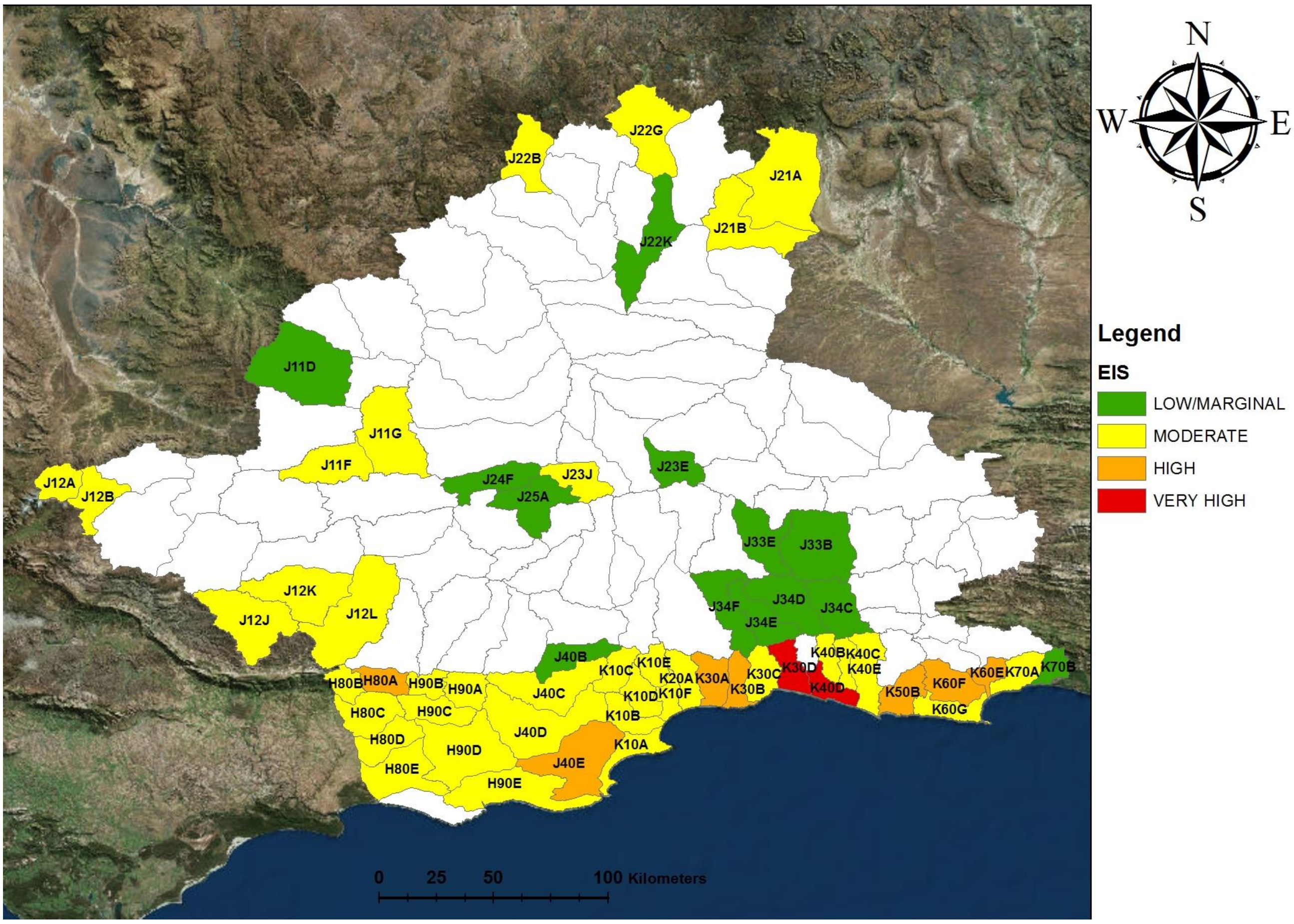

Figure II The average EIS of wetlands within select catchments

Wetland Present Ecological State

*The overall condition of wetlands in the interior catchments is estimated to be mostly in B and C ecological categories (**Figure III**). The majority of the wetlands in the study area are concentrated in the wetter coastal zone, in catchments that are often highly transformed by agricultural activities (pastures and cropping), forestry (afforestation) and urban areas as the majority of the population is in this zone. In addition to the direct impacts of these landuse practices on wetlands, additional factors, such as dams, flow reductions, nutrient enrichment and the spread of invasive vegetation into wetlands, have all impacted upon the PES of the wetlands in the coastal catchments. Consequently, wetlands are on average in a poorer condition along the coast than in the interior (**Figure IV**).*

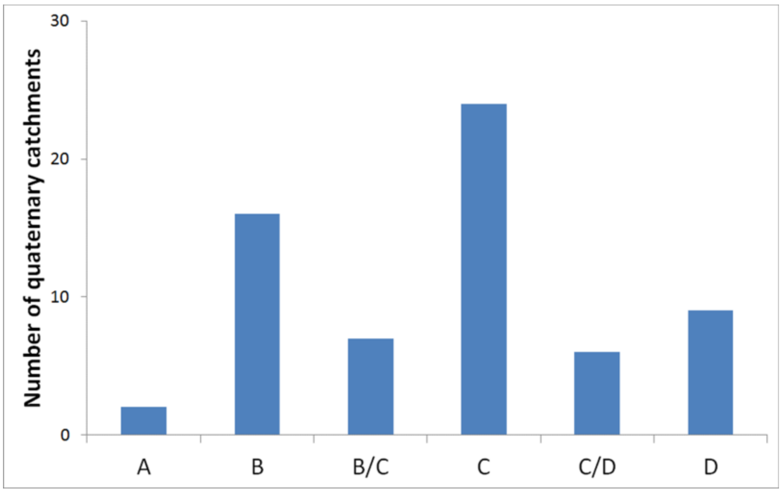

Figure III Summary of the PES scores for the assessed quaternary catchments

Although there are few wetlands in the interior of the catchment, many wetlands and streams in the Karoo are degraded by erosive gullies (dongas) caused by overgrazing, large camp systems, tree removal and burning. Further impacts are caused by the presence of 'thirsty' alien trees that reduce flow or even totally dry up springs and lower water tables.

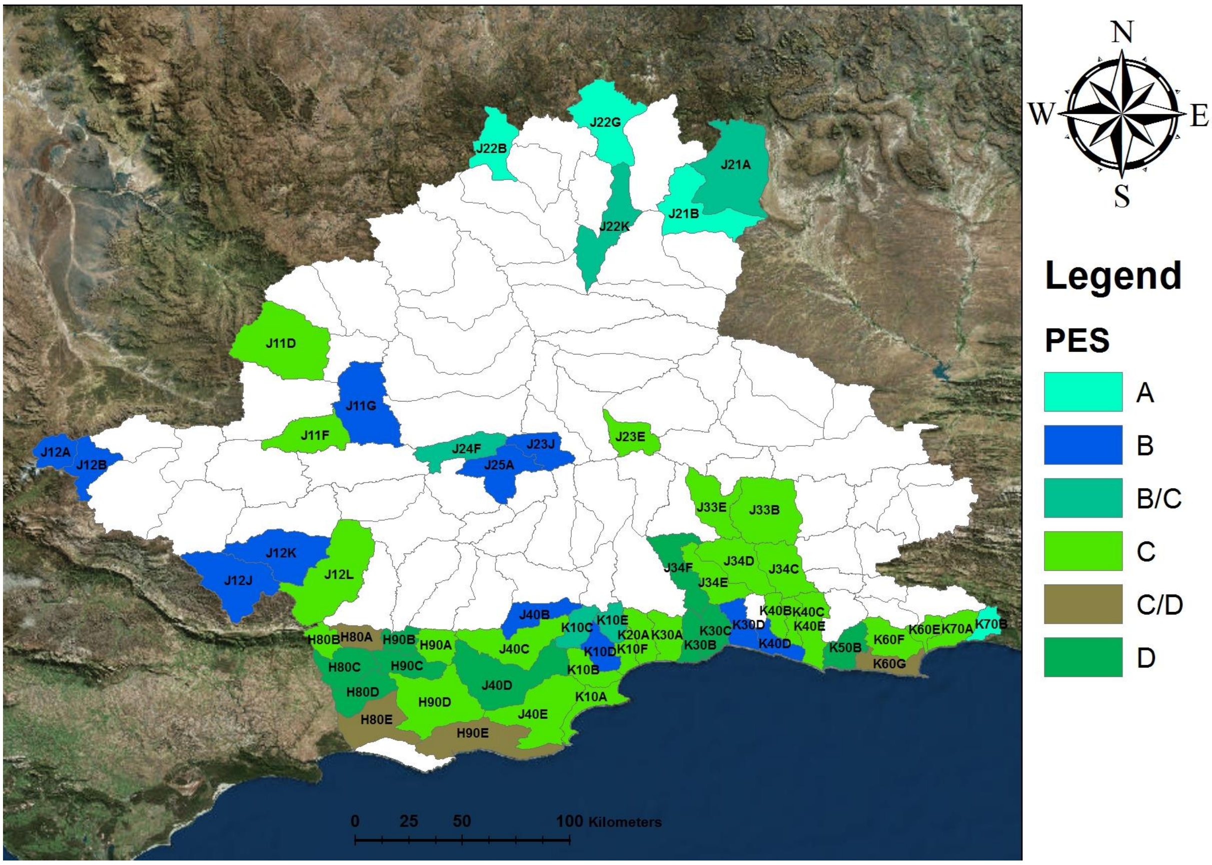

Figure IV The average PES of wetlands in select catchments

*Each quaternary catchment characterised by High or Very High EIS scores was assessed in terms of best attainable REC in light of their high EIS status. Select catchments with high EIS can achieve an improvement in the PES with the implementation of moderate (non-flow related) management actions (**Table I**). **Across the study area, the control of invasive vegetation in and alongside wetlands is a key management action to achieve the REC.***

Table I ***The average EIS and PES of wetlands for assessed catchments in the study area. High and Very High EIS and High (A and B) PES catchments are highlighted.***

Quaternary Catchment	*Desktop Wetland EIS*		*Weighted Desktop PES*		*REC*	*How to achieve the REC*
	Score	*EIS category*	*Score*	*PES Category*		
K10A	1.8	MODERATE	3.6	**C**	C	Control invasive alien vegetation, erosion and landuse encroachment.
K10B	1.9	MODERATE	3.2	**C**	C	
K10C	1.9	MODERATE	4.0	**B/C**	B/C	
K10D	2.0	MODERATE	4.1	**B/C**	B/C	
K10E	1.9	MODERATE	4.0	**B/C**	B/C	
K10F	2.0	MODERATE	3.4	**C**	C	
K20A	1.9	MODERATE	3.3	**C**	C	
K30A	2.8	**HIGH**	3.3	**C**	C	
K30B	2.7	**HIGH**	2.8	**D**	**C/D**	Buffers in urban and agricultural areas, manage water quality, erosion and invasive vegetation.
K30C	2.0	MODERATE	2.4	**D**	D	Control invasive alien vegetation, erosion and landuse encroachment.
K30D	3.6	**VERY HIGH**	4.1	**B**	B	
K40A	2.0	MODERATE	2.7	**D**	D	
K40B	2.0	MODERATE	3.8	**C**	C	
K40C	2.0	MODERATE	3.4	**C**	C	
K40D	3.6	**VERY HIGH**	4.4	**B**	B	
K40E	2.0	MODERATE	4.0	**B/C**	B/C	
K50A	2.0	MODERATE	3.9	**B/C**	B/C	
K50B	2.8	**HIGH**	2.9	**C/D**	**C**	Protect and improve the condition of remaining wetland patches, control invasive vegetation.
K60A	2.0	MODERATE	4.1	**B**	B	Control invasive alien vegetation, erosion and landuse encroachment.
K60B	2.0	MODERATE	4.5	**B**	B	
K60C	2.0	MODERATE	4.5	**B**	B	
K60D	2.1	**HIGH**	4.9	**A**	A	
K60E	2.1	**HIGH**	3.8	**C**	C	
K60F	2.4	**HIGH**	3.4	**C**	C	
K60G	1.9	MODERATE	3.3	**C**	C	
K70A	1.6	MODERATE	3.5	**C**	C	
K70B	1.0	LOW	4.7	**A**	A	
H80A	2.1	**HIGH**	3.0	**C/D**	**C**	
H80B	1.7	MODERATE	3.2	**C**	C	
H80C	1.4	MODERATE	2.3	**D**	D	
H80D	1.4	MODERATE	2.5	**D**	D	
H80E	1.5	MODERATE	2.9	**C/D**	C/D	
H90A	1.9	MODERATE	3.5	**C**	C	

Quaternary Catchment	*Desktop Wetland EIS*		*Weighted Desktop PES*		*REC*	*How to achieve the REC*
	Score	*EIS category*	*Score*	*PES Category*		
H90B	*2.0*	*MODERATE*	*2.8*	***D***	*D*	*Control invasive alien vegetation, erosion and landuse encroachment.*
H90C	*2.0*	*MODERATE*	*2.6*	***D***	*D*	
H90D	*1.6*	*MODERATE*	*3.3*	***C***	*C*	
H90E	*1.7*	*MODERATE*	*3.0*	***C/D***	*C/D*	
J11D	*1.0*	*LOW*	*3.6*	***C***	*C*	
J11F	*1.1*	*MODERATE*	*3.9*	***C***	*C*	
J11G	*1.1*	*MODERATE*	*4.1*	***B***	*B*	
J12A	*1.8*	*MODERATE*	*4.2*	***B***	*B*	
J12B	*2.0*	*MODERATE*	*4.4*	***B***	*B*	
J12J	*1.8*	*MODERATE*	*4.3*	***B***	*B*	
J12K	*1.9*	*MODERATE*	*4.5*	***B***	*B*	
J12L	*1.6*	*MODERATE*	*3.6*	***C***	*C*	
J21A	*1.6*	*MODERATE*	*4.1*	***B/C***	*B/C*	
J21B	*1.6*	*MODERATE*	*4.5*	***B***	*B*	
J22B	*1.1*	*MODERATE*	*4.5*	***B***	*B*	
J22G	*1.1*	*MODERATE*	*4.5*	***B***	*B*	
J22K	*1.0*	*LOW*	*3.9*	***B/C***	*B/C*	
J23E	*1.0*	*LOW*	*3.4*	***C***	*C*	
J23J	*1.2*	*MODERATE*	*4.4*	***B***	*B*	
J24F	*1.0*	*LOW*	*3.8*	***C***	*C*	
J25A	*0.9*	*LOW*	*4.3*	***B***	*B*	
J33B	*1.0*	*LOW*	*3.3*	***C***	*C*	
J33E	*0.9*	*LOW*	*3.4*	***C***	*C*	
J34C	*0.9*	*LOW*	*3.6*	***C***	*C*	
J34D	*0.7*	*LOW*	*3.4*	***C***	*C*	
J34E	*1.0*	*LOW*	*3.1*	***C/D***	*C/D*	
J34F	*0.9*	*LOW*	*2.9*	***D***	*D*	
J40B	*1.0*	*LOW*	*4.3*	***B***	*B*	
J40C	*1.4*	*MODERATE*	*3.1*	***C/D***	*C/D*	
J40D	*1.4*	*MODERATE*	*2.8*	***D***	*D*	
J40E	*2.1*	***HIGH***	*3.3*	***C***	*C*	

PRIORITY WETLANDS

In addition to the identification and assessment of important catchments, some wetlands were also assessed on an individual level. Based on information from the local Southern Cape Wetlands forum and the regional Dept. of Water and Sanitation, 33 potential priority wetlands were identified in the Water Management Area. Prioritisation was based on the physical, hydrological and ecological condition of the wetland and the threats to degradation. Two high priority wetlands, the Duiwenhoks unchannelled valley bottom, a large palmiet-dominated wetland, and the Bitou floodplain, were assessed in the field. Both wetlands have a moderate importance. The Duiwenhoks is in a D Ecological Condition, largely due to extensive erosion of the palmiet wetland. The Bitou wetland is in a C ecological condition, largely attributable to landuse conversion. Like many wetlands across the WMA, the impacts of invasive alien vegetation are ubiquitous and the removal *and control of woody alien trees can greatly reduce or even reverse some of the wetland degradation in the region.*

WETLAND RESOURCE UNITS

*There are thousands of wetlands in South Africa, and their sheer number precludes a site-specific approach to wetland management. In order to effectively manage these many wetlands, Wetland Resource Units (WRUs) were delineated. Nine Wetland Resource Units were identified across the WMA (**Figure V**). The characteristics of typical hydrogeomorphic (HGM) wetland types found within each are described (**Table II**). To facilitate more efficient and informed water use authorisation evaluation and licence processing, recommended ecological specifications for the management of wetlands within the different Wetland Resource Units are provided in **Section 6** of the report.*

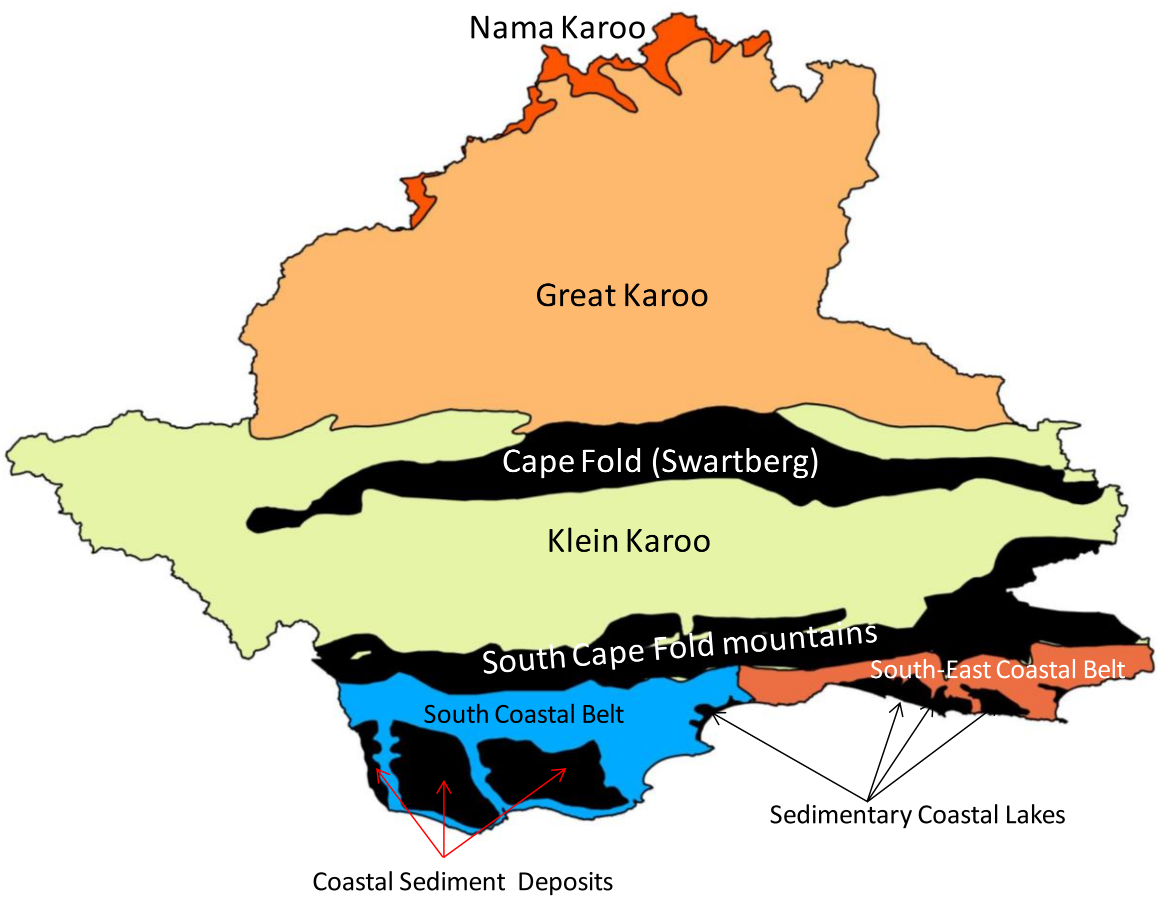

Figure V The Wetland Resource Units of the Gouritz study area

Table II Summary of typical wetland characteristics and hydrogeomorphic (HGM) wetland types in each Wetland Resource Unit (WRU) of the study area.

WRU	***Typical wetlands***	***NFEPA HGM types***	***Characteristics of HGM type***
Nama Karoo	*Seeps with a likely high degree of groundwater dependence.*	*Depression*	*Saline, temporary to seasonal*
		Seep	*Groundwater-dependant, seasonal or permanent*
Great Karoo	*Small seeps and river-linked wetlands with a likely high degree of direct and indirect groundwater dependence respectively.*	*Valley bottom*	*Saline, temporary to seasonal*
		Seep	*Groundwater-dependant, seasonal or permanent*
		Depression	*Saline, temporary to seasonal*
		Depression	*Seasonal to permanently saturated or inundated*
Klein Karoo	*Small seeps and river-linked wetlands with a likely high degree of direct and indirect groundwater dependence respectively.*	*Valley bottom*	*Saline, temporary to seasonal*
		Seep	*Direct or indirect groundwater link, seasonal or permanent*
Swartberg Cape Fold Mountains	*Small seeps associated with groundwater-fed springs.*	*Seep*	*Groundwater-dependant, seasonal or permanent*
South Cape Fold Mountains	*Small seeps associated with groundwater-fed springs.*	*Seep*	*Groundwater-dependant, seasonal or permanent*
South Coastal Belt	*Channelled and unchannelled valley bottom wetlands; extensive seepage wetlands (especially in granitic areas).*	*Valley bottom*	*Permanently saturated*
		Valley bottom	*Seasonally saturated*
		Seep	*Groundwater-dependant, seasonal or permanent*
		Depression	*Brack to fresh, temporary to seasonal*
South-East Coastal Belt	*Channelled and unchannelled valley bottom wetlands.*	*Valley bottom*	*Seasonal or permanent*
		Seep	*Groundwater-dependant, seasonal or permanent*
Sedimentary (Coastal Lakes)	*Lakes and wetland flats.*	*Depression*	*Coastal lakes ranging from fresh to brackish*
Coastal Sedimentary Deposit	*Desktop information shows wetlands are very infrequent – possibly due to deep infiltrating soils and a lack of shallow/perched water tables. Interdune depressional wetlands are present, suggesting groundwater contributions.*	*Valley bottom*	*Seasonal or permanent*
		Flat	*Seasonal or permanent*
		Seep	*Probably seasonal*

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ACRONYMS

AIP	Alien invasive plants
CD: WE	Chief Directorate: Water Ecosystems
CMA	Catchment Management Agency
DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning
DWA	Department Water Affairs (name change from DWAF applicable after April 2009)
DWAF	Department Water Affairs and Forestry
DWS	Department of Water and Sanitation (Name change from DWA applicable after May 2014)
EC	Ecological Category
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
FSC	Forest Stewardship Council
HGM	Hydrogeomorphic (hydrological and geomorphological wetland characteristics)
IBA	Important Bird Area
IHI	Index of Habitat Integrity
MAR	Mean Annual Runoff
NFEPA	National Freshwater Ecosystem Priority Area
NWA	National Water Act
NWRCS	National Water Resource Classification System
PES	Present Ecological State
REC	Recommended Ecological Category
SANBI	South African National Biodiversity Institute
TMG	Table Mountain Group
WfWetlands	Working for Wetlands
WMA	Water Management Area
WRU	Wetland Resource Unit
WULA	Water Use Licence Application

GLOSSARY

EcoRegions	Denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources, and are designed to serve as a spatial framework for the research, assessment, management and monitoring of ecosystems and ecosystem components. Several levels or scales of EcoRegions can be delineated (e.g. Level I low resolution/detail; Level III high resolution and detail). In South Africa, EcoRegions form the basis of the River Health monitoring assessments with Level II delineations available for use.
EcoSpecs	Ecological specifications necessary to achieve the REC.
Ecostatus	The overall PES and EIS of the resource. It represents the totality of the features and characteristics of a river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services. The Ecostatus value is an integrated ecological state made up of a combination of various PES findings from component Ecostatus assessments (such as for invertebrates, fish, riparian vegetation, geomorphology, hydrology and water quality).
Endorheic	Closed drainage e.g. a pan or inward draining lake.
Floodplain	A valley bottom wetland which is inundated when a river overtops its banks during flood events resulting in the wetland soils being saturated for extended periods of time.
Groundwater	Subsurface water in the zone in which permeable rocks, and often the overlying soil, are saturated under pressure equal to or greater than atmospheric pressure.
Groundwater table	The upper limit of the groundwater.
Hydrogeomorphic Unit	A Hydrogeomorphic (HGM) Unit is a single “reach”, segment or unit of a particular type of HGM wetland type.
Hydric soil	Soil that in its undrained condition is saturated or flooded long enough during the growing season to develop anaerobic conditions, which favour the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrogeomorphic	Refers to particular wetland typing (“classification”) methods based on the landscape (morphological) setting and hydrological characteristics of different wetland types.
Interflow	Relates to water moving downslope through the soil profile (i.e. below the surface, but not yet deep enough to be considered as true groundwater). This can be perched flows (where flows in the soil create locally perched water tables due to impervious layers in the soil or geology preventing seepage to deeper groundwater aquifers).

Palustrine	Palustrine (wetland) are all non-tidal wetlands dominated by persistent emergent plants (e.g. reeds) emergent mosses or lichens, or shrubs or trees (see Cowardin *et al*., 1979).
Peat	Peat is a brownish-black organic soil that is formed in acidic, anaerobic wetland conditions. It is composed mainly of partially-decomposed, loosely compacted organic matter with more than 50% carbon. The 50% carbon content is mostly applicable for the sphagnum peat moss peat deposits in the Northern Hemisphere. The South African soil classification uses a > 10% carbon content as a guideline. Inorganic soil particles are blown or washed into peatlands and also form part of the peat.
Perched water table	The upper limit of a zone of saturation in soil, separated by a relatively impermeable unsaturated zone from the main body of groundwater.
Permanent wetland	Permanently wet soil is soil that is flooded or waterlogged to the soil surface throughout the year, in most years.
Present Ecological State	Present Ecological State is a term for the current ecological condition of the resource. This is assessed relative to the deviation from the Reference State.
Ramsar wetland	A wetland of international importance which is listed as part of the Ramsar International treaty for wetland protection. The Ramsar Convention is an international treaty for the conservation and sustainable utilization of wetlands, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
Recommended Ecological Category	This is the ecological category that, based on the importance/sensitivity and PES of the water resource, determines the recommended category required to protect and manage the water resource to allow for future use of the system.
Reference Condition	Reference State/Condition is the natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development.
Riparian	Riparian includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent, and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.
Seasonal wetland	Seasonally wet soil is soil which is flooded or waterlogged to the soil surface for extended periods (> 1 month) during the wet season, but is predominantly dry during the dry season.

Temporary wetland Temporarily wet soil is the soil close to the soil surface (i.e. within 50 cm) which is wet for periods > 2 weeks during the wet season in most years. However, it is seldom flooded or saturated at the surface for longer than a month.

Wetland delineation Wetland delineation is the determination and marking of the boundary of a wetland on a map. The DWAF (2005) guidelines should be employed to undertake this for field application.

Wetland Resource Unit An area of a catchment which has wetlands with similar characteristics, processes and also broadly similar sensitivities to particular developments and impacts.

Wetland Refers to land that is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (National Water Act 36 of 1998).

1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The National Water Act (Act No. 36 of 1998) (NWA), **Section 3** requires that the Reserve be determined for water resources, i.e. the quantity, quality and reliability of water needed to sustain both human use and aquatic ecosystems, so as to meet the requirements for economic development without seriously impacting on the long-term integrity of ecosystems. The Reserve is one of a range of measures aimed at the ecological protection of water resources and the provision of basic human needs (i.e. in areas where people are not supplied directly from a formal water service delivery system and thus directly dependent on the resource according to Schedule 1 of the NWA). The Chief Directorate: Water Ecosystems (CD: WE within DWS) is tasked with the responsibility of ensuring that the Reserve is determined to enable the use in the assessment of water allocation and licensing applications.

The study area is the former Gouritz Water Management Area (WMA), which is now part of the Breede-Gouritz WMA. The requirement for detailed Reserve studies in the Gouritz study area became apparent for the following reasons:

- Various licence applications in the area;
- Gaps identified as part of the earlier Outeniqua Reserve determination;
- The conservation status of various priority water resources in the catchment, together with existing and potential impacts to them; and
- Increasing developmental pressures and secondary impacts related from the aforementioned and the subsequent impact on the availability of water.

1.2 STUDY AREA OVERVIEW

The study area encompasses the Gouritz Water Management Area, comprising drainage areas H, J and K (**Figure 1.1**). This Water Management Area (WMA) is situated along the southern coast of South Africa but extends inland across the Little Karoo and into the Great Karoo. The area covers about 53 000 km^2 and includes the Gouritz River catchment, the bulk of the WMA, with its main tributaries, the Groot, Gamka and Olifants rivers as well as secondary tributaries, the Touws, Dwyka, Buffels, Koekemoers, Kamma, Leeu, Vals, Stink and Kammanassie Rivers.

Along the coast to the east and west of the Gouritz River are several smaller coastal catchments. The Duiwenhoks and Goukou Rivers drain the coastal belt west of the Gouritz River, while the Garden Route area to the east of the Gouritz consists of several smaller rivers including the Knysna and Keurbooms Rivers. The catchments of the coastal belt also contain a number of important coastal lakes and wetlands. For instance, the Wilderness Lakes near Sedgefield are a designated Ramsar wetland site and the Knysna Lagoon[1] is considered the largest and most important estuary in the country (Turpie, 2004). Rainfall decreases from the coast inland, with mean annual precipitation varying from as high as 865 mm in the coastal areas, which experience year round rainfall, to as little as 160 mm in the drier areas inland to the north, which experience late summer rainfall.

Four main Level I EcoRegions characterise the study area (**Figure 1.2**), namely:

- the South Eastern Coastal Belt;

[1] Estuaries are not evaluated in this report as the definition of wetlands in the National Water Act refers only to inland freshwater wetlands.

- the Southern Coastal Belt;
- Southern Cape Folded Mountains, and
- The Great Karoo EcoRegion.

Additionally, the very northern extremities of the WMA extend into the Nama Karoo EcoRegion, associated with the Great Escarpment which forms the northern boundary of the WMA. A small pocket of the Western Folded Mountains EcoRegion is present in the far west of the WMA (**Figure 1.2**). EcoRegions reflect a variety of biophysical factors which influence ecological processes and the distribution of biota, with the finer scale Level II Ecoregional distribution (**Figure 1.3**) reflecting to a large degree the underlying geological characteristics(**Figure 1.4**). Along the southern coastal belt, sections of Granite, Conglomerate and Quartzite are dominant, whilst immediately adjacent to the coast old quaternary sediments (derived from fossil dunes and old sea beds) have been deposited in places. North of this lies an east-west deposit of Table Mountain sedimentary group, and this resistant feature has given rise to the Langeberge – a mountain range running from east to west separating the inland Klein Karoo from the coastal regions.

The Klein Karoo lies to the north of the Langeberge and is about 10-15 km wide, and the Groot and Gamka tributaries arise here. This area belongs to the Bokkeveld Group and consists of sandstones and shales. A complex mix of geologies is associated with the folded mountainous regions, with an extensive deposit of the Adelaide Group extending from the Swartberg Mountains north to the great escarpment which forms the northern boundary of the WMA.

Further inland, north of the Swartberg Mountains, is the Great Karoo. The Great Karoo consists of flat plains and low hills formed by Karoo sediments and doleritic intrusions. Towards the south the terrain becomes mountainous consisting of sandstones, shales and tillites of the Cape Supergroup. In the Olifants River catchment, in the vicinity of Oudtshoorn, the geology consists of sandstones, quartzite and conglomerates of the Malmesbury Group, overlain in the valley floors by alluvial deposits. The great Karoo extends northward to the Great Escarpment.

Across this study area, large numbers of wetlands are present, many of which are regarded as conservation priorities (**Figure 1.5**).

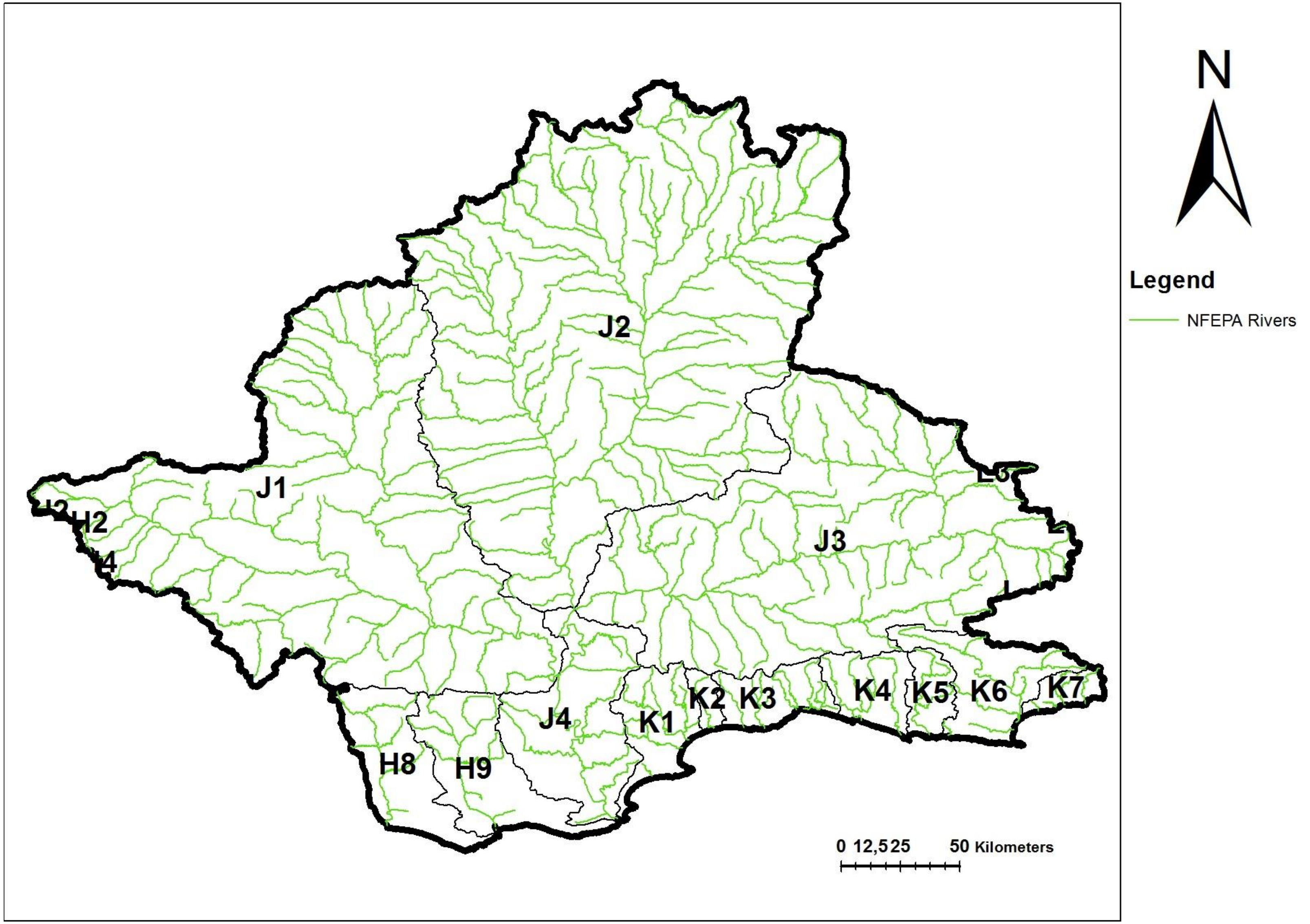

Figure 1.1 The secondary catchments of the study area

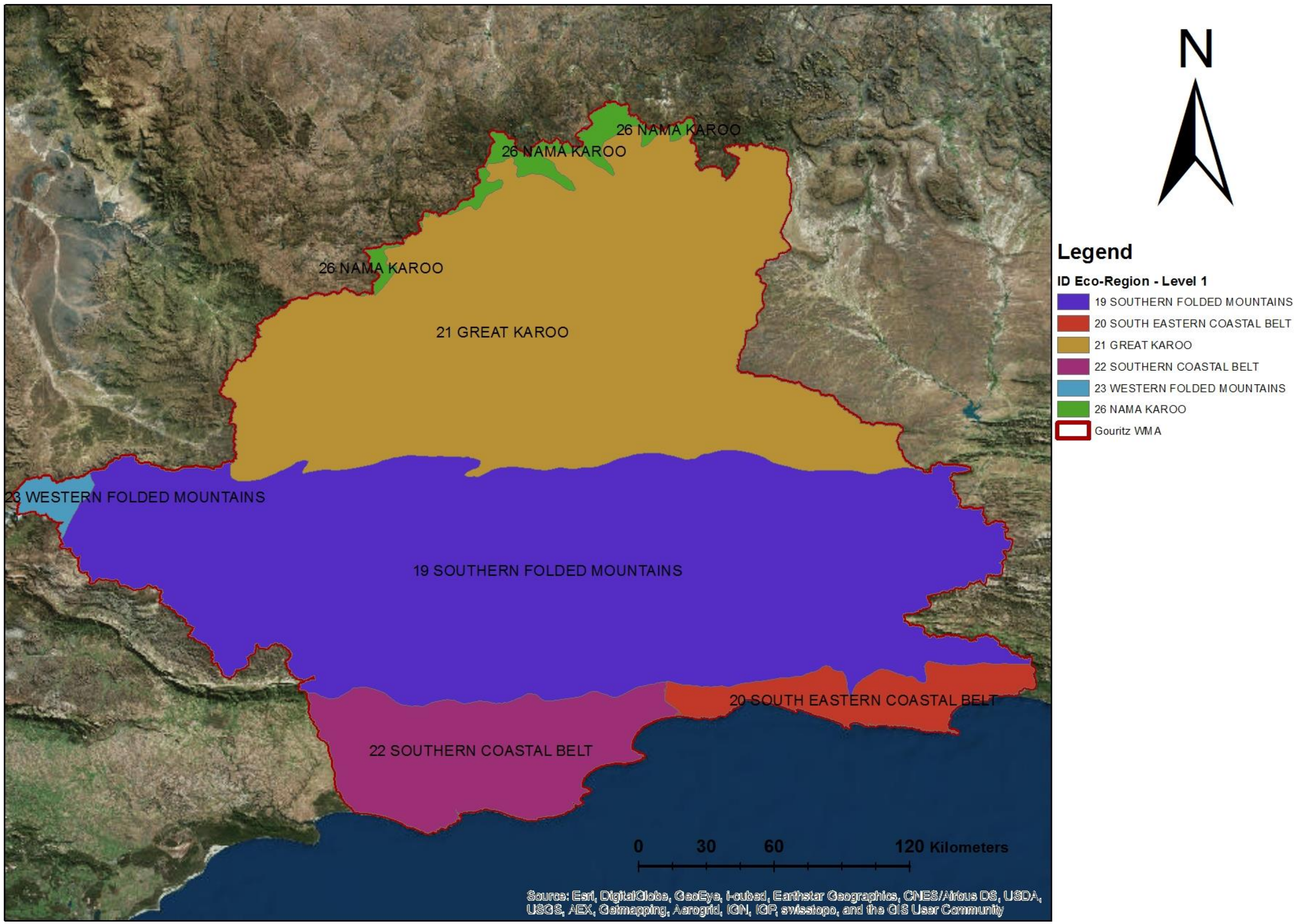

Figure 1.2 Level I EcoRegions within the study area (after Kleynhans *et al*., 2005)

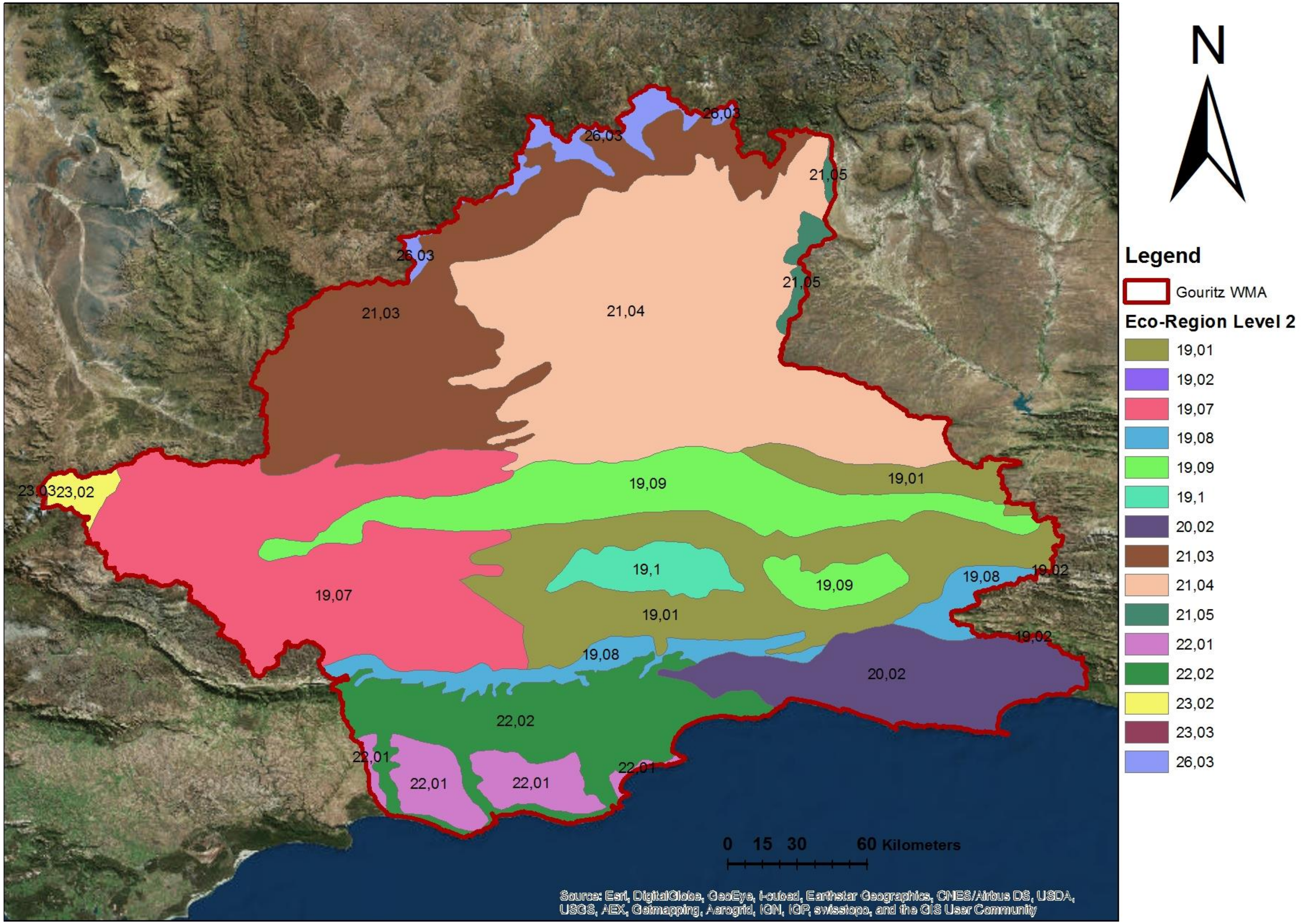

Figure 1.3 Level II EcoRegions within the study area (after Kleynhans *et al*., 2005)

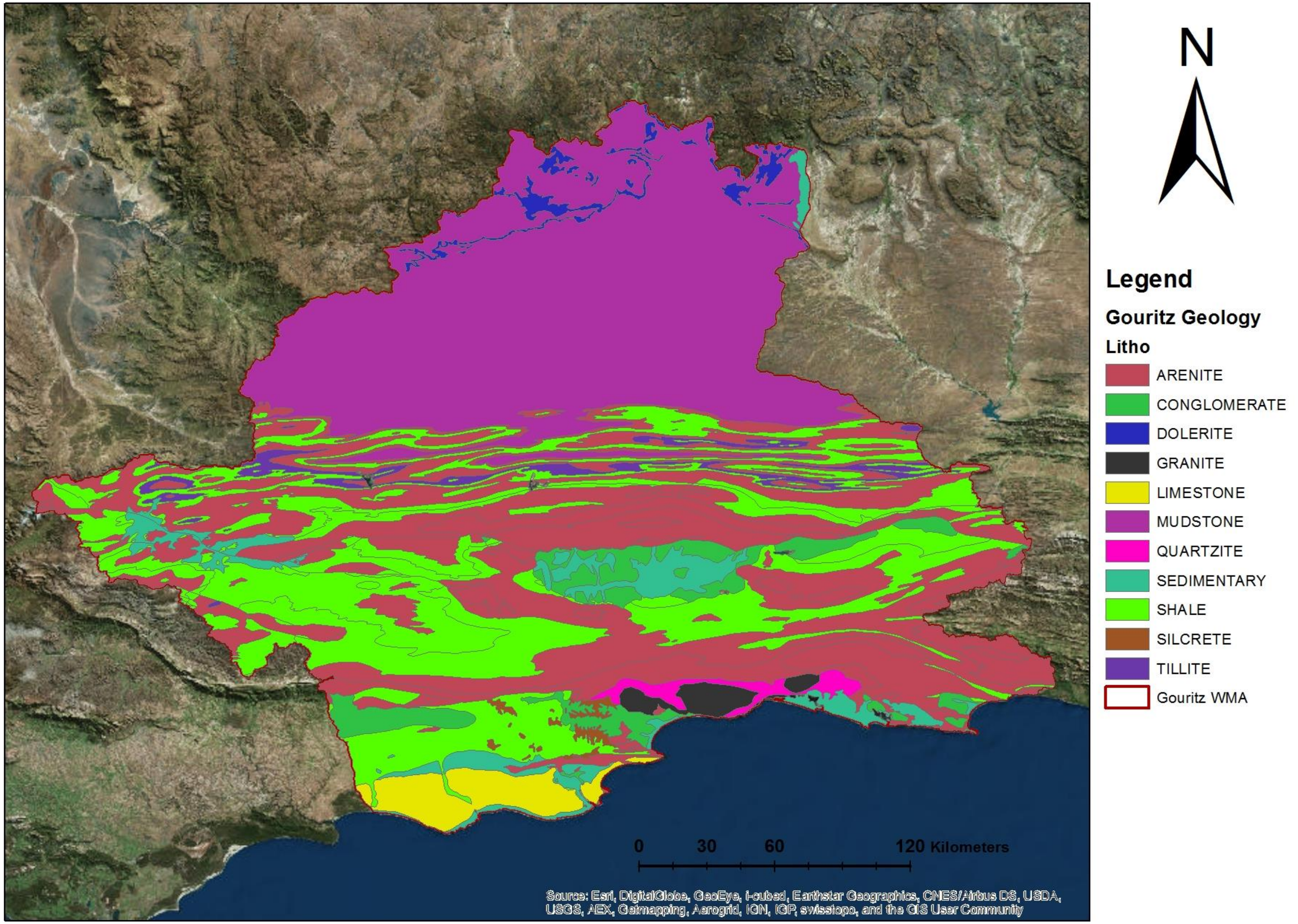

Figure 1.4 Simplified geology of the study area (geology information provided by DWS)

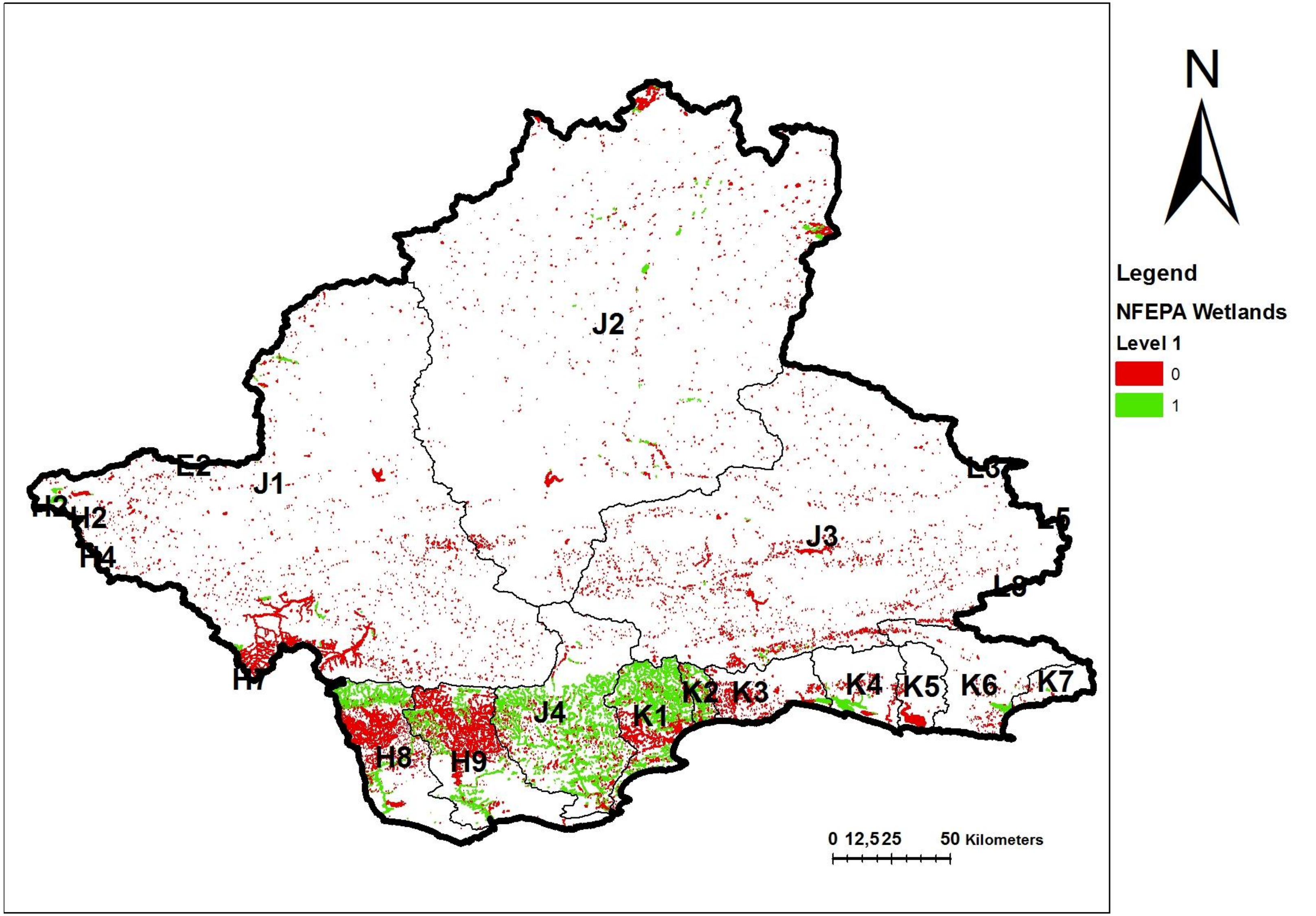

Figure 1.5 **The extent and density of wetlands across the study area, as indicated by the SANBI NFEPA wetland layer (Driver *et al*., 2012). Level 1 NFEPAs are regarded as conservation priorities whereas level 0 wetlands are regarded as non-priority wetlands.**

1.3 WETLANDS

In South Africa, the Department of Water and Sanitation (DWS) is the custodian of the nation's water resources, including wetlands (see "What is a Wetland" below). The DWS is mandated through the National Water Act (Act 36 of 1998) to ensure the conservation, protection and sustainable utilisation of wetlands. For effective implementation of the National Water Act, but also for a wider range of activities such as conservation planning and management, it is important that the ecological condition, and importance and sensitivity of wetlands be determined and managed.

What is a Wetland?

As defined by the South African National Water Act (Act 36 of 1998), a wetland is "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

Wetlands are essentially an expression of the presence of surface or near-surface water in the landscape. This water can either be static (e.g. pans) or slowly moving through the landscape. The source of the water can include surface flow, interflow (water flowing through the soil profile), groundwater (including deep and/or perched groundwater), direct rainfall, or any combination of these. Whatever the source, the water must be present for long enough to influence both the soil properties and the vegetation. In practice, the wetland boundary is defined as the position in the landscape where hydric indicators occur in the soil within 0.5 m of the surface (DWAF, 2005). Where these hydric indicators are deeper than 0.5 m, they generally do not support wetland adapted plants. Thus, the 0.5 m measurement traditionally forms the boundary between terrestrial and wetland adapted plant species.

Wetlands are amongst the most impacted and degraded of all ecological systems. Global assessments indicate that a large proportion of wetlands have been destroyed and the majority of remaining wetlands are degraded or under threat of degradation (Finlayson and Spiers, 1999). In South Africa, more than half of the country's wetlands are estimated to have been destroyed or converted into areas of lower functional importance (DEA, 2007). This is typically because wetland resources are often under-appreciated, resulting in inadequate management, unsustainable exploitation and consequently, poor wetland integrity (Ramsar 2011; UNESCO 2011). The main pressures on wetland ecosystems are typically non-flow related impacts such as encroachment from cultivation and impacts of urban development, mining, dam construction and poor grazing management. More widespread catchment impacts like alteration of flows, pollutants and sediment from surrounding land uses also lead to wetland degradation (Driver *et al*., 2012).

In addition to the mandate of the National Water Act, South Africa is a contracting party to the Ramsar Convention on Wetlands and has an obligation to promote the conservation and responsible use of wetlands. The assessment and monitoring of wetland condition is therefore an important component in managing the use of wetlands (Ramsar Convention, 2002). In an assessment of the State of the Environment in the Western Cape Province, which represents the majority of the Gouritz study area, DEADP (2013) noted that there was insufficient data to confirm the condition or trends of the ecological condition of wetlands.

As described above, most of the impacts affecting wetlands are non-flow related and therefore Ecological Water Requirement (EWR) or Reserve studies have not been undertaken for the wetlands of the Gouritz study area. However, due to a lack of even basic baseline information on wetland importance and condition in the study area, an assessment of the status quo and identification of priority wetlands within the study area has been undertaken as part of this study.

This report provides a description and Ecostatus (status quo) assessment of the wetlands across the study area, as well as identifying priority wetlands within the study area. The majority of the work undertaken has been at a desktop level, with limited field verification of desktop data. A field assessment of the Ecostatus of two high priority wetlands was undertaken in December 2014 in conjunction with DWS personnel. In addition, management guidelines and recommended ecological specifications (EcoSpecs) for the wetlands in the Gouritz have been developed for consideration in the evaluation of Water Use Licences and other applications for authorisation of the water resource which could potentially affect wetlands i.e. Section 21 c and i water use as specified in the NWA 36 of 1998.

1.4 OUTLINE OF THIS REPORT

This wetland report builds upon the earlier work undertaken in selected coastal catchments of the Gouritz WMA (DWA, 2010) and aims to provide a description of the types of wetlands within the study area; a baseline status quo assessment of wetlands within select catchments, and assessment of select priority individual wetlands within the study area. In addition, the wetlands have been grouped into Wetland Resource Units to enable the development of management recommendations and identification of recommended ecological specifications or objectives.

The report outline is as follows:

- **Section 1** provides general background to the study.
- **Section 2** describes the approaches adopted for the baseline assessments.
- **Section 3** provides the baseline assessment of wetlands at the quaternary catchment scale.
- **Section 4** lists the priority wetlands of the study area.
- **Section 5** provides the baseline assessment of selected priority wetlands.
- **Section 6** describes the management recommendations for the Wetland Resource Units of the study area.
- **Section 7** lists references.
- **Appendix A** provides comments from various reviewers.

2 APPROACH

2.1 BASELINE ASSESSMENT OF QUATERNARY CATCHMENTS

Since there are too many wetlands to evaluate on an individual basis, a desktop level quaternary-scale catchment assessment of the wetlands across the entire study area was undertaken. This information was used to determine the average EIS and PES categories of wetlands within assessed quaternary catchments. A desktop scoring system for quaternary catchment scale PES and EIS determination was developed during this study for this purpose.

Catchments which have very small and/or few wetlands could not be reliably assessed at the desktop level. Quaternary catchments which have less than 0.5% of wetlands in the catchment by surface area (indicated from the NFEPA wetland map) were excluded from the assessment.

2.1.1 Desktop EIS assessment of the wetlands at quaternary catchment scale

The river quaternary desktop EIS assessment tool (Kleynhans, 2000) was adapted for use in determining the EIS of wetlands at the quaternary catchment scale. Criteria that could be assessed using available desktop information were identified (**Table 2.1**). These were rated from low (score of 1) to very high (score of 4). Assessment of direct human benefits (such as grazing, subsistence agriculture, etc.) and the potential hydrological functional importance of wetlands (such as flood attenuation) were precluded from the desktop assessment because these could not be reliably assessed at the desktop level[2].

A weighted average score for each quaternary catchment was then calculated and EIS categories assigned. EIS categories are:

- ***none/marginal*** (for catchments which are comprised of less than 0.5% wetlands by surface area);
- ***low/marginal***, for wetlands which are on average only of local importance;
- ***moderate***, for wetlands which are on average of local to regional importance;
- ***high***, for wetlands which are on average of regional to national importance, and
- ***very high***, for wetlands which are on average of national to international importance.

[2] Hydrological functions and Direct Human Benefits of wetlands are however assessed as part of higher confidence, field-based Wetland EIS assessments as part of the Wetland Reserve RDM methods (Rountree *et al*., 2013). These criteria were evaluated in this study for the two priority wetlands.

Table 2.1 The list of criteria used to derive the quaternary scale EIS scores for wetlands. Each criterion was rated from 1 (low) to 4 (very high) using available desktop data.

Ecological Importance and Sensitivity criteria:	Data used to inform scoring:
Diversity of wetland types	NFEPA maps, Google Earth
Density of wetlands	NFEPA maps, Google Earth, SANBI wetland probability layer
Unique wetlands – size; type etc.	
Species richness	NFEPA information, vegetation maps
Importance of conservation and natural areas	Presence of formal conservation areas, Important Bird Areas (IBAs)
Migration route/corridor – links to other systems	NFEPA maps, Google Earth, SANBI wetland probability layer
Rare/endangered/unique populations	NFEPA information, vegetation maps, IBAs
Sensitivity to water quality changes	Wetland HGM types (Google Earth)
Sensitivity to upstream flow changes	Wetland HGM types (Google Earth)
Dependence on groundwater	Regional geology maps

2.1.2 Desktop PES assessment of the wetlands at quaternary catchment scale

Low confidence desktop assessments of the Wetland PES were conducted for each of the quaternary catchments in the study area, using approaches based on, and ensuring consistency with, similar desktop quaternary scale Ecostatus assessments for rivers and tributaries (Kleynhans, 2000). These were undertaken to provide a baseline (status quo) overview of the wetlands across the study area.

The impact criteria from the Wetland Index of Habitat Integrity (Wetland IHI) PES assessment tool (DWAF, 2007) were divided into those that needed to be considered at the catchment scale and those that needed to be assessed at the individual wetland unit (i.e. within-wetland) scale (**Table 2.2).** Each was rated on a scale of 0 (no impact evident) to 5 (the maximum possible extent or intensity of impact possible) for each quaternary catchment. An average weighted score for each quaternary catchment was then calculated and PES categories (**Table 2.3**) assigned using the approach of Kleynhans (2000). These results yield an average PES category for all wetlands within the relevant quaternary catchment.

Table 2.2 The list of criteria (potential impacts) assessed for the desktop wetland PES assessment

Criteria assessed at the Quaternary Catchment Scale:
Afforestation/invasive plants
Dams, irrigation, other flow reduction activities
Extent of urbanisation/catchment hardening
Mining/urban/cropping – water quality factors
Criteria assessed within the wetlands:
Invasive plants
Landuse activities (mining-cropping-grazing)
Altered hydrology (drains/dams)
Erosion of wetlands

Table 2.3 Ecological Categories (ECs) and descriptions

EC	Description of EC
A	Unmodified, natural.
A/B	Boundary category between A and B.
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
B/C	Boundary category between B and C.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
C/D	Boundary category between C and D.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
D/E	Boundary category between D and E.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E/F	Boundary category between E and F.
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

2.2 IDENTIFICATION OF PRIORITY WETLANDS

Priority wetlands within the catchment were identified from workshops and data derived from the Working for Wetlands (WfWetlands) programme in conjunction with the Southern Cape Wetlands Forum, from literature sources and consultations with WfWetlands, DWS and the stakeholder meeting of October 2013.

The initial identification of wetlands and catchments was undertaken in a workshop with members of the Southern Cape Wetland Forum and thereafter a small expert group scored the identified wetlands according to the following criteria:

- biodiversity condition;
- hydrological condition;
- physical condition; and
- threats.

Assessment of the socio-economic locality and options for rehabilitation were also collated where available. Scores were given from 1-10 as follows:

Biodiversity: This score is based on diversity and/or uniqueness of species and habitats within the wetland. A high score is given if there is a combination of unique species, unique habitats, many different species and/or habitats. A high score is assigned to systems with high biodiversity. A wetland can however have a high score with just a few unique species.

Hydrological condition: This score was based on the degree of hydrological functionality the wetland still has and the importance of its function to the larger drainage system (e.g. downstream). For example many wetlands and catchments are impacted by alien species, abstraction and infrastructure such as roads, weirs and dams, all of which alters the hydrology of the system. A high score is given if the system is still largely natural and/or is important to the hydrological functioning of the larger aquatic drainage system.

Physical condition: This score is based on the current physical condition of the wetland system. The habitat that the wetland provides to maintain its functionality to produce the goods and services from i.e. flood attenuation, groundwater recharge, habitat for birds, or provide fish stocks or reeds for subsistence use etc. A high score is given if the system is still largely intact and functional.

Threats: This score is based on the short to medium term level of threat on the system. This refers specifically to erosion, alien invasive species, water abstraction, pollution, and development encroachment (e.g. residential development) that may impact the system and cause wetland loss.

From these data, a median condition score was derived from the biodiversity, physical and hydrological condition scores. The wetlands were then ranked by threat (a reflection of water use pressures and risks to the sustainability of the current ecological condition) and the median condition score (which provides an indication of the PES). Highly threatened wetlands with high PES were prioritised. Estuaries were excluded from the prioritisation as these are being investigated in a parallel study (DWS 2015a, b, c). Previously assessed sites (Groenvlei Lake and the Malgaate wetlands assessed in DWA, 2009) were also excluded from consideration for the field assessments of this study to ensure that relevant new data could be collected for high priority, high risk sites.

2.3 BASELINE ASSESSMENT OF SELECT PRIORITY WETLANDS

Rapid field assessments were undertaken for the two highest priority wetlands (see **Section 5** of this report) during December 2014. Field assessments were undertaken in conjunction with regional and head office DWS staff. PES and EIS of these two wetlands were determined during the field assessments. Furthermore, potential management actions which could maintain and/or improve the PES of these two wetlands were determined during the field assessment. PES was assessed using the Wetland IHI (DWAF, 2007) and EIS using the Rapid Reserve methods for wetland importance (Rountree *et al*., 2013). The REC was determined through consideration of the resultant PES and EIS scores and, where the EIS was high or very high, feasibility of improvement of the PES.

2.4 DELINEATION OF WETLAND RESOURCE UNITS

There are thousands of wetlands within the study area, and it would be difficult, if not impossible, to map every single wetland or take a site-specific approach to wetland management. In order to effectively manage these many wetlands, an approach to classify wetlands with similar characteristics and group them into WRUs, has been developed.

The South African National Biodiversity Institute's (SANBI, unpublished) Wetland Probability Map and NFEPA wetland maps (**Figure 1.5**) were used as a first-level assessment of wetland occurrence within the study area. These data are not ground-truthed and should thus be treated with caution. Many small wetlands are not mapped and farm dams are often included in the dataset. Although dams are artificial wetlands, many earth farm dams are located in seepage or valley bottom wetlands and can therefore be used to indicate likely locations (but not extents) of the wetlands. Despite the introduction of error through inclusion of farm dams, limited independent preliminary verification suggests that these spatial data provide a significant underestimate of the actual occurrence and extent of wetlands; primarily due to the omission of many seepage wetlands. Despite all these limitations, these data provide an important indication of wetland distribution data for the country. The SANBI NFEPA map provides a more conservative estimate and density of wetlands across the study area, but importantly denotes potential priority wetlands which are considered to be regionally or nationally important water resources.

Associated biophysical characteristics were used to delineate the catchment into regions of homogenous areas with wetlands of similar types and/or underlying biophysical processes and drivers (refer to **Section 6**). This followed the approaches of DWA (2009), DWA (2010) and Louw *et al.* (2010).

2.5 MANAGEMENT RECOMMENDATIONS FOR WETLAND RESOURCE UNITS

Recommendations for the management of wetlands within the various WRUs were developed from available data and information derived from rapid assessments of the catchment.

3 BASELINE ASSESSMENT OF WETLANDS: QUATERNARY CATCHMENT SCALE

Rainfall is a key determinant of wetland occurrence. High wetland densities are generally found along the wetter coastal catchment areas, but exceptions to this are in the porous coastal sediments and limestones on the coast in the extreme south of the study area, where very few wetlands are present due to deeply draining soils and to limited surface water exposure.

The quaternary catchments of the study area were screened for the presence of wetlands using the available NFEPA wetland layer. Quaternary catchments which had less than a 0.5% coverage of wetlands within them were excluded from the baseline assessment as these catchments have very small and/or cryptic wetlands and the low coverage of wetlands in the catchment means that this catchment, at a regional or national level, is not important in terms of wetland coverage. For catchments with more than 0.5% of wetlands coverage (**Figure 3.1**), the average EIS and PES of wetlands within the quaternary were determined using the scoring system described in **Section 2.1**.

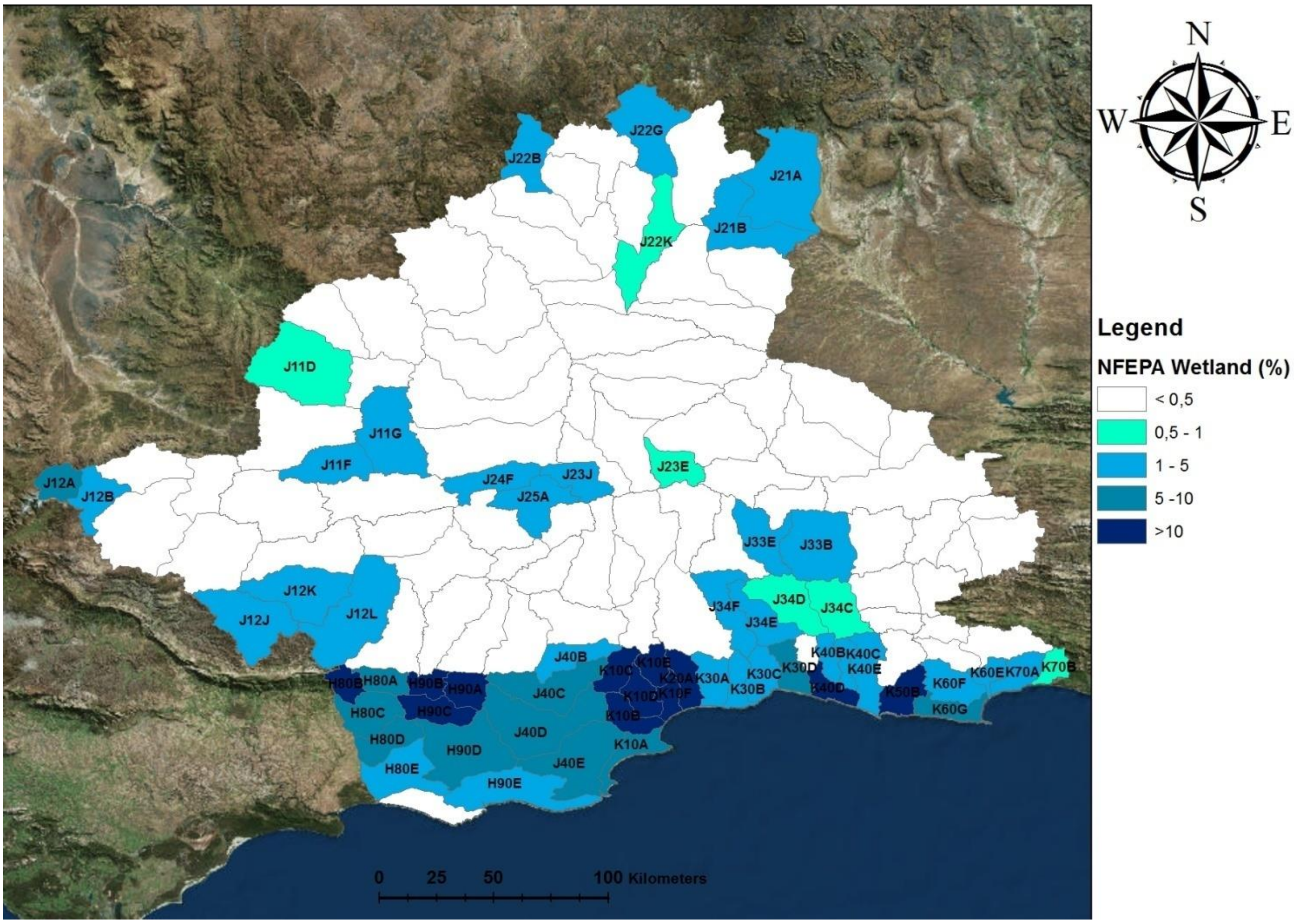

Figure 3.1 Quaternary catchments of the study area categorised by the % area of wetlands within them

3.1 EIS OF WETLANDS WITHIN THE GOURITZ STUDY AREA

In the drier interior of the WMA, wetland prevalence is generally very low, as expected, and many catchments have such low densities of wetlands (less than 0.5%) that no catchment level assessments were undertaken due to their low wetland importance (**Figure 3.1**). The few Karoo wetlands found here do however provide important local functions, such as grazing resources, trapping flood flows and can play an important role in water table recharge functions.

Although moderate EIS scores dominate the study area (**Figure 3.2**), the high rainfall coastal zone of the study area is characterised by catchments with moderate, high and very high EIS wetlands. These catchments include Ramsar wetlands (wetlands of international importance) such as Wilderness and Groenvlei lakes in quaternary catchments K30D and K40D respectively, which both have Very High EIS.

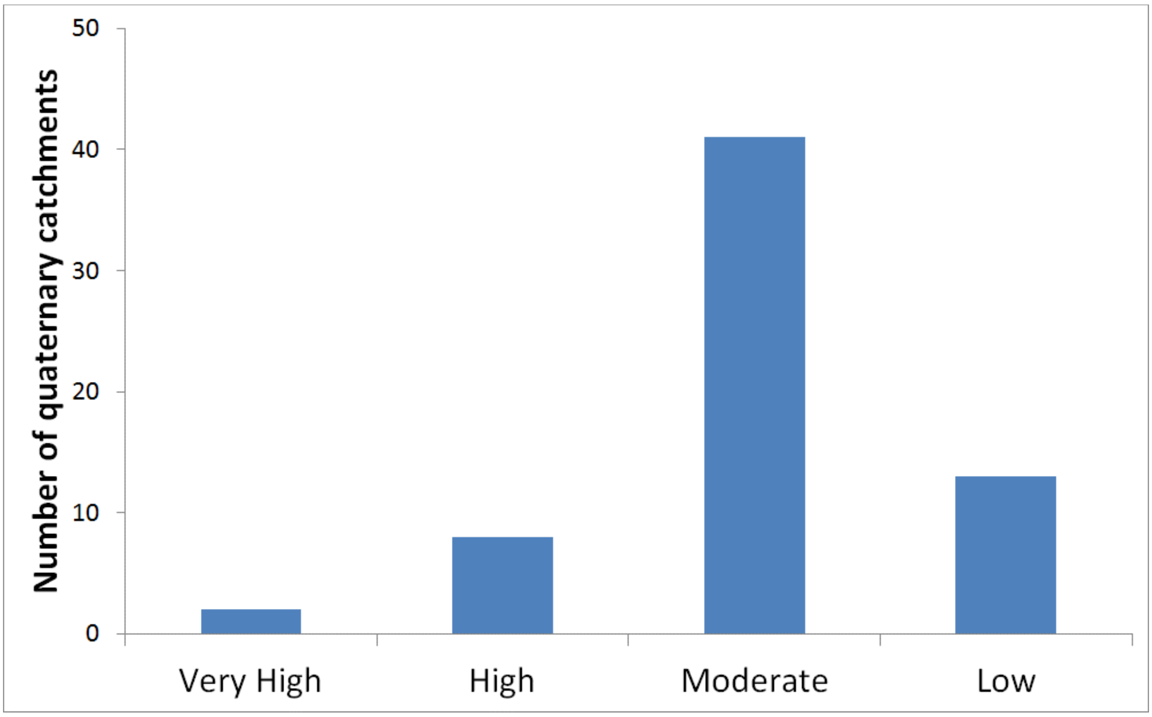

Figure 3.2 Summary of the EIS scores for the catchments assessed

3.2 PES OF WETLANDS WITHIN THE GOURITZ STUDY AREA

The majority of the wetlands in the study area are concentrated in the wetter coastal zone. These catchments are often highly transformed by agricultural activities (pastures and cropping), forestry (afforestation) and urban areas as the majority of the population is in this zone. In addition to the direct impacts of these land use practices on wetlands, additional factors, such as dams, abstraction, nutrient enrichment and the spread of invasive vegetation into wetlands, have all impacted upon the PES (**Figure 3.3**) of the wetlands in the coastal catchments. Consequently, wetlands are on average in a poorer condition along the coast than in the interior (**Figure 3.4**).

Wetlands in the drier interior are few – most catchments have less than 0.5% wetlands by area compared with typically at least ten times that proportion in the coastal catchments. Although there are few wetlands, many wetlands and streams in the Karoo are degraded by erosive gullies (dongas) caused by overgrazing, large camp systems, tree removal and burning. Degradation is likely to have started with the intensive livestock operations of early European farmers (Smuts, 2012) which caused erosion and declines in forage productivity (Milton and Dean, 1995). Additional degradation of watercourses may also have been initiated by old access routes – wetlands in the area functioned as the roads for ox-wagon carts that transported people and goods through the Karoo prior to the arrival of cars (Dean and Milton, 1999). Further impacts are caused by the presence of "thirsty" alien trees that reduce flow or even totally dry up springs and lower water tables.

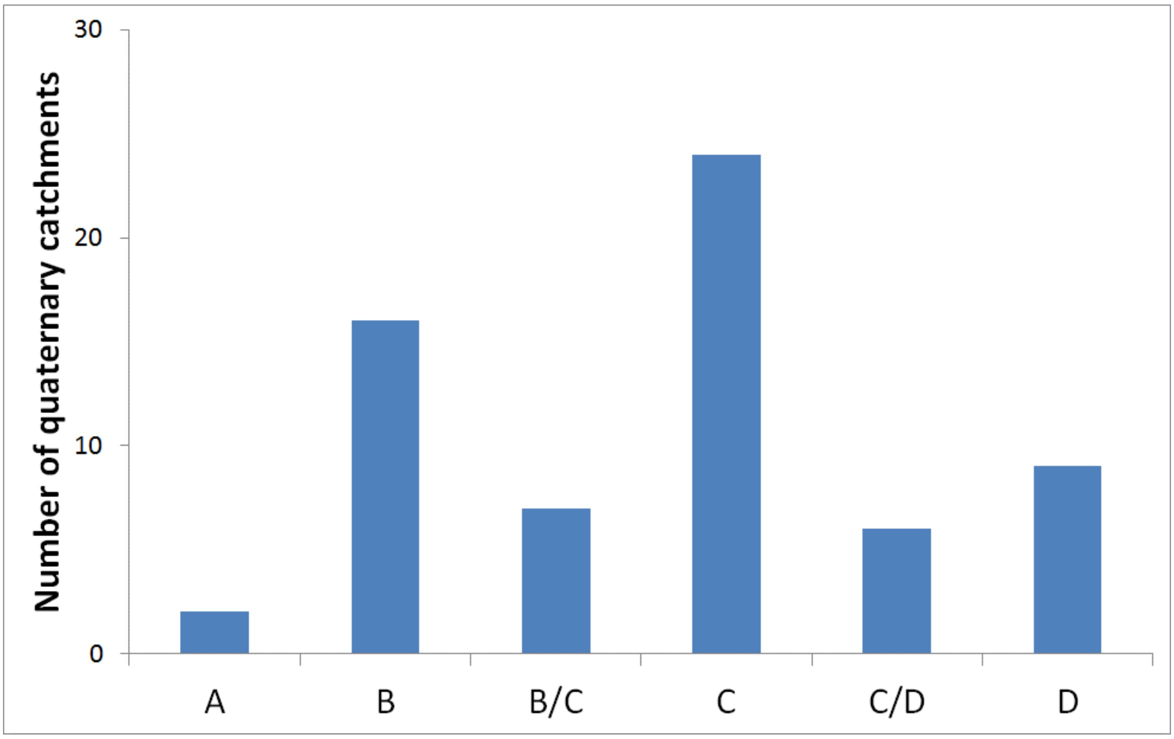

Figure 3.3 Summary of the PES scores for the catchments assessed

However, despite these impacts, extensive areas of the catchment have relatively limited areas of direct land use transformation and large areas of natural or near-natural areas, including inaccessible mountainous regions where occasional springs and seeps maintain small wetlands. The overall condition of wetlands in the interior catchments is thus estimated to mostly be in B and C ecological categories (**Figure 3.5**) and the median EC of wetlands in the study area is a C (**Figure 3.3**).

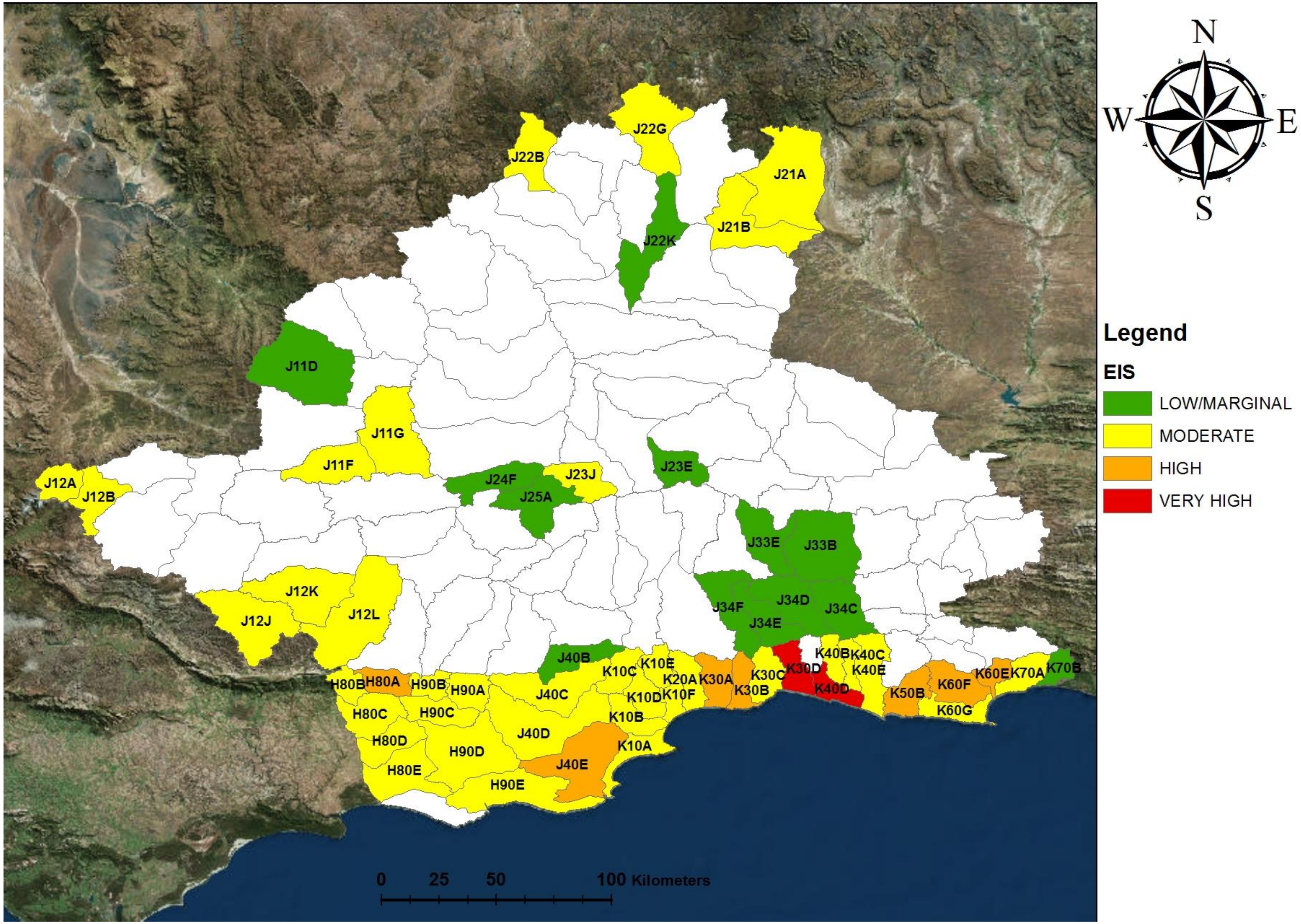

Figure 3.4 The average EIS of wetlands within assessed catchments

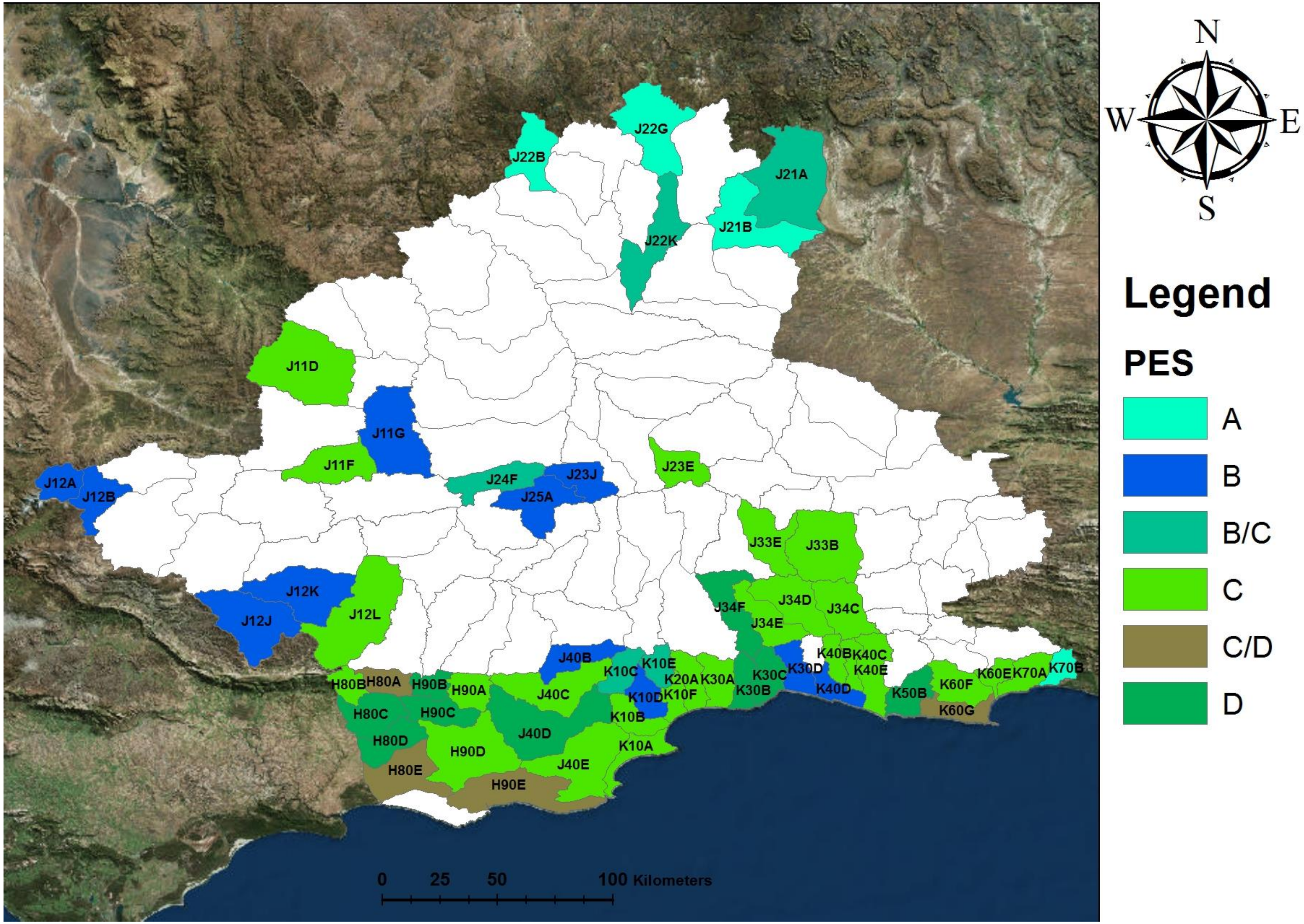

Figure 3.5 The average PES of wetlands in assessed catchments

3.3 REC OF WETLANDS PER CATCHMENT

Each quaternary catchment characterised by High or Very High EIS scores was assessed in terms of best attainable ECs (Recommended Ecological Category) in light of their high EIS status, the ability of practicable actions to achieve a higher than PES REC, and the current PES. Select catchments with high EIS can achieve an improvement in the PES with the implementation of moderate (non-flow related) management actions (**Table 3.1**). For all catchments, the control of invasive vegetation in and alongside remaining wetlands is a key management action to maintain the PES of the wetlands.

Table 3.1 The average EIS and PES of wetlands for assessed catchments in the study area. High and Very High EIS and High A and B category catchments are highlighted.

Quaternary Catchment	Desktop Wetland EIS		Weighted Desktop PES		REC	How to achieve the REC
	score	EIS Category	score	PES Category		
K10A	1.8	MODERATE	3.6	**C**	C	Control invasive alien vegetation, erosion and landuse encroachment
K10B	1.9	MODERATE	3.2	**C**	C	
K10C	1.9	MODERATE	4.0	**B/C**	B/C	
K10D	2.0	MODERATE	4.1	**B/C**	B/C	
K10E	1.9	MODERATE	4.0	**B/C**	B/C	
K10F	2.0	MODERATE	3.4	**C**	C	
K20A	1.9	MODERATE	3.3	**C**	C	
K30A	2.8	**HIGH**	3.3	**C**	C	
K30B	2.7	**HIGH**	2.8	**D**	**C/D**	*Buffers in urban and agricultural areas, manage water quality, erosion and invasive vegetation.*
K30C	2.0	MODERATE	2.4	**D**	D	Control invasive alien vegetation, erosion and landuse encroachment
K30D	3.6	**VERY HIGH**	4.1	**B**	B	
K40A	2.0	MODERATE	2.7	**D**	D	
K40B	2.0	MODERATE	3.8	**C**	C	
K40C	2.0	MODERATE	3.4	**C**	C	
K40D	3.6	**VERY HIGH**	4.4	**B**	B	
K40E	2.0	MODERATE	4.0	**B/C**	B/C	
K50A	2.0	MODERATE	3.9	**B/C**	B/C	
K50B	2.8	**HIGH**	2.9	**C/D**	**C**	*No net loss or degradation of remaining wetland patches, control invasive vegetation*
K60A	2.0	MODERATE	4.1	**B**	B	Control invasive alien vegetation, erosion and landuse encroachment
K60B	2.0	MODERATE	4.5	**B**	B	
K60C	2.0	MODERATE	4.5	**B**	B	
K60D	2.1	**HIGH**	4.9	**A**	A	
K60E	2.1	**HIGH**	3.8	**C**	C	
K60F	2.4	**HIGH**	3.4	**C**	C	
K60G	1.9	MODERATE	3.3	**C**	C	
K70A	1.6	MODERATE	3.5	**C**	C	
K70B	1.0	LOW	4.7	**A**	A	
H80A	2.1	**HIGH**	3.0	**C/D**	**C**	
H80B	1.7	MODERATE	3.2	**C**	C	
H80C	1.4	MODERATE	2.3	**D**	D	
H80D	1.4	MODERATE	2.5	**D**	D	
H80E	1.5	MODERATE	2.9	**C/D**	C/D	
H90A	1.9	MODERATE	3.5	**C**	C	

Quaternary Catchment	Desktop Wetland EIS		Weighted Desktop PES		REC	How to achieve the REC
	score	EIS Category	score	PES Category		
H90B	2.0	MODERATE	2.8	**D**	D	Control invasive alien vegetation, erosion and landuse encroachment
H90C	2.0	MODERATE	2.6	**D**	D	
H90D	1.6	MODERATE	3.3	**C**	C	
H90E	1.7	MODERATE	3.0	**C/D**	C/D	
J11D	1.0	LOW	3.6	**C**	C	
J11F	1.1	MODERATE	3.9	**C**	C	
J11G	1.1	MODERATE	4.1	**B**	B	
J12A	1.8	MODERATE	4.2	**B**	B	
J12B	2.0	MODERATE	4.4	**B**	B	
J12J	1.8	MODERATE	4.3	**B**	B	
J12K	1.9	MODERATE	4.5	**B**	B	
J12L	1.6	MODERATE	3.6	**C**	C	
J21A	1.6	MODERATE	4.1	**B/C**	B/C	
J21B	1.6	MODERATE	4.5	**B**	B	
J22B	1.1	MODERATE	4.5	**B**	B	
J22G	1.1	MODERATE	4.5	**B**	B	
J22K	1.0	LOW	3.9	**B/C**	B/C	
J23E	1.0	LOW	3.4	**C**	C	
J23J	1.2	MODERATE	4.4	**B**	B	
J24F	1.0	LOW	3.8	**C**	C	
J25A	0.9	LOW	4.3	**B**	B	
J33B	1.0	LOW	3.3	**C**	C	
J33E	0.9	LOW	3.4	**C**	C	
J34C	0.9	LOW	3.6	**C**	C	
J34D	0.7	LOW	3.4	**C**	C	
J34E	1.0	LOW	3.1	**C/D**	C/D	
J34F	0.9	LOW	2.9	**D**	D	
J40B	1.0	LOW	4.3	**B**	B	
J40C	1.4	MODERATE	3.1	**C/D**	C/D	
J40D	1.4	MODERATE	2.8	**D**	D	
J40E	2.1	**HIGH**	3.3	**C**	C	

4 PRIORITY WETLANDS IN THE STUDY AREA

A list of priority wetlands was identified and their characteristics, major threats and rehabilitation recommendations evaluated using data provided by the southern Cape Wetlands Forum and SANBI (**Table 4.1**). The condition of each potential priority wetland was scored from one to ten for biodiversity, hydrology and physical condition and a median score derived to represent the overall condition of the wetland, and wetlands were ranked according to their threat score and overall ecological condition estimate (**Table 4.2**). Estuarine wetlands (Knysna, Swartvlei, Noetzie, Groot Brak, Goukou and Goukamma estuaries) that had been identified as potential priority wetlands were excluded from further assessment as estuaries were assessed separately in a parallel study as part of this project (DWS 2015a, b and c).

Table 4.1 Condition, threats and rehabilitation recommendations for priority wetlands in the Gouritz study area

Wetland	Characteristics of wetland	Major threats	Rehabilitation recommendations
Duiwenhoks	Hydrological condition: partially degraded. Physical condition: upper reaches are intact, but very large, rapidly eroding donga is degrading the wetland. Socio-economic/poverty: it flows into the Duiwenhoks dam which supplies a large amount of water.	Major headcut, agricultural encroachment, burning/removal of palmiet.	Erosion dongas need to be stabilised to protect remaining wetlands. Rehabilitation of the entire eroded system is not feasible. These interventions will be very costly, but will protect downstream catchment watercourse from further sedimentation impacts.
Goukou river system	Biodiversity: Fairly pristine for a palmiet system. Socio-economic/poverty: supply of water, and farms depend on it. Physical condition: fairly pristine, lower down it is degraded. Two of the tributaries are degraded.	Agriculture; invasive alien vegetation.	One rehabilitation structure that needs to be built to secure a large area of wetland.
Bitou River floodplain and estuary	Biodiversity: has a unique mixture of biodiversity. The floodplain transitions to the estuary (confluence with the Keurbooms estuary). Hydrological intactness: waste water return flows, reduced inflows.	Encroachment from existing and proposed landuses. In addition, minor impacts from a proposed dam may occur in future, and invasive alien vegetation on the floodplains.	
Keurbooms river catchment (upper)	Hydrological intactness: it is important as it feeds the entire Keurbooms. Socio-economic/poverty: it is an important area, score similar to Upper Palmiet – but slightly higher because it is bigger. Physical condition: in the upper areas there was a lot of erosion – there are also dams, but to get in there it would be very expensive.	Very high threat due to the amount of AIPs everywhere, there are also trout farms in this system.	There are many small problems that can be dealt with; especially the management of invasive alien plants, but the upper catchment is difficult to access and rehabilitation there would be challenging.
Gwaing river system	Biodiversity: it is an urban river that runs through George, with a large number of wetlands throughout the area, it is fairly degraded. Socio-economic/poverty: golf courses etc. benefit.	Very high – development, pollution, waste water discharge from Waste Water Plant.	Alien clearing, river rehabilitation, it would be a good investment to remove Alien Invasive Plants (AIPs) in these wetlands as they are easily accessible etc.

Wetland	Characteristics of wetland	Major threats	Rehabilitation recommendations
Salt River system (Knysna)	Hydrological intactness: large quantities of siltation, there is an informal settlement above it. Socio-economic/poverty: there is a large community of people living in poverty nearby. It is comparable to Bigai River. Physical condition: not good, but probably better than the Bigai River, there are also alien species.	High threats particularly from sewerage.	Education and clean-up exercises could be done, intervention measures would be expensive.
Groenvlei	Biodiversity: It is the only endorheic coastal lake and the water level is about 3 meters above sea-level. Very unique. Hydrological intactness: hydrology is marginally changed. Socio-economic/poverty: it is important for recreation such as bass angling. Essentially all lakes in this area are fairly important for tourism etc. Physical condition: still good.	There are a number of threats – alien fish, bass, carp, tilapia etc., groundwater use, pollution, hydrological changes, and development.	Interventions would include curbing groundwater use and development, and control alien fish (carp – have decreased from fishing, which is good news). Some can be solved, could do more signage and interpretation.
Salt River system (Crags)	Biodiversity: this is probably comparable to the Groot River, particularly in invertebrates, it has no fish. Hydrological intactness: there is more water going out of this river than the previous example; however there is still a fair amount flowing down it. Socio-economic/poverty: it is providing water, there is the possibility of tours by local communities. Physical condition: it is currently still fairly pristine.	The threats to this system are high – Kurland Polo Estate in particular – sewerage and pollutants from the estate, the threat is quite high because it's pristine downstream, there are also plans to pipe water to Plettenberg Bay from this system.	Alien removal in upper catchments could be done.

Wetland	Characteristics of wetland	Major threats	Rehabilitation recommendations
Upper Knysna catchment (incl. Gouna)	Biodiversity: high biodiversity – there is still a lot of Palmiet, Gouna – has high biodiversity, Knysna River has important invertebrates and there are a diversity of habitats (big pools, vleis etc.) in this system which is very rare. Hydrological intactness: mostly intact, 99% of water abstraction comes from lower parts of this system. There are some plantations in Gouna. Socio-economic/poverty: it is important because it's feeding into the Knysna Estuary and providing water. Physical condition: Gouna is good but there are plantations and dairy farms, Knysna is not in as good condition but there is clearing going on.	There are a number of threats such as erosion and AIPs, however this is being addressed. It's not as bad as the Palmiet, but no one has looked into it much.	A lot of high altitude AIP removal work would have to be done which is expensive.
Kaaimans river system	Socio-economic/poverty: extremely important for George. Physical condition: still in good condition.	Threats: high, a dam is being built.	Invasive alien plant control, but it is a very steep system.
Tshokwane wetland (lower Keurbooms)	Already impacted by extensive development and encroachment.	Proposed development, currently draining, alien plants, mining nearby and roads.	Road needs better drainage, change culverts.
Wilderness Lakes system	Biodiversity: it is a national park and a Ramsar site. Hydrological intactness: it is modified, it does still get breached, and the percentage of loss of flow is high. Socio-economic/poverty: very important for recreation and tourism. Physical condition: there is a lot of modification, emergent vegetation because the flooding has been altered.	Creeping development, effluent etc.	There are some small interventions that could help, rehabilitate the vegetation, and do artificial flooding.
Karatara	Biodiversity: similar to Diep and Wolwe river. Hydrological intactness: the most modified of the three, abstraction high. Socio-economic/poverty: need water for Sedgefield from this system. Physical condition: probably quite good, nor heavily eroded.	Abstraction, AIPs, but there are two clearing programmes going on.	Not much that can be done, they are building a dam.

Wetland	Characteristics of wetland	Major threats	Rehabilitation recommendations
Wolwe / Diep River	Physical condition: there is a lot of development in the middle reaches, with changes to the riparian zone, localised erosion etc.	A possible threat is the reversal of the forestry exit decision – there could be reforestation pressure.	Monitor any expansion of afforestation to limit encroachment; IAP control.
Groot Brak plateau / Varings River	Impacted from reduced flows and invasive alien vegetation.	Threats: AIPs and farming, there are a lot of applications for increased abstraction for farming.	Rehabilitation: alien clearing.
Maalgate river system	Hydrological intactness: there are numerous farm dams. Socio-economic/poverty: many people benefit – farming.	AIPs, trout farms and other farming activities.	AIP clearing, not much can be done about farm dams.
Klein Wolwe	Hydrological intactness: highly modified, compounded by farm dams etc. Socio-economic/poverty: important for industry. Physical condition: Highly modified, lowest in terms of river health assessment.	Dairy farming impacts.	There have been effluent spills – milk by-products. Could do artificial wetlands before it goes into the estuary to purify water – so there is opportunity.
Piesang River	Biodiversity: very degraded. Hydrological intactness: inter-basin transfer, dams. Socio-economic/poverty: high value as the town relies on the water. Physical condition: physical condition is probably all right in terms of the estuary at the bottom.	High from development (sewage, dumping, municipal dump seepage etc.)	Some rehabilitation potential at the Roodefontein Golf Estate. There are some opportunities in the upper catchment.
Duiwenhoks (eastern eroded reach)	Hydrological intactness: degraded. Physical condition: not much left, essentially just an erosion gully.	Erosion dongas are the primary threat, as well as IAPs.	Could be rehabilitated slightly, the wetlands need to be rehydrated, but this will be very costly. However, in the long term it would save the entire system downstream.
Bigai River (Knysna Golf course)	Biodiversity: not much, it’s an urbanised river system, Typha is an indication that it is degraded, but this will help to filter the water before going into the Knysna Estuary. Socio-economic/poverty: it is near to areas of poverty, it is important locally but not for tourism.	High effluent from Hornlee and Hunters Home, erosion etc.	Minor - rehabilitate erosion problems.

Wetland	Characteristics of wetland	Major threats	Rehabilitation recommendations
Upper Groot Doring seep zones	Biodiversity: high species diversity. Hydrological intactness: fairly intact. Socio-economic/poverty: feeds into the Doring River system, many farmers probably benefit.	Severe groundwater abstraction near the Zebra Railway Station.	Not much can be done at this point except monitoring.
Hoogekraal		Golf estate and Sedgefield inter-basin transfer.	In the upper reaches there are possible areas which could provide opportunities for erosion preventions etc.
Touw River	Biodiversity: this system extends to the top of Outeniqua, mostly falls into protected areas. Hydrological intactness: only a small amount of abstraction. Physical condition: the condition is still fairly good, it is not incised, AIPs clearing has been ongoing.	Abstraction will increase, another 35% is predicted to be abstracted for Wilderness, there is also a threat from pollution, sewerage pipes etc.	Can't stop development, but can sort out the AIPs.
Geelbeksvlei / Brandwag River	Degraded due to IAPs and reduced flows.	Aliens, water abstraction.	Not much can be done.
Goukamma/ Homtini upper catchment	Biodiversity: the mountain catchment is fairly good, there are farmlands in the middle reaches, and the system rejuvenates slightly towards lower reaches. Hydrological intactness: the headwaters are not very impacted. Socio-economic/poverty: a lot of people depend on it, but it's not that crucial. Physical condition: there are some nice forested gorges.	Aliens, agriculture.	Alien removal, erosion could be solved but it is steep terrain.
Moordkuil River	Biodiversity: Palmiet wetlands in this system. Hydrological intactness: still intact, mostly AIPs affect the flow, abstraction high. Socio-economic/poverty: important.	Heavy AIP infestation.	Alien clearing can be done – wattle.
Duive River / Langvlei Spruit	Hydrological intactness: it is a perennial river that stops flowing – altered. Physical condition: August 2008 floods affected it severely in lower reaches, it is eroded.	Increased agricultural use.	It is quite an inaccessible region so interventions would be costly.

Wetland	Characteristics of wetland	Major threats	Rehabilitation recommendations
Robberg Vlei	Not much was known about this vlei amongst the expert group, scoring was done intuitively	Probably high from development and storm water etc.	
Ruigtevlei	Biodiversity: very saline, mainly reeds, not a unique system, plantations surround it. Hydrological intactness: there are a number of roads, it's possibly been fairly modified in the past 100 years – there may have been more links between this and Groenvlei. Socio-economic/poverty: not a lot of value.	Plantations – water level could have been affected by the plantations, it's also in the aeolian sand dune system. Probably also groundwater fed.	Limited opportunities for rehabilitation.
Perdespruit	Hydrological intactness: it is completely altered, it used to be one of the temporary channels that was part of the bigger system when flooding. The connectivity with Swartvlei has been lost. There are culverts. Physical condition: road culverts etc.	Threats are getting worse – AIPs etc.	In order to restore this system – millions would have to be invested, all the constrictions would have to be removed, the N2 would have to be moved, and therefore this is not viable.
Vankervelsvlei	Biodiversity: extremely unique aspargnum wetland (forms the peat). A plant survey has been done. Hydrological intactness: very intact, groundwater fed by the TMG aquifer – not affected by the plantations at all. Socio-economic/poverty: it is not really benefiting anyone per se, but the plantation owners won't touch it – it's safe. It could have tourism potential. Physical condition: good.	TMG abstraction would be the only perceivable threat.	Low cost for high return – tourism – signage etc. Another similar small wetland was identified nearby, but this had been impacted by trees and had dried up (found by FSC – Forest Stewardship Council).
Groot River (including Nature's Valley)	Biodiversity: this is quite a diverse and pristine system, with two red-data-book fish species. The system does not really have large wetlands upstream, but there are fynbos seeps in the mountains. There are several systems that are similar systems in terms of biodiversity, so it is not unique. The Upper Groot River is mostly contained within a conservation area so it is fairly secure. A pristine area like this should be important as it has a high corridor function. Socio-economic/poverty: socio-economic benefit/potential is low; there are not many houses there. Physical condition: the system is virtually pristine physically.	Possible development and water abstraction. Sewage is only a minor problem in Nature's Valley.	A strategic intervention could be to raise the road, and move three houses, this could solve the artificial breaching problem of the estuary system. A high input for relatively low return, so a low score.

Wetland	Characteristics of wetland	Major threats	Rehabilitation recommendations
Upper Palmiet (Soetkraal/Keurbooms)	Biodiversity: this area was last burnt in 2005, there is a large alien invasive problem, but making headway with this. Ten years ago it was completely degraded with wattle, hakea and pine. An important fish species is found here: Pseudobarbas, it is the only place where it does not co-occur with alien fish, it is also the most endangered fish in SANParks land. Hydrological intactness: it flows into the Keurbooms River so it is important, however there are also alien invasive plants (AIPs). Socio-economic/poverty: it is feeding into a big system where there is a lot of development. Plettenberg Bay is taking water from Keurbooms. Physical condition: it seems fairly unmodified, AIPs may have changed it, it is eroded towards the east, but unsure.	AIPs are a threat in the whole catchment, but it is being dealt with.	There is already an existing project here and it is also in a conservation area.

Table 4.2 Summary of the criteria and scores used to rank priority wetlands in the Gouritz study area

Wetland name	**Condition** (0: highly degraded; 10: pristine)				**Risk of degradation** (0: none to 10: high, immediate threat)	Comments on impacts	**Priority ranking number and consideration for rapid wetland assessment** (two priority wetlands were selected for rapid Ecostatus assessment)
	Biodiversity	**Hydrological**	**Physical**	**Median score**			
Duiwenhoks (upper catchment)	9	8	9	**9**	***9***	Primarily non-flow related: Still pristine Palmiet wetland in uppermost zone, but high risk of rapid erosion as well as encroachment from agriculture.	1: Priority # 1: large wetland threatened by rapid erosion and invasive vegetation, as well as flow abstractions.
Goukou river system	8	8	7	**8**	***9***	Primarily non-flow related: Palmiet wetland system which is eroding fast, farming impacts	2: Excluded from wetland assessment as the wetland type, threats and processes are very similar to priority #1.
Bitou River floodplain and estuary	8	6	7	**7**	***9***	Non-flow and flow related: In the lower zone there is infilling and impacts from roads/bridges. Upstream alien plants, roads through the floodplain and farming impact upon the floodplain.	3: Priority for wetland assessment as this system has a unique mix of biodiversity, but is threatened by waste-water return flows, abstraction and proposed dam developments.
Keurbooms river catchment (upper)	6	6	5	**6**	***9***	Alien invasive vegetation and forestry. Alien fish (trout) are present.	4: River reserve site is located here to address flow problems.
Gwaing river system	6	6	4	**6**	***9***	Alien plants. Development pressures, urban impacts (township, industry). Pollution.	5: A large number of wetlands are present in this urban (city of George) watercourse. Alien clearing should be considered to improve the EC.
Salt river system (Knysna)	4	4	5	**4**	***9***	Urban development, siltation and water quality (sewage) impacts.	6
Groenvlei	8	9	8	**8**	***8***	Groundwater dependant wetland which is impacted by alien fish species. Minor development pressures, although boreholes are potentially a risk.	7: Evaluated in the previous Outeniqua study. EIS and PES are high.
Salt river system (Crags)	9	8	8	**8**	***8***	Near pristine system but threats from catchment degradation (aliens, farming, housing, polo fields, industry) are present. Significant threat from abstraction.	8

Wetland name	Condition (0: highly degraded; 10: pristine)				Risk of degradation (0: none to 10: high, immediate threat)	Comments on impacts	Priority ranking number and consideration for rapid wetland assessment (two priority wetlands were selected for rapid Ecostatus assessment)
	Biodiversity	Hydrological	Physical	Median score			
Upper Knysna catchment (incl. Gouna)	9	8	7	**8**	***8***	Farming pressures, alien vegetation, abstraction and afforestation.	9
Kaaimans river system	8	6	8	**8**	***8***	Road impact, plus potential and current water abstraction.	10
Tshokwane wetland (lower Keurbooms)	8	7	7	**7**	***8***	Infested with alien plants, drains, and road needs installation of better culverts. Potential development pressure.	11
Wilderness Lakes system	10	6	6	**6**	***8***	This Ramsar site of interconnected lakes is threatened by continued development creep and effluent (water quality) risks associated with elevated nutrients and pesticides. Abstraction and alien fish are also of concern.	12
Karatara	8	6	7	**7**	***8***	Stressed by abstraction. Farming pressure. Alien plants.	13
Wolwe / Diep River	8	7	6	**7**	***8***	Stressed by abstraction. Farming pressure. Alien plants. Reforestation pressure	14
Groot Brak plateau / Varings River	6	6	6	**6**	***8***	Abstraction. Farming pressure. Alien plants.	15
Maalgate River system	7	5	6	**6**	***8***	Alien plants. Golf course development. Farming pressure. Upper area granite geology.	16
Klein Wolwe	5	4	4	**4**	***8***	Stressed by abstraction. Farming pressure. Alien plants. Opportunity for artificial wetland in lower reach	17
Piesang river	4	3	4	**4**	***8***	Urban development. Sewage. Dumping. Municipal dump seepage.	18
Duiwenhoks (eroded reach)	4	4	2	**4**	***8***	Degraded palmiet system affected by deep erosion donga.	19

Wetland name	Condition (0: highly degraded; 10: pristine)				**Risk of degradation** (0: none to 10: high, immediate threat)	Comments on impacts	**Priority ranking number and consideration for rapid wetland assessment** (two priority wetlands were selected for rapid Ecostatus assessment)
	Biodiversity	**Hydrological**	**Physical**	**Median score**			
Bigai River (Knysna Golf course)	3	3	3	**3**	***8***	Urban and farming. Development.	20
Upper Groot Doring seep zones	8	9	8	**8**	***7***	Wilderness area. Drains into Klein Karoo.	21
Hoogekraal	8	8	8	**8**	***7***	Stressed by abstraction. Farming pressure. Alien plants	22
Touw River	8	8	8	**8**	***7***	Ramsar site. Development pressures. Potential pollution (nutrients, pesticides). Farming impacts. Abstraction threat. Alien fish.	23
Geelbeksvlei / Brandwag River	7	7	7	**7**	***7***	Alien aquatic plants. Big (size counts).	24
Goukamma/ Homtini upper catchment	6	7	7	**7**	***7***	Abstraction and farming. Alien vegetation	25
Moordkuil river	7	7	6	**7**	***7***	Alien plants. Opportunity – alien clearing.	26
Duive River / Langvlei Spruit	6	5	5	**5**	***7***	Farming pressure. Abstraction. Alien plants. Alien fish & other fauna. Plantations	27
Robberg Vlei	5	6	5	**5**	***7***	Dry. Isolated from main water source (from Piesang river?). Development pressure.	28
Ruigtevlei	7	6	6	**6**	***6***	Plantation impacts. Sedgefield waterworks abstraction. Ecological corridor.	29
Perdespruit	3	2	3	**3**	***6***	Blocked shortcut flow to Swartvlei. Floodplain. Flooded under flood conditions. Could be opened easily. Alien infested.	30
Vankerwelsvlei	9	10	10	**10**	***5***	Unique. Peat system. Plantation. Ground water fed. Opportunities for monitoring and interpretation.	31: Unique wetland but very low risk of impacts.

Wetland name	Condition (0: highly degraded; 10: pristine)				Risk of degradation (0: none to 10: high, immediate threat)	Comments on impacts	Priority ranking number and consideration for rapid wetland assessment (two priority wetlands were selected for rapid Ecostatus assessment)
	Biodiversity	Hydrological	Physical	Median score			
Groot River (incl. Nature's Valley)	7	9	9	**9**	***4***	Degraded and sewage problems (lower catchment) upper area pristine. Possible development threat (water abstraction). Artificial breaching of estuary.	32
Upper Palmiet (Soetkraal/ Keurbooms)	8	8	6	**8**	***4***	Lots of work done. Lots of aliens still. Post-fire rehab needed. Water for Plettenberg Bay.	33

5 BASELINE ASSESSMENT OF SELECT PRIORITY WETLANDS

Of the 33 potential priority wetlands identified in the WMA, two of the highest priority wetlands were selected for field assessments. The purpose of the field assessments was to verify the desktop data and information, to determine the Ecostatus (PES, EIS and REC) of the priority wetlands, to identify the threats and achievable management actions which could be implemented to halt or reverse degradation, and to provide field-based wetland assessment training opportunities to DWS national and regional staff.

The two priority wetlands selected were the Duiwenhoks valley bottom wetland and Bitou floodplain. Although the Goukou wetland complex scored slightly higher in the priority ranking (**Table 4.1**), the issues in the Goukou system are very similar to those in the immediately adjacent Duiwenhoks system in that there are large degraded, eroding palmiet valley bottom wetlands in both catchments. By including the assessment of the Bitou wetland, it offered the opportunity to assess a similarly high priority wetland, but to examine and understand a different wetland type with different management challenges to the Duiwenhoks (and Goukou) wetlands.

5.1 DUIWENHOKS

The Duiwenhoks wetland is located in the H80A quaternary catchment. The upper catchment is within the Southern Fold Mountain EcoRegion, but where the river flows out into the flatter coastal belt (**Figure 5.1**). The subsequent deposition of alluvium derived from the steep mountainous streams, and associated growth of vegetation upon this alluvium, resulted in the creation of extensive valley bottom wetlands. The Duiwenhoks wetland was once a very large wetland system (**Figure 5.2**) characterised by unchannelled and weakly channelled valley bottom wetlands which would have been dominated by palmiet and *Phragmites* vegetation.

5.1.1 EIS

The large wetlands which were present in this basin, and the adjacent Goukou catchment, once represented good examples of large valley bottom palmiet wetlands which are present in the foothill valleys of the Western Cape and parts of the Eastern Cape provinces. Ecological Importance and Sensitivity of the Duiwenhoks are estimated to be Moderate, in that the conservation of this large wetland is likely to be locally to regionally in terms of its ecology, and its strong flood attenuation and sediment trapping functions would be important for the downstream catchment.

ECOLOGICAL IMPORTANCE & SENSITIVITY	**Moderate**
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**Moderate**
DIRECT HUMAN BENEFITS	**Low**

The moderate importance of the hydrological functions of these wetland types is attributed to their flood attenuation, baseflow maintenance and sediment trapping functions of intact wetlands. Direct subsistence use and human benefits from these wetlands is low as it is not likely that in this largely commercial agricultural and protected area catchment, rural residents would be directly dependent on the wetland. Overall, ***importance of the wetland is thus Moderate***.

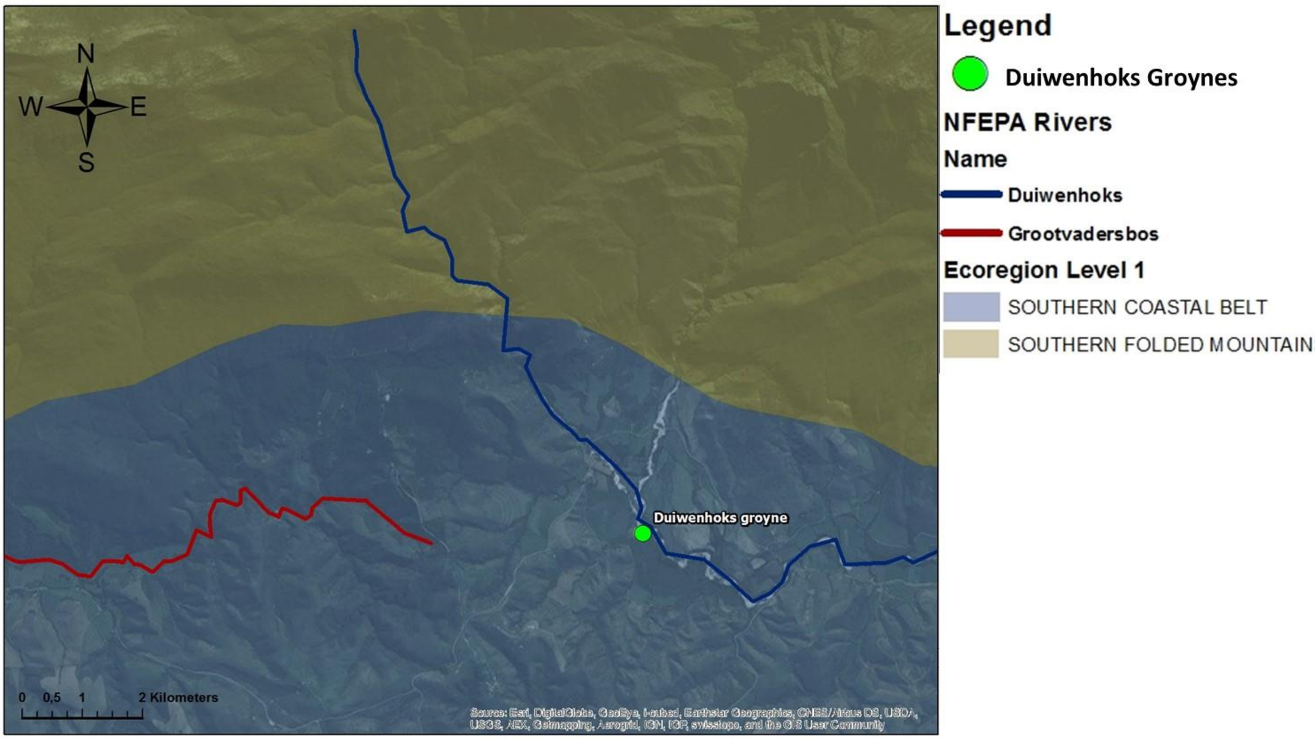

Figure 5.1 **The Duiwenhoks wetland is located at the start of the Southern Coastal Belt EcoRegion. The upstream catchment flows out of the Southern Fold Mountain EcoRegion**

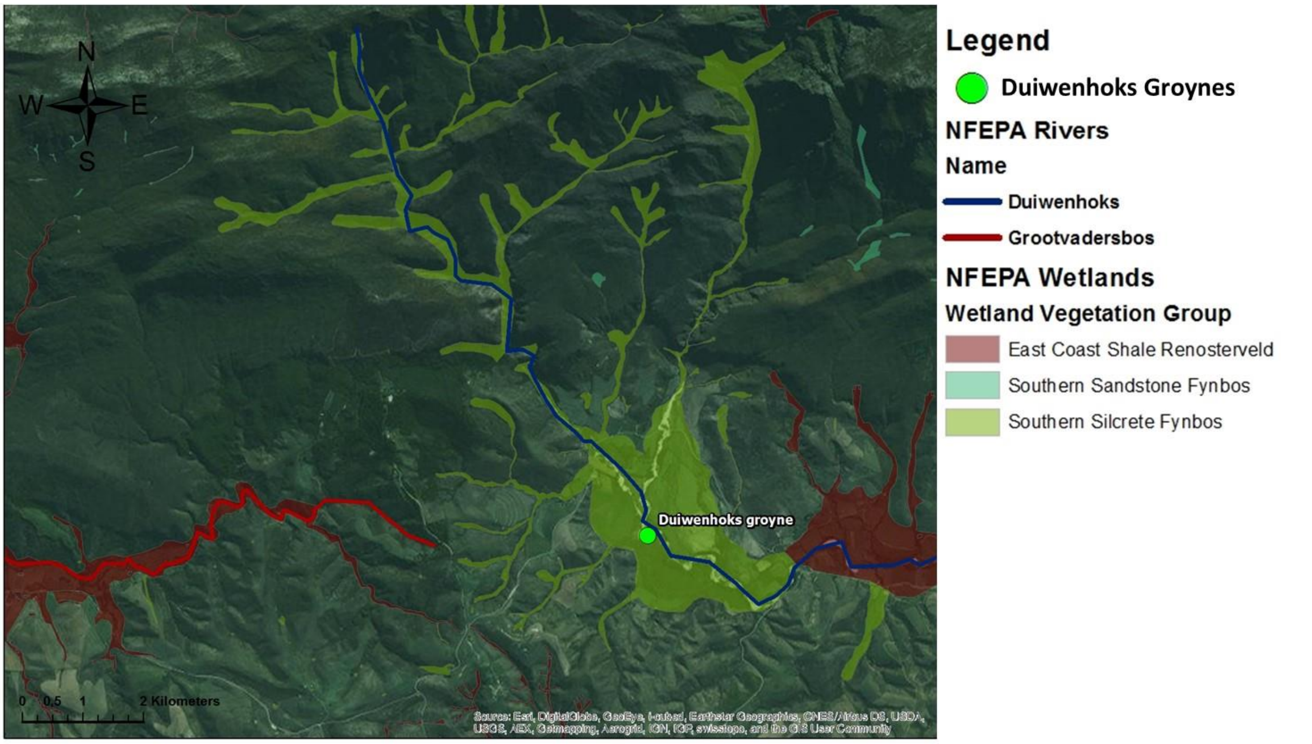

Figure 5.2 **The Duiwenhoks wetland. The main (western) arm of the wetland (northwest of the groynes indicated) was assessed in the field**

5.1.2 PES

Although in the upperwestern section of the basin, some large intact wetland patches remain (**Figure 5.3**), even here the wetland is impacted by invasive alien vegetation and, most importantly, an extensive, actively eroding donga (**Figure 5.4**). For the remainder of the basin, the situation is far worse, with a large erosion donga having impacted the wetlands for many decades (**Figure 5.5**).

Figure 5.3 A section of remaining intact wetland (foreground) with the eroded channel flanked by extensive stands of invasive alien trees further back

The erosion of the wetland and diversion of flows into the eroded donga channel has caused reduced flows on the wetland (valley bottom), resulting in desiccation and degradation of remaining wetland areas. The encroachment of agricultural areas, and construction of dykes, drains and road crossings, all serve to further reduce and degrade the remaining wetland areas. The concentrated flows in the eroded channel cause high flow velocities and this has resulted in the continued erosion of the bed and banks of the dongas. Once the protective, binding layer of vegetation is eroded off the wetland surface, the erosion process is advanced and very expensive, to stop or contain.

The eroded nature of the wetland, together with invasive woody vegetation and encroachment of agricultural areas into the wetlands, are the main causes of the PES, which was assessed to be in a D Ecological Category (largely modified). Based on the site visit, study results, expert opinion and the diversion from the natural state this wetland is on a negative trajectory and requires management intervention. The REC for this wetland, given its moderate EIS, should be to maintain the current condition of the D Category. This will require the stabilisation and remediation of the current impacts, most notably erosion, to halt the negative trajectory of change.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE		
	PES Category	***Confidence Rating***
DRIVING PROCESSES:		
Hydrology	**C/D**	*3.4*
Geomorphology	**E**	*4.0*
Water Quality	**A**	*3.0*
WETLAND LAND-USE ACTIVITIES:		
Vegetation Alteration Score	**C**	***4.0***
OVERALL PES CATEGORY (%)		**D (57%)**

5.1.3 Recommendations for future management

The moderate importance and degraded condition (D) of the wetland suggests that the REC will be equal to the PES. This is supported by the impracticable and expensive remediation that would be necessary to redress the extensive, widespread erosion across the wetland. It is not practical, or affordable, to rehabilitate the wetland back to a higher category as the erosion dongas are too wide, deep and long to fill in.

However, because the wetland is still actively eroding, to maintain the PES (and thus ensure the REC in the longer term), the current ongoing impacts will need to be reduced and stabilised. This is important for both the wetland, and for downstream river and estuary reaches which are affected by the sediment loads and reduced dry season baseflows resulting from the widespread erosion.

- Preventing erosion in the remaining sections of the wetland is the most important task. The stabilisation and remediation of peat erosion in this catchment will aid in part in the achievement of the REC for the estuary (DWS, 2015). The Western Cape Department of Agriculture has committed extensive funding for the construction of large scale rehabilitation structures to reduce the sediment eroded from the wetland from flowing downstream and smothering further aquatic habitat, and further reducing the flood capacity of the downstream river reaches.
- As a secondary objective to prevent any additional degradation, woody alien vegetation should be removed and prevented from re-establishing within or alongside the wetland areas. Woody invasive trees shade out the indigenous wetland vegetation, directly reducing the wetland condition, but the reduced cover of wetland vegetation can also encourage further erosion of the wetland which will further degrade the condition of the wetland vegetation, but also reduce hydrological functions and encourage more sediment deposition downstream.

- No encroachment of agricultural areas within the wetland, or immediately alongside it, should be permitted. The draining of the wetland areas and/or diverting of flows have already initiated widespread erosion in former pristine wetland areas and further degradation of this type must be prevented.

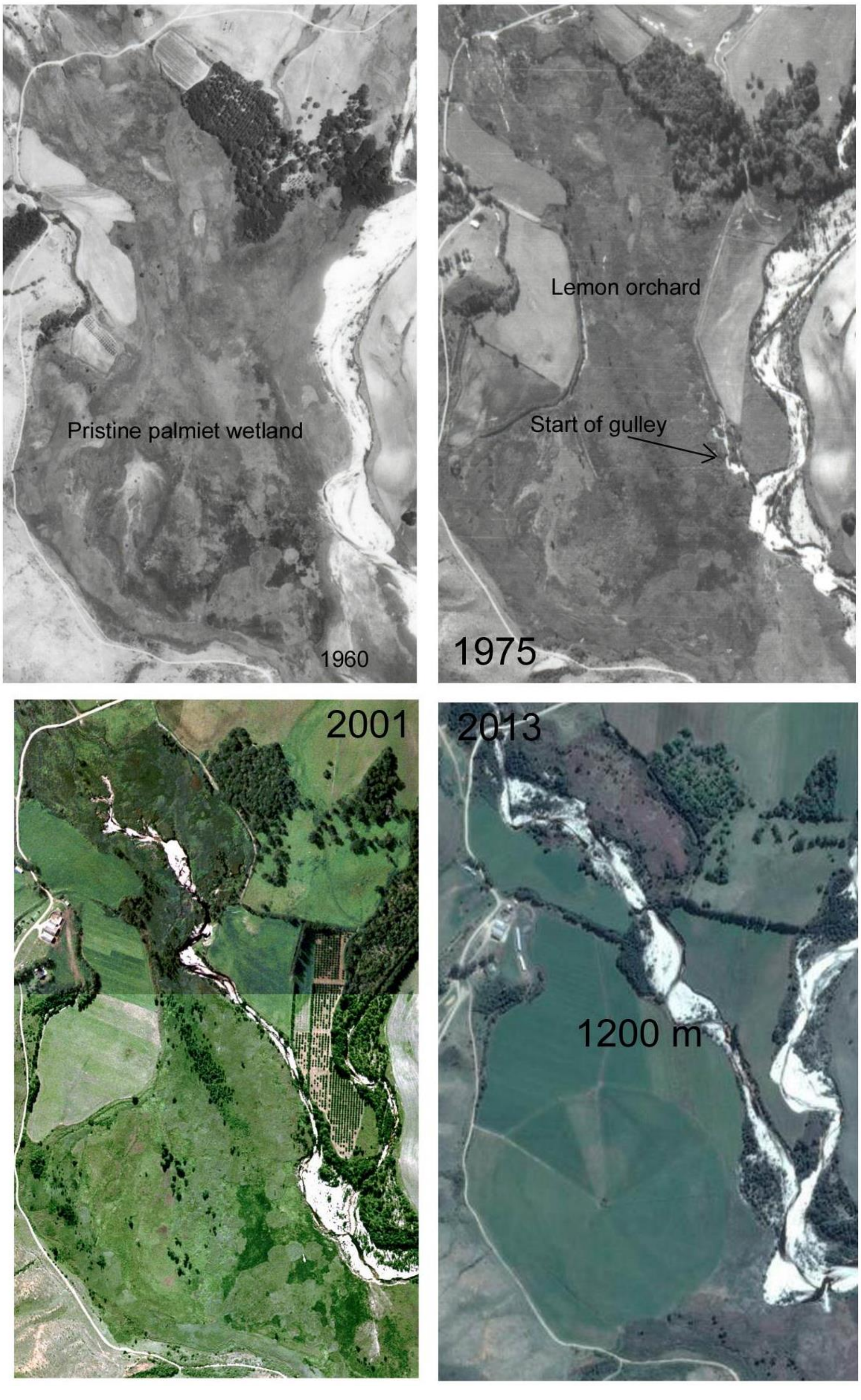

Figure 5.4 Aerial photos from 1960 (top left), 1975 (top right), 2001 (bottom left) and 2013 (bottom right) show the upper westward section of the Duiwenhoks wetland. These images show erosion over the last 40 years due to the westward migration of the erosion donga, enabled and accelerated by the construction of flow diversions and drains around a lemon orchard in the wetland (images: Hans King)

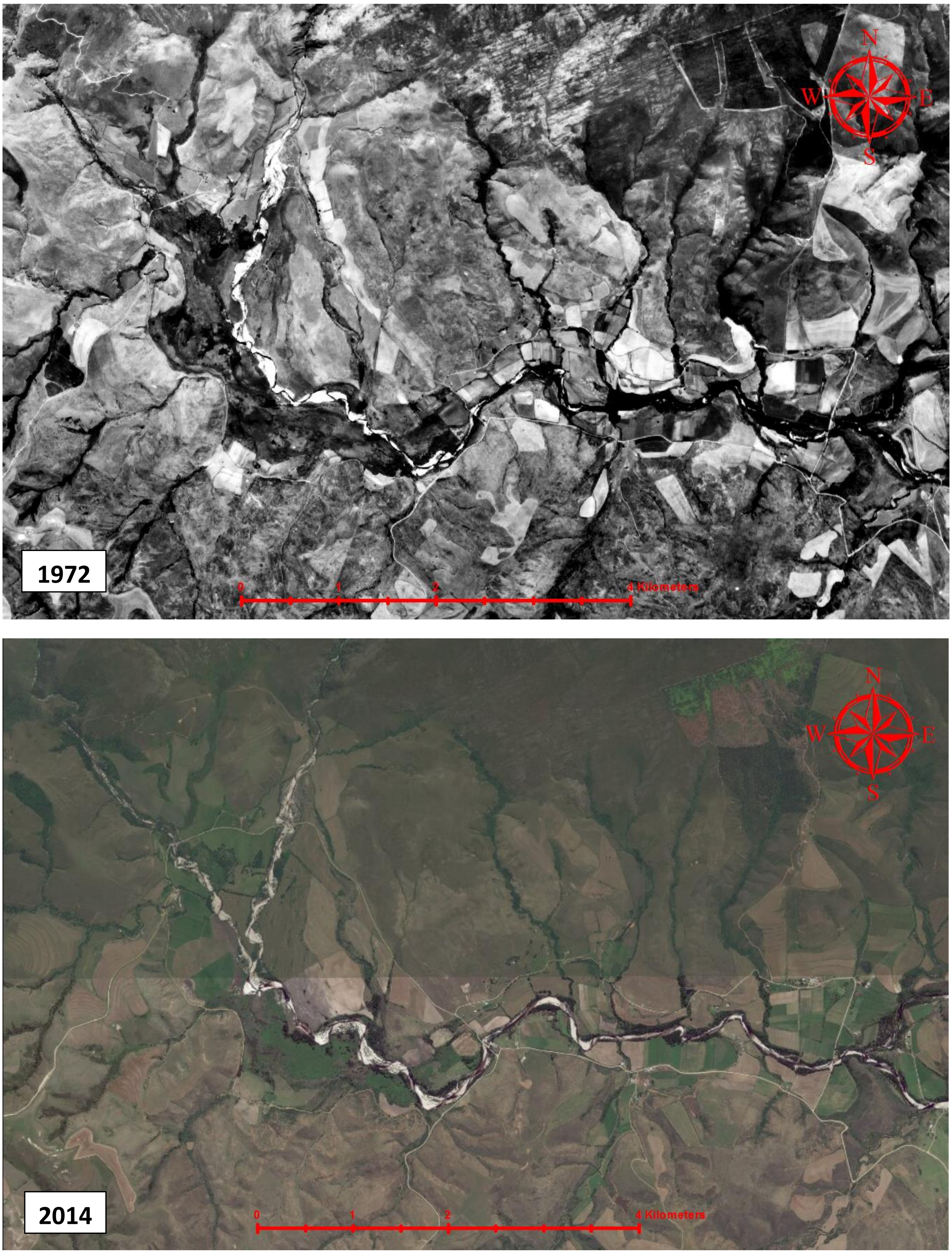

Figure 5.5 The erosion donga along the Duiwenhoks was already present in 1972 (top image), but had widened and branched westwards by 2014

5.2 BITOU FLOODPLAIN

The Bitou floodplain is located in quaternary catchment K60F upstream of the confluence of the Bitou River with the Keurbooms estuary. The upper reaches of the floodplain are characterised by a meandering alluvial channel through a floodplain which is extensively under agricultural uses. This gradually changes to an increasingly estuarine-influenced system towards the confluence with the Keurbooms.

The indigenous vegetation on the estuary floodplain is Endangered Shale Fynbos which has been designated as a CBA in the Bitou, but most of this vegetation has been lost in the conversion to agriculture. The floodplains and salt marshes of the Bitou have historically been subjected to reclamation for agricultural purposes, but on the lower reaches, this was not successful due to the presence of saline groundwater (Bornman, 2004). Bird species numbers and total counts for the Bitou Estuary have decreased and this has been attributed to pollution from effluent, pesticides and fertilizers, damage by livestock, siltation of the estuary, reed encroachment and residential development (Taylor *et al*., 1999). In addition, alien tree species, most notably *Acacia melanoxylon*, *Acacia saligna* and *Acacia mearnsii*, have invaded sections of the floodplains.

5.2.1 EIS

Ecological Importance and Sensitivity of the Bitou wetlands is estimated to be Moderate. Although the floodplain and associated wetlands flow into the much larger Keurbooms estuary, which is ranked as the 18th most important estuary in South Africa, the Bitou catchment is small and contribution of flows are small. In addition, the Bitou floodplain has been extensively transformed by agricultural activities, but the lower lying areas and estuarine wetlands are more intact. Large numbers of birds are associated with the area, including Blue Cranes (IUCN Vulnerable species).

ECOLOGICAL IMPORTANCE & SENSITIVITY	**Moderate**
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**Moderate**
DIRECT HUMAN BENEFITS	**Low**

The flood attenuation and sediment trapping functions of intact wetlands afford a moderate importance to the hydrological functions of this floodplain. The area is largely composed of residential smallholdings and commerical farms, so subsistence use and direct dependence on the wetland for a subsistence livelihood (direct human benefits) is expected to be low. Overall, ***importance of the wetland is thus Moderate***, indicating a local to regional importance for the wetland.

5.2.2 PES

The Present Ecological State of the Bitou wetland is rated as a C category, partially due to catchment issues, such as reduced flows, but also due to direct impacts on the floodplain itself. In particular, the alteration (conversion) of floodplain vegetation to agricultural pastures has had the biggest impact upon the PES.

Large pine plantations within the catchment are expected to have slightly reduced baseflows. On the floodplain and margins thereof, the intensive agricultural activities have reduced the condition of the floodplain through:

- Loss of wetland habitat due to some small areas of infilling;
- Extensive conversion of vegetation from indigenous species to pasture grasslands (**Figure 5.6**);

- Overgrazing and bank destabilisation; and
- Nutrient-rich runoff from agricultural lands.

Invasive alien vegetation and encroachment of residential and other infrastructure on the floodplain have also further reduced the ecological condition of the system. There is reduced hydrological connectivity across the floodplain due to road crossings (small culverts) and bridges, as well as levees and excavated canals/channels which facilitate drainage.

In 1961 there were 45 ha of freshwater wetlands above the Wittedrif Bridge on the Bitou system, but by 2006 these had been reduced to less than 30 ha. Reduced flows, infrastructure impacts, development encroachment and land use conversion have all impacted upon the floodplain and its wetlands.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE		
	PES Category	***Confidence Rating***
DRIVING PROCESSES:		
Hydrology	**C**	*2.2*
Geomorphology	**C**	*3.0*
Water Quality	**C**	*1.9*
WETLAND LANDUSE ACTIVITIES:		
Vegetation Alteration Score	**D**	*3.0*
OVERALL PES CATEGORY (%)		**C (63%)**

Figure 5.6 The floodplains of the Bitou valley have largely been converted to planted pastures

5.2.3 Recommendations for future management

The Bitou floodplain is a popular birding area and most of the land is agricultural and under private ownership. The Bitou Valley Foundation (an NPO founded by local resident Julie Carlisle) has a vision to rehabilitate the wetland and incorporate the establishment of a birding route, linking riverine, wetland and estuarine coastal habitats through the development of bird hides. The spatial development plan for the area (CNdV Africa (Pty) Ltd., 2013) recommended that agricultural activities be removed from the floodplains and the land be converted to a private nature reserve; ironically with simultaneous development of farmers markets on the main roads. With extensive rehabilitation of the floodplains, this would improve the PES of the floodplain, but the DWS's support for this long term vision of floodplain restoration should be weighed against the loss of agricultural resources and potential reduction of local employment opportunities.

In the short term, the moderate importance and PES condition (C) of the wetland suggests that the REC should be to maintain the C condition. Due to the existing infrastructure and economic dependence of agriculture on the floodplain, it is unlikely to be able to achieve a B condition wetland across the entire system. To maintain the PES (and thus ensure the sustained achievement of the REC), the current ongoing impacts will need to be reduced and stabilised.

- Invasive woody alien vegetation should be removed from the floodplain wherever possible, and must be removed from all riparian zones along the river channel. This will promote an increase in the indigenous vegetation through reduced shading.
- Vegetated buffer areas along streams and canals would assist to reduce turbidity and sediment losses from the floodplain through stabilised stream and canal banks. They may also assist with some nutrient trapping and thus a potential reduction in nutrient-rich runoff from the agricultural areas.

5.2.4 The proposed Wadrif Dam

An off-channel storage dam has been proposed within the Bitou catchment. An evaluation of the specialist river study undertaken as part of the EIA determined that the "*construction of the dam ... should not have much effect on the Bitou River – and ultimately the Keurbooms Estuary – provided certain mitigation measures are met*" (Belcher *et al*., 2012). The mitigation measures suggested releasing an appropriate environmental flow downstream of the dam, to rehabilitate or re-establish the riparian zones of the receiving stream as well as stream banks at the dam construction site (these areas were to be replanted with indigenous plants and kept clean of invasive alien plants).

Given that the dam is an off-channel storage dam, receiving the bulk of its water from the adjacent Keurbooms catchment, the direct impact upon the Bitou appears minimal. There may be some minor impact upon the Keurbooms estuary, arising from the reduced baseflows due to the diversion of flows to the storage dam, and the potential increased saltwater intrusions upstream in to the Keurbooms and lower Bitou systems may cause some indirect impact and expansion of estuarine wetland areas.

6 MANAGEMENT OF WETLANDS

6.1 WETLAND RESOURCE UNITS

There are thousands of wetlands in South Africa, and it would be difficult, if not impossible, to map every single wetland as many are small (i.e. beyond a reasonable mapping scale), some are cryptic (i.e. not be easily identified) and others have been extensively modified, thus making their identification and delineation difficult. Even if all the wetlands within a region could be identified and mapped, their sheer number would preclude a site-specific approach to wetland management. The delineation of WRUs allows DWS and other natural resource managers to manage wetlands on the basis of similar characteristics, driving processes and sensitivities to developments and other impacts. For instance, the information about wetland processes and sensitivities for a WRU can be used to aid Water User Licence Applications (WULAs) or evaluate the risks posed by development activities to wetlands. The delineation of WRUs may also provide important information for other studies, such as buffer zone determination, which may require some basic information of wetlands in the areas being assessed. Nine broad Wetland Resource Units (WRUs) were identified in the Gouritz study area (**Figure 6.1**) and the typical wetland types and characteristics found in each WRU have been identified (**Table 6.1**).

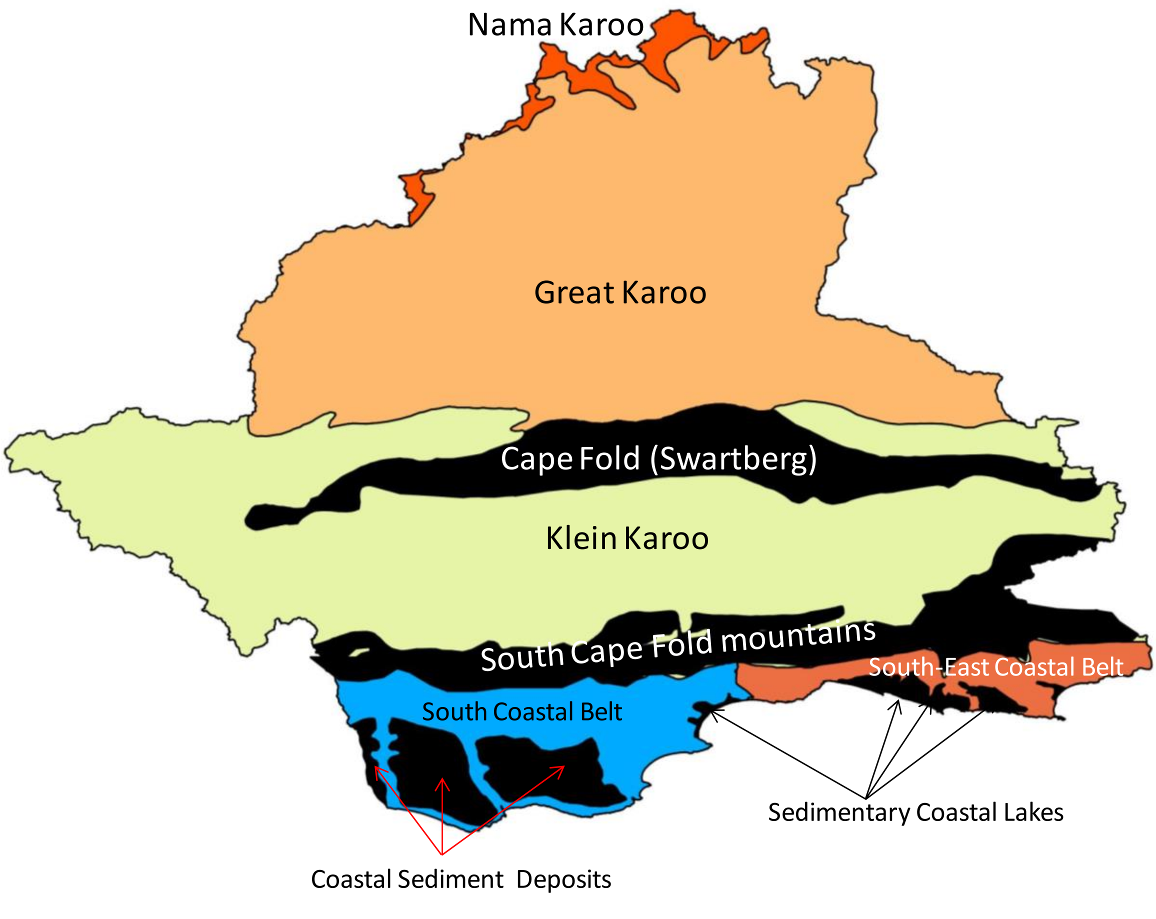

Figure 6.1 The Wetland Resource Units of the Gouritz Study area

The use of WRUs does not, however, preclude the need for detailed Reserve studies for large, unique or highly-sensitive individual wetlands where potential developments are likely to have a significant impact upon water availability. However, the majority of wetland impacts tend to be non-flow related, and thus many WULAs relating to non-flow related impacts can be evaluated against the characteristics and sensitivities of wetlands within the relevant WRU.

Table 6.1 Summary of WRUs and their wetland types in the Gouritz study area

WRU	Typical wetlands	NFEPA HGM types	Characteristics of HGM type
Nama Karoo	Seeps with a likely high degree of groundwater dependence.	Depression	Saline, temporary to seasonal
		Seep	Groundwater-dependant, seasonal or permanent
Great Karoo	Small seeps and river-linked wetlands with a likely high degree of direct and indirect groundwater dependence respectively.	Valley bottom	Saline, temporary to seasonal
		Seep	Groundwater-dependant, seasonal or permanent
		Depression	Saline, temporary to seasonal
		Depression	Seasonal to permanently saturated or inundated
Klein Karoo	Small seeps and river-linked wetlands with a likely high degree of direct and indirect groundwater dependence respectively.	Valley bottom	Saline, temporary to seasonal
		Seep	Direct or indirect groundwater link, seasonal or permanent
Swartberg Cape Fold Mountains	Small seeps associated with groundwater-fed springs.	Seep	Groundwater-dependant, seasonal or permanent
South Cape Fold Mountains	Small seeps associated with groundwater-fed springs.	Seep	Groundwater-dependant, seasonal or permanent
South Coastal Belt	Channelled and unchannelled valley bottom wetlands; extensive seepage wetlands (especially in granitic areas).	Valley bottom	Permanently saturated
		Valley bottom	Seasonally saturated
		Seep	Groundwater-dependant, seasonal or permanent
		Depression	Brack to fresh, temporary to seasonal
South-East Coastal Belt	Channelled and unchannelled valley bottom wetlands.	Valley bottom	Seasonal or permanent
		Seep	Groundwater-dependant, seasonal or permanent
Sedimentary (Coastal Lakes)	Lakes and wetland flats.	Depression	Coastal lakes ranging from fresh to brackish
Coastal Sedimentary Deposit	Desktop information shows wetlands are very infrequent - possible due to deep infiltrating soils and a lack of shallow/perched water tables. Interdune depressional wetlands are present, suggesting groundwater contributions.	Valley bottom	Seasonal or permanent
		Flat	Seasonal or permanent
		Seep	Probably seasonal

6.1.1 Nama Karoo WRU

A small area of Nama Karoo fringes the northernmost boundary of the Gouritz WMA (**Figure 6.1**), within the headwaters of the Groot catchment only. The Nama Karoo is an arid Biome, with mean annual precipitation of approximately 165 mm (Mucina and Rutherford, 2006).

The distribution and extent of wetlands in the area is likely linked to rainfall, geology, topography and soils. Mucina and Rutherford (2006) report that the majority of rivers in the region are non-perennial, and that certain short streams terminate in extensive shallow lakes or washes (where confined streams wash out across very flat areas), with certain of these intermittently linked to one another. These wetland types have been named "**Bushmanland Vloere**" and they typically dry out during each year. The formation of these shallow lakes and washes (grouped for this report into the depression wetland type) is favoured by the flat to gently undulating rocky or sandy plains (Mucina and Rutherford, 2006) and possibly also by shallow sands over dorbanks and hardpan calcretes (Ellis and Lambrechts, 1986). Dominant characteristics of these depression wetlands are that they are **saline** and subject to non-perennial i.e. **seasonal inundation**.

A second type of wetland is anticipated in the Nama Karoo WRU, namely, **occasional seeps** with a likely high degree of groundwater dependence. Dominant characteristics of these seep wetlands are that they are **seasonal or permanently saturated**.

In general however, there is very limited data on wetlands in this WRU. Although it represents a very small portion of this study area, decision-makers and consultants should stay alert to reports of wetland types that do not fit with the two types described above. In such cases, steps should be taken to ensure that:

a) Any reported "undescribed wetland type" is subjected to review and, if valid, added to the wetland types described for this WRU, and
b) Ecological specifications are appropriate for the new type.

The bushmanland vloere (depressional wetlands) may be impacted by scattered invasive alien *Prosopis* trees, mined for salt or transformed by dams or dry land cultivation (Mucina and Rutherford, 2006). This non-perennial wetland type is most sensitive to physical disturbance.

The seeps may be similarly impacted (apart from salt mining), as well as from trampling and over-grazing. This seasonal to permanently-wet wetland type is sensitive to both physical disturbance as well as to water quality and quantity impacts.

Key threats to the wetlands in this WRU thus include:

- Transformation into dams;
- Transformation through cultivation;
- Invasive alien *Prosopis glandulosa* (Honey Mesquite) infestations;
- Mining for salt; and
- Trampling and over-grazing.

6.1.2 Great Karoo WRU

The Great Karoo WRU makes up a substantial portion of the northern region of the Gouritz WMA, including the northernmost (upper) sections of the Olifants, Groot and Gamka catchments (**Figure 6.1**). The Great Karoo is part of the Succulent Karoo Biome, and includes low-relief plains below the Great Escarpment. Due to the rain shadow of the Swartberg Mountains, mean annual precipitation is extremely low – approximately 165 mm (Mucina and Rutherford, 2006). As distribution and extent of wetlands in the area is likely linked to rainfall, and the rainfall is extremely low, wetlands are consequently very scarce.

CSDM (2000) as part of the Inland Waters layer identified depressional wetland types within the WRU. No descriptions were found for these depressions and they were not visited on the ground. It is anticipated that they may fall into two main groups, namely,

1. Perennial pans i.e. permanently saturated or inundated that are likely to be freshwater, and
2. Non-perennial and dry pans i.e. temporary or seasonally saturated or inundated, which are likely to be saline.

The only wetland-related systems recorded by Mucina and Rutherford (2006) are non-perennial, saline systems associated with rivers and drainage lines, which they have named Southern Karoo riviere. These systems are dependent on rainfall events and likely take the form of dry drainage features – **temporary to seasonally saturated** river-linked wetlands, sometimes dominated by dense stands of *Phragmites australis* (reeds), that are subject to sporadic flood surges (Mucina and Rutherford, 2006).

Although this WRU has not been extensively investigated on the ground, it is expected that this WRU also supports a greater number of small, non-saline, seasonal to permanently saturated seeps with a likely high degree of direct groundwater dependence.

Decision-makers and consultants should stay alert to reports of wetland types that do not fit with the wetland types described above. In such cases, steps should be taken to ensure that:

a) Any reported “undescribed wetland type” is subjected to review and, if valid, added to the wetland types described for this WRU, and
b) Ecological specifications are appropriate for the new type.

Impacts to valley bottom areas also include transformation for cultivation and building of dams. Increased nutrient inputs from flood events and concentrated grazing pressure may also impact these systems (Mucina and Rutherford, 2006). Invasive alien plants which threaten these habitats include *Agave americana, Opuntia* species, *Prosopis* species, *Salix babylonica, Shinus molle, Atriplex eardleyae, A. lindleyi* subsp. *inflata, Cirsium vulgare, Salsola kali* and *Schkuhria pinnata* (Mucina and Rutherford, 2006).

Impacts to seeps and depressional wetlands have not been investigated in detail for the area but it is expected that they would be sensitive to physical alteration and to changes in water quantity and quality, as well as invasive alien vegetation.

Key threats to the wetlands in this WRU thus include:

- Direct transformation of the wetlands due to grazing pressure, cultivation and building of dams and other infrastructure (i.e. roads, low water bridges etc);
- Increased nutrient inputs; and
- Invasive alien plants.

6.1.3 Klein Karoo WRU

The Klein Karoo covers a relatively extensive portion of the Gouritz WMA, including the southernmost (lower) third of the Olifants, Groot and Gamka catchments (**Figure 6.1**). The Klein Karoo is part of the Succulent Karoo Biome and includes plains and undulating hills between the Swartberg Cape Fold Mountains and South Cape Fold Mountains. The distribution and extent of wetlands in the area is likely linked to rainfall, geology, topography and soils. Certain areas are subject to the rain shadow of the Langeberg Mountains, others to sporadic, torrential rains brought by western cold fronts. Mean annual precipitation is approximately 290 mm (Mucina and Rutherford, 2006).

The only wetland-related systems recorded by Mucina and Rutherford (2006) are non-perennial, saline systems associated with rivers and drainage lines, which they named **Muscadel riviere** valley bottom wetlands and drainage lines. These are flat, broad alluvial deposits dominated by *Acacia karroo* and *Salsola* species (Mucina and Rutherford, 2006). Similar to the systems of the Great Karoo, these are sporadically flooded (non-perennial) systems (Mucina and Rutherford, 2006).

Other wetlands of the Klein Karoo WRU are expected to be small seeps and river-linked wetlands with a likely high degree of direct and indirect groundwater dependence, respectively. Dominant characteristics of these seep wetlands are that they are not saline, and are seasonal to permanently saturated.

This WRU has not been extensively investigated on the ground, and decision-makers and consultants should stay alert to reports of the wetland types that do not fit with the types described above. In such cases, it may be necessary to take extra steps to ensure that:

a) Any reported “undescribed wetland type” is subjected to review and, if valid, added to the wetland types described for this WRU, and
b) Ecological specifications are appropriate for the new type.

“Muscadel riviere” wetland types have been designated “Endangered” in the National Biodiversity Assessment (2011) due to extensive transformation of these alluvial areas by cultivation (vineyards and orchards) and road-building. Invasive alien plant infestations include *Arundo donax, Atriplex lindleyi* subsp. *inflata, Chenopodium* species, *Tamarix chinensis* and *T. ramossissima (*Mucina and Rutherford, 2006).

Impacts to seeps have not been investigated in detail for the area but it is expected that they would be sensitive to physical alteration and to changes in water quantity and quality.

Key threats to the wetlands in this WRU thus include:
- Transformation for cultivation and building of roads;
- Increased nutrient inputs; and
- Invasive alien plants.

6.1.4 Swartberg Cape Fold Mountains WRU

The Swartberg Cape Fold Mountains extend in a band from west to east across the middle of the Gouritz WMA, and include sections of the Olifants, Groot and Gamka catchments (**Figure 6.1**). Mean annual precipitation is approximately 285 mm (Mucina and Rutherford, 2006). Very little information is available regarding wetlands of the Swartberg Cape Fold Mountains WRU but they are known to include small seeps associated with groundwater-fed springs.

The condition of the seeps has not been extensively ground-truthed, but it is anticipated that any water source areas in this WRU has been subject to use and a certain amount of manipulation due to the scarcity of this resource. Dominant characteristics of these seep wetlands are that they are likely to be seasonal to permanently saturated. Threats are limited due to the inaccessibility of many wetlands in this mountainous WRU, but would include:
- Physical alterations from agricultural landuse activities; and
- Trampling and grazing.

6.1.5 South Cape Fold Mountains WRU

The South Cape Fold Mountains extend in a band from west to east parallel to the coast within the Gouritz WMA (**Figure 6.1**), including southernmost sections of the Gamka and Olifants catchments and small northern sections of the Gouritz and Coastal Gouritz catchments. Rainfall is typically greater than 500mm per annum (Vlok *et al*., 2005) and can be up to 1000 mm.

Wetlands of the South Cape Fold Mountains WRU are expected to include small seeps associated with groundwater-fed springs. This area benefits from a regional assessment undertaken by Vlok *et al*. (2005) as part of the C.A.P.E. fine-scale planning project. The dominant wetland type in this WRU is anticipated to be seep wetlands on quartzitic, sandstone-derived acid sands. Soils often have a high organic content. “After fire there is usually a rich assembly of geophytes[3] (especially Iridaceae and Orchidaceae) present, many of which are rare and endemic and distinctive of the different vegetation units of this habitat type” (Vlok *et al*., 2005). The seeps at higher altitudes are reportedly dominated by ericas, such as *Erica curviflora* and restios. Seeps on lower slopes are dominated by taller woody shrubs, such as *Brachylaena neriifolia, Brabejum stellatifolium, Cliffortia strobilifera, Leacadendron salicifolium*, *Berzelia intermedia, Grubbia rosmarinifolia* and *Psoralea* spp. (Vlok, 2007). Certain systems include *Psoralea aphylla* and *Leacadendron conicum*. Special species noted by Vlok *et al.* (2005) for these seeps for the Goukou upper catchment include *Berzelia burchellii, B. galpinii, Disa subtenuicornis, Erica amicorum, E. obconica* and *E. tethrathecoides,* and for both the Duiwenhoks and Goukou upper catchments include *Nivenia fruticosa*, and the near-endemic *Empleurum fragrans*. For the two Brak rivers: *Erica aneimena, E.*

[3] bulbs

gillii, E. juniperina. Dominant characteristics of these seep wetlands are that they are seasonal to permanently saturated.

Key threats to the wetlands in this WRU thus include:

- Too frequent fires;
- Cultivation within the wetland areas;
- Expansion of afforestation; and
- Invasive alien woody species into wetlands.

6.1.6 South Coastal Belt WRU

The South Coastal Belt comprises the western section of coastal terrace within the Gouritz WMA, and includes much of the Gouritz catchment (**Figure 6.1**). Mean annual precipitation is approximately 600 mm (Mucina and Rutherford, 2006). The wetlands of the South Coastal Belt WRU are expected to be dominated by extensive seepage wetlands (especially in granitic areas) and channelled and unchannelled valley bottom wetlands. At least two distinct valley bottom wetland types, distinguished by water regime and dominant vegetation, are present within the WRU.

The wettest (permanently wet) valley bottom types are typically located at the base of the sandstone mountain range and are likely fed by a combination of overland flow driven by the high rainfall off the mountains as well as a constant groundwater contribution from the adjacent quartzitic sandstone. They may contain extensive peat deposits. These wetlands are found along the upper stretches of rivers draining mountain fynbos and can support a complex of reeds, palmiet and restios, low moisture-loving shrubs including *Berzelia* and *Cliffortia* (Mucina and Rutherford 2006). Vlok *et al*. (2005) has contributed extensive species information for these systems, noting that *Prionium serratum* (palmiet) typically dominates the flooded area, flanked by *Brabejum stellatifolium, Cliffortia strobilifera, Brachylaena neriifolia, Hallera lucida, Ilex mitis, Salix mucronata, Calopsis paniculatus, Psoralea aphylla* and *Wachendorfia thyrsifolia*. *Psorelea filifolia* is a regional endemic in the Duiwenhoks, Breede and Goukou systems (Vlok *et al*., 2005). Many wetlands of this type have developed extensive and deep (up to 8 m in places) peat soils, and in places many be several hundred metres wide.

Vlok *et al.* (2005) has also contributed descriptions of the drier (seasonally saturated) valley bottoms of the region where surface water flows are non-perennial. *Acacia karroo* is prominent, as well as shrubs such as *Dodonaea angustifolia* and *Passerina obtusifolia* and grasses and sedges (e.g. C*ynodon dactylon, Cyperis marginatus, Cyperis textilis, Digitaria eriantha, Eragrostis capensis, Eragrostis curvula, Hyparrhenia hirta, Pennisetum macrourum, Pentashistis colorata, Sporobolus africanus, Themeda triandra*, etc.).

No specific descriptions of the seeps of granitic areas are available but they are anticipated to be common, especially in the granitic areas of the catchment. Seasonal and perennial seeps will also be present immediately at the coast, flowing directly to the sea. Similar seeps in the Port Elizabeth vicinity have been noted to have a particular important contribution into the marine environment. These systems are fed by springs and flow short distances to outlet directly to the sea. They are "*directly linked to the marine ecosystem and often have an interesting fauna present, e.g. an* *abundance of crabs. They may well be important breeding sites for vital pollinators of specialized plant species of adjacent terrestrial habitat types, e.g. tabanid and nemastrid flies*" (Vlok *et al*., 2005). Most systems are currently dominated by only one species *Stenotaphrum secundatum*, but the local endemic *Cliffortia longifolia* may be present in intact systems (Vlok *et al.*, 2005).

The Riversdale Plain has a high density of seasonal, fresh to brackish water depressional wetlands. Vlok *et al*. (2005) noted the presence in more pristine systems of *Marsilea schelpeana*, as well as the following vegetation species: *Aponogeton distachyos, Spiloxene aquatica, Juncus capensis* and *Juncus punctorius,* with *Aponogeton junceus, Juncus acutus, Eragrostis plana* and *Sporobolus africanus* on quartzitic soils and *Ornithogolum flexuosum* on shale soils. A second distinct depression type was distinguished in the foothills, vegetated with *Berzelia intermedia, Erica quadragularis, Triglochin bulbosa, Lachenalia muirii* and *Chondropetalum microcarpum* and localised endemic and threatened wetland species *Erica bauera* (Vlok *et al*., 2005). A third type is described by Vlok *et al*. (2005) within strandveld vegetation, supporting *Elegia* and *Hypodiscus* species, *Leucadendron linifolium, Spiloxene aquatica*, as well as *Berzelia intermedia* and *Erica quadrangularis* in those systems where freshwater/groundwater is available. Systems at the northern base of limestone outcrops often support *Chondropetalum microcarpum*, and *Trichlochin bulbosa* (Vlok *et al*., 2005), and occasionally *Lachenalia muirii, Erica bauera,* and *Marsilea schelpeana*.

The valley bottom wetlands are the most heavily impacted within this WRU. Palmiet wetlands are subject to clearing of natural vegetation, cultivation and invasive alien plant invasion. Many wetlands are currently densely invaded by *Acacia mearnsii* and much of the surrounding land is used for intensive agricultural land-use practices. Deep and extensive irrigation channels are present in many wetlands. Severe erosion and loss of peatlands (a scarce and vulnerable carbon-rich soil type) has occurred in many of the systems. Many systems have been transformed to irrigated pasture, and in other systems almost all the natural vegetation has been removed.

Many of the seep wetlands have lost species diversity possibly due to changes in nutrients and other water quality and quantity issues.

Vlok *et al*. (2005) notes that many depressions located on shale-derived soils have been ploughed up and alien grasses now dominate the vegetation (e.g. *Lolium* species), however, they still attract large numbers of waterfowl when they are filled with water. He notes that most pans on the coastal plain and foothills are also completely transformed through impacts by agriculture (ploughing, heavy grazing and trampling by livestock and game). Many are also heavily infested by the exotic invasive trees, especially *Acacia cyclops* and *A. saligna*. The depressional areas will be sensitive to both changes in water quality and hydrological regime.

Key threats to the wetlands in this WRU thus include:

- Clearing of natural vegetation, cultivation and invasive alien plant invasion;
- Too frequent or too infrequent fires;
- Invasive alien vegetation;
- Change in hydrology (irrigation canal, ditches, dams, pumps, sumps/kuile); and
- Gully erosion.

6.1.7 South East Coastal Belt WRU

The South East Coastal Belt comprises the eastern section of coastal terrace within the Gouritz WMA, and includes much of the Coastal Gouritz catchment (**Figure 6.1**) where mean annual precipitation is approximately 600 mm (Mucina and Rutherford, 2006).

The WRU is dominated by relatively steep gradient streams which do not favour the support of extensive valley bottom wetlands, however, valley bottoms wetlands are present in areas where gradient flattens out or there is contribution from side seeps. These channelled and unchannelled valley bottom wetlands would be seasonally to permanently saturated.

In the more mountainous areas dominated by sandstone and other hard rock geology, areas of hillslope seepage may be present, for example, the extensive areas under development pressure in the mid-catchment above Knysna. These wetlands are often temporary to seasonally saturated and are dependent on rainfall events.

Widespread land use conversion and encroachment of land use has impacted upon wetlands. At the catchment scale, dams, irrigated agriculture and afforestation have reduced inflows to wetlands, and around urban and industrial areas, and to a lesser extent agriculture, water quality has negatively affected downstream wetlands. Within the wetlands themselves, encroachment of agriculture, forestry and development has caused degradation of wetlands. Drainage of wetlands associated with these land use change, as well as erosion by subsequent dongas, has reduced wetted area and duration within wetlands, causing further degradation.

Seeps have been impacted by agricultural activities and development. Many seeps have been ploughed or drained in agricultural areas, and seeps near the coast are additionally threatened by resort, housing, and urban development, especially in the vicinity of Knysna.

Key threats to the wetlands in this WRU thus include:

- Encroachment from forestry and agriculture are the main impacts in central and upper catchments;
- Encroachment from low cost housing and urban areas in coastal areas;
- Clearing of natural vegetation and cultivation around and in the wetlands;
- Invasive alien vegetation; and
- Changes in hydrology.

6.1.8 Sedimentary (Coastal Lakes) WRU

The Sedimentary (Coastal Lakes) areas have a mean annual precipitation of approximately 850 mm (Mucina and Rutherford, 2006). This WRU is characterised by very large lakes and other depressional wetlands (including Groenvlei, Wilderness Lakes and Sedgefield); extensive seepage wetlands, and channelled valley bottom wetlands. The wetlands tend to be permanently inundated with fresh to brackish water.

The coastal lakes have been impacted by changes to hydrology due to upstream activities, and from road and rail infrastructure restricting flood flows, as well as the human manipulation of opening and closing estuaries where the lakes are connected to the estuary. This has led to terrestrialisation in certain areas, unnatural sedimentation and influenced salinity gradients (towards becoming more fresh) in others, concomitant changes in vegetation and decreased support of some bird species. Ploughing and draining has encroached within the wet edges of some wetlands. Due to their location near the coast, these systems are also particularly threatened by resort, housing, and urban development.

The role of groundwater in maintaining these wetlands is important, although this may take the form of both the regional aquifer and/or localised perched aquifers. There are some suggestions (Roets, 2008) that TMG plays a significant role in maintaining isolated wetlands in the dunes of this WRU, especially the isolated Vankervelsvlei. However, these assumptions contradict earlier research (Irving and Meadows, 1997) and have been refuted by available data and recent research (Parsons, 2009; Parsons, 2014). Isolated wetlands high up on the dunes are more likely to be dependent on local perched water tables than the regional groundwater aquifer. It is however possible that the TMG discharges into the regional coastal aquifer and thus probably plays an important role for the large lakes in the area (Parsons, 2009).

Key threats to the wetlands in this WRU thus include:

- Change in hydrology and salinity;
- High nutrient and sediment inputs;
- Harvesting of fauna and flora;
- Reduced flows and groundwater levels due to afforestation;
- Development within the demarcated wetland area;
- Coastal development; and
- Cultivation and draining.

6.1.9 Coastal Sedimentary Deposit

The Coastal Sedimentary WRU is comprised of patches along the south-western coastal section of the study area that are underlain by limestones. There is a low incidence of wetlands (valley bottoms, flats and seeps) in this WRU due the deep, free-draining soils and absence of perched water tables. Analysis of Google Earth imagery suggests that the wetlands that are present are primarily interdune depressional wetlands. Vegetation in the wetlands is dominated by South Coast Sand Fynbos and South Coast Limestone Fynbos.

The wetland habitats (wetlands, depressions and moister soil facies) are more vulnerable to the risk of degradation due to the higher agricultural potential. Many of the wetlands are already highly transformed.

Key threats to the wetlands in this WRU thus include:

- Clearing of natural vegetation, cultivation and invasive alien plant invasion;
- Too frequent or too infrequent fire; and
- Invasive alien vegetation.

6.2 ECOLOGICAL SPECIFICATIONS (ECOSPECS)

The Recommended Ecological Category (REC) for wetlands in the select catchments (those with more than 0.5% NFEPA wetlands within them) are indicated in **Table 3.1**. Recommendations for the management of the priority wetlands assessed (Duiwenhoks and Bitou) are provided in **Section 4** of this report.

At the catchment or study area scale, narrative Ecological Specifications (EcoSpecs) or recommendations for the management of wetlands within the identified WRUs to meet the prescribed RECs, are listed below.

6.2.1 Ecological specifications for wetlands in the Nama Karoo WRU

Source: Mucina and Rutherford (2006).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006) and CSDM inland waters layer (2000).

- There should be no expansion of agriculture or other land uses into remaining intact wetland areas.
- Intact wetlands should not be dammed.
- There should be no further encroachment of woody alien vegetation into wetland areas.
- Generally, seeps are groundwater-fed, but are also influenced by runoff from the surrounding catchment. There should be no change in the natural hydrology of the seep system – e.g. from seasonal to perennial, or from ephemeral to seasonal.

6.2.2 Ecological specifications for wetlands in the Great Karoo WRU

Source: Mucina and Rutherford (2006).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006) and CSDM inland waters layer (2000).

- There should be no expansion of agriculture or other land uses into remaining intact wetland areas.
- Intact wetlands should not be dammed.
- There should be no further encroachment of woody alien vegetation into wetland areas.
- There should be no change in the natural hydrology of the wetland – e.g. from seasonal to perennial, or from ephemeral to seasonal.
- There should be no degradation of water quality such that it impacts upon the condition of downstream wetlands.

6.2.3 Ecological specifications for wetlands in the Klein Karoo WRU

Source: Mucina and Rutherford (2006).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006) and CSDM inland waters layer (2000).

- There should be no expansion of agriculture or other land uses into remaining intact wetland areas.

- Intact wetlands should not be dammed.
- There should be no further encroachment of woody alien vegetation into wetland areas.
- There should be no change in the natural hydrology of the wetland – e.g. from seasonal to perennial, or from ephemeral to seasonal.
- There should be no degradation of water quality such that it impacts upon the condition of downstream wetlands.

6.2.4 Ecological specifications for wetlands in the Swartberg Cape Fold Mountains WRU

Source: Mucina and Rutherford (2006).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006) and CSDM inland waters layer (2000).

- There should be no physical alterations to remaining intact wetland areas.

6.2.5 Ecological specifications for wetlands in the South Cape Fold Mountains WRU

Source: Vlok *et al*. (2005).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006) and CSDM inland waters layer (2000).

- There should be no further encroachment of woody alien vegetation into wetland areas.
- There should be no change in the natural hydrology of the wetland – e.g. from perennial to seasonal or the natural fire regime, both of which contribute to maintaining the high biodiversity and support of endemic species in these systems.
- Wetland vegetation should be dominated by indigenous species.

6.2.6 Ecological specifications for wetlands in the South Coastal Belt WRU

Source: Mucina and Rutherford (2006).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006) and CSDM inland waters layer (2000).

- Maintain the optimum vegetation age (since last fire) to best support biodiversity and maintain natural processes and functioning.
- Control the spread of invasive alien vegetation and ensure a follow up maintenance plan is in place.
- No new roads through intact wetland.
- No new cultivation in intact wetland.
- Maintain the natural water regime, such that lowered water levels do not allow organic soils to dry out, leading to risk of erosion or sub-surface fire.
- Identify presence of special plant species.
- Maintain appropriate seasonal water regime.

6.2.7 Ecological specifications for wetlands in the South East Coastal Belt WRU

Source: Mucina and Rutherford (2006).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006) and CSDM inland waters layer (2000).

- There should be no further encroachment of woody alien vegetation into wetland areas.
- There should be no change in the natural hydrology of the wetland – e.g. from perennial to seasonal.
- Wetland vegetation should be dominated by indigenous species.
- There should be no physical alterations to remaining intact wetland areas.

6.2.8 Ecological specifications for wetlands in the Sedimentary (Coastal Lakes) WRU

Source: Mucina and Rutherford (2006).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006) and CSDM inland waters layer (2000).

- Maintain appropriate water regime.
- There should be no further encroachment of cultivation vegetation into wetland areas.
- No increases in salinity and/or nutrients in runoff entering the wetland, which might result in the creation of eutrophic and potentially oxygen depleted habitats, changes in plant zonation and community structure and a proliferation of weedy elements.

6.2.9 Ecological specifications for wetlands in the Coastal Sedimentary Deposit WRU

Source: Mucina and Rutherford (2006).
Baseline data: NFEPA (2011), Mucina and Rutherford (2006).

- There should be no further encroachment of cultivation vegetation into wetland areas.
- No increases in salinity and/or nutrients in runoff entering the wetland, which might result in the creation of eutrophic and potentially oxygen depleted habitats, changes in plant zonation and community structure and a proliferation of weedy elements.

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APPENDIX A: COMMENTS AND RESPONSE REGISTER

The valuable comments and suggestions from the six reviewers, and their role in improving the clarity and quality of this report, are gratefully acknowledged. Grammar, spelling errors and minor editorial comments have been corrected directly in the document. The remaining comments are addressed below in the comments and responses table.

The external reviewer has not made any mention of the TOR or Inception Report, so some comments appeared to be out of context with the project scope, DWS Reserve needs and the agreed upon approach as outlined in the Inception Report. This author confirms that the scope of work as outlined in the inception report has been addressed through the work presented in this report.

In line with a number of the external reviewer comments, it is recommended that the DWS consider whether improved wetland maps for WMAs would be a required deliverable from Reserve studies, and if so, allow for very significant budget expansions for the overall studies that this would require.

Comment	Response
Comments from Patsy Scherman (technical team leader)	
Review comments were provided in hard copy and have been addressed directly in the document.	
Comments from Aldu le Grange (project leader)	
Review comments were provided in hard copy, were largely of an editorial or stylist nature and have been addressed directly in the document or through the final report style editing.	
Comments from Thapelo Machaba (DWS)	
Review comments were editorial and have been addressed directly in the document.	
Comments from Esther Lekalake (DWS)	
Nutrient, pg iv	Typo error addressed
Management, pg viii	Typo error addressed
Table 4.1 has 34? Maybe it will less confusing if you don't give Goukou the number, pg x	Clarity has been provided between the catchment scale assessment and the assessment of individual priority wetlands.
Ecological, pg x	Typo error addressed

Comment	Response
Quaternary, pg 2-1	Typo error addressed
Duiwenhoeks - Consistency with the spelling	Document has been corrected to consistently reflect the correct “Duiwenhoks” spelling.
Add DWA (2010) to reference list	Added to the ref list
Why is the REC the PES?	In some cases it is not economically or practically feasible to increase a high PES to a higher EC, despite a high EIS. The REC is thus set as the PES, which must then be maintained.
Also highlight	highlighted
spelling	Typo error addressed
Write in full	Plett replaced with Plettenberg Bay
Comments from Barbara Weston (DWS)	
Indicate below that in theory this should have gone up a whole category but B catergory will suffice, recommend strick monitoring of what???? Yes check the stars above high EIS should increase half a category and see comment below	I do not follow an approach that the RECs must automatically go up (above the PES) just because the EIS is high. I only recommend a higher than PES REC when: - It is practicable to achieve a higher PES, and - The current PES is moderate or lower. Is this correct? Would you prefer automatically higher RECs for all areas where the EIS is high or very high?
Recommend bufferline delineation	The legal mechanisms to enact buffers are not clear and the tools for consistently and reliably determining required buffers are still being tested. Our national legislation already protects the temporary and seasonal zones of wetlands (these often used as buffer zones in other countries), and moreover the DWS already enforces a 500m authorisation zone around wetlands. I therefore find it difficult to motivate for any additional costs for society or developers on top of the above already in place.
Why does the Bitou only have a moderate importance is it not a unique system and palmiet is that also not rare and unique /scares?	This only examines the floodplain (not the estuary) and this is degraded and not particularly unique in terms of size or wetland type as there are larger and more complex, formally protected similar coastal wetlands in the region. Palmiet is widely distributed from the Western through to Eastern Cape. Although large intact palmiet wetlands are increasingly rare, unfortunately the Duiwenhoks, due to extensive erosion and incision, no longer represents an unchannelled valley bottom wetland type.
Give an indication below this table what the scores	Explanations are inserted to the table.

Comment	Response
represents is out of 10 where 1 is bad, 5 average, 9 ????	
Tabulate the descriptions of priority wetlands to make the section easier to read	Section has been tabulated in landscape format as recommended.
Yes I agree but because there are so many wetlands we have to focus on the priority ones that have now for this round been odentified as hotspots areas based on pressure or its ecological importance. What we need to point out in this document that could be used for condtions are the risks to the wetlands in a WRU i.e what type of development are those wetlands most sensitive to for instance flow should not be reduced to the Bitou wetlands due to the impact it will have on its functionality. Also this first stab is to identify redflags and we should indicate with the DSS where further investigations would be required before we authorise any development that could negativerly impact the wetland and/or cause a nett loss.	Basic Ecostatus information is required for all WULAs, but none of this baseline information was previously available. Quat/sub-quat scale information is used for rivers and, until we have each wetland mapped and Ecostatus determined, this is a feasible way to generate this information. Low risk WULAs can utilise the baseline information and assessment of risks for wetlands in the different Wetland Resource Units to guide the evaluations of the WULAs. The specific issues and risks of the individual known priority wetlands have been noted in Section 4 of the report.
Provide examples of data sources	The table has been updated to reflect that available desktop data (such as geology maps) that were used to inform the scoring.
Fig 5.1: Enlarge the legend a bit cant read it	Legend has been enlarged
Section 5.1.3: The recommendations that could be used for conditions are being lost here under the PES section, I recommend you do the PES and EIS of the TWO wetlands first and then in a separate section below address the recommendations since this is very important .	The PES is an earlier section and the recommendations section is not under the PES, but a section following after. Recommendations are thus linked to each of the priority wetlands. I think they will be lost if we move them away from the sections of the specific wetlands which they relate to.
Are you referring to the source of the impact or the impact itself? Surely you would need to look at both to ensure that the damage done by the impact is remediated to prevent any further degradation but also the cause of the problem should be considered as well?	The impact – the eroding donga. The ultimate initial cause/s are not well documented (the wetland is already eroding in the earliest aerial photographs) and for the eroded section of the wetland, rehabilitation is not possible. Thus the recommendation is to focus on managing the impact and arrest the eroding donga to protect what sections are still salvageable.

Comment	Response
What about recommending a buffer area around this wetland in which impacts should be managed and prevented in the future.	The need to manage invasive vegetation within and alongside the wetland has already been highlighted immediately above. Any additional needs in terms of a buffer are tangential to the very immediate needs of fixing the erosion and may create a very incorrect impression that the creation of a “buffer” will be a good mechanism, in this case, for maintaining or improving the PES.
Blue Cranes (threatened species)	Added that the Blue Cranes are an IUCN Vulnerable species
Is Bitou in a nature conservation area?	Not a conservation area – this is discussed earlier in this section and has been reiterated here.
What is the role/function that the Bitou wetland play in relation to the Keurbooms estuary should we not mention this in support of its importance	The Bitou feeds to the Keurbooms, but its contribution is small and this has been noted in the report.
Pehaps you should add a coloumn that indicates what is the most “major” threat to this type of wetland i.e for floodplains the reduction of flow is detrimental due to the reduction in the wetted parameter loss of habitat functionality or something like this remember this section is under management thus you must make the link otherwise if it is just science then it will be difficult to interpret.	The threats are listed and described for each WRU in the section immediately following this table. To repeat these threats/impacts would make the table several pages long and we would not be able to show the summary of wetland types (the main objective of this table) easily.
This detailed description of the wetlands should move up to Section 2 where the wetlands are described and then you leave the table in this section.	Section 2 is the methods section of the report, whereas this table relates to the results of the analysis: the characteristics of wetland types identified in each resource unit. I have left this in this section.
Request that common names be provided for vegetation species	Common names have been added only for key dominant species (reeds, palmiet), but are otherwise left as the correct scientific names to be consistent with the river and estuary reports.
EcoSpecs: I think we should put this in a table format think it will read easier.	The Numerical EcoSpecs, referred to in this section, are tabulated in Table 3.1, whereas the narrative ones are written as text in this section.
Comments from Justine Ewart-Smith (external reviewer)	
Are priority wetlands those with greater than 0.5% area? I cannot tell whether the priority wetlands are a subset of those that were initially selected according to the 0.5% rule. Based	I have clarified that these are individual priority wetlands, and removed references of “priority” relating to the quaternary catchments with 0.5% or more wetland area.

Comment	Response
on Figures ii and iv, it seems that the priorty wetlands are the quaternary catchments with > 0.5% wetlands but this isn't clear.	
The EcoSpecs were determined for the WRUs, not the wetland types as indicated here.	Clarified that the EcoSpecs are per quaternary catchment and per WRU.
I have concerns about whether the WRUs delineated in this study adequately represent wetlands with similar characteristics thay allow extrapolation of management guidelines etc. I have commented on this in the review document.	Concerns relating to the WRU classification approach and subsequent scale of investigation are discussed in that section below.
What does this mean? No further loss of wetland habitat? Or what? The statement is vague.	I changed the statement: "*Protect and improve the condition of remaining wetland patches, control invasive vegetation*".
The difference between priority wetlands and priority catchments is confusing and needs to be more explicitly explained	Explanation provided between quaternary catchment versus individual wetland assessments
You need to explain this more – the legend does not show what is what. Are you saying that the green wetlands are the conservation priorities? Need to be more explicit	These have been explained in the figure caption
Confusing as to what Level 0 and level 1 FEPAs are	These have been explained in the figure caption
More detail is needed on the way in which different criteria were weighted and the reasoning behind the weightings that were assigned to each of the criteria listed in Table 2.1.	The EcoStatus tools are typically provided as electronic appendices but for the purposes of brevity, and the non-academic nature of the reports, the detailed scoring, rankings and weightings are not unpacked in the main reports. The electronic tools will be available on a CD as a study deliverable.
Perhaps you could provide a table as an appendix which gives the name of those already assessed, what was assessed and a reference to that assessment)	Reference to the previous study has been repeated here.
I'm not convinced that the generic broad scale approach will provide the sort of information that is required for evaluation of water use licence applications.	Basic Ecostatus information is required for all WULA's, but none of this baseline information was previously available. Quat/sub-quat scale information is used for rivers and, until we have each wetland mapped and Ecostatus determined, this is a feasible way to generate this information. Low risk WULAs

Comment	Response
	can utilise the baseline information and assessment of risks for wetlands in the different Wetland Resource Units to guide the evaluations of the WULAs.
Are these the priority catchments? Confusing	Apologies for the confusion. I corrected the report to consistently distinguish between assessed quaternary catchments (where catchment scale Ecostatus assessments were undertaken) and priority individual wetlands. Priority individual wetlands where identified based on available local knowledge of the areas.
I question whether this approach has any practical use – How can this level of assessment be used to evaluate WULAs or help with management of the resource in general?	**B. Weston (DWS) response:** It could give direction where further work will be required and guide DWS to recommend a higher level of reserve pending on the type of proposed conditions. If it is smaller developments that are not going to negatively impact the current PES (also bearing in mind what the current PES), then a more EIA route can be followed by setting conditions and not necessarily flow. But the conditions and specifications should be very clear for region or CMA to implement.
Why did you use average for the EIS and PES rating?	This is a standard approach used in most EcoStatus tools. Weighted averages (weighted according to more important aspects influencing the PES/EIS) are used to derive overall EcoStatus categories.
More detail is needed on the way in which different criteria were weighted and the reasoning behind the weightings that were assigned to each of the criteria listed in Table 2.1. (same comment for Table 2.2)	The DWS has previously requested that their reports be more concise, with the Ecostatus models provided electronically only. We have followed those recommendations for this report.
What was the source of information to score these criteria? Particularly groundwater dependence?	The table has been updated to reflect that available desktop data (such as geology maps) that were used to inform the scoring.
Do you mean the threat of habitat loss associated with development? Infrastructure can affect wetlands indirectly through hydrological and water quality changes for example but I think you mean the direct loss due to expansion in to wetlands – this needs to be specified.	Corrected to state development encroachment
On what basis did you decide to use a median score here as opposed to an average? See comments for using average score for EIS and PES at the quaternary catchment level.	This was used to provide an indication of PES, based on the three criteria considered and scored by the local wetland forum. The small sample size (only three criteria) would make the mean very sensitive to any outliers, so the median provides a better indication of average condition.
But this study was not at a national scale but rather at a	Corrected to denote study area.

Comment	Response
catchment scale.	
There are a number of studies now that have shown the level of inaccuracy associated with the presence of wetlands mapped by NFEPA.	As noted in the comments, there are known limitation with the available desktop wetland map, but this study was not an attempt to replicate or refine the existing SANBI wetlands map. The DEA has dedicated full-time staff responsible for that task, an ongoing DEA programme which has cost many millions of Rands. Duplication of this role by the DWS would be an inefficient spend of public funds and the suggested verification and refinement of the map for this very large study area using the high resolution Spot imagery would be prohibitively expensive. The only large WMA in the country where this has been undertaken is the high priority upper Olifants catchment, and this was only made possible with large-scale funding from the coal mining industry. Moreover, the desktop assessment of Ecostatus which used this map was developed to be able to use existing, available desktop information to ensure fast and cost-effective assessments.
I understand and appreciate that the assessment cannot be undertaken at a site-specific level but I question whether the desktop information should have been verified during this study.	
Perhaps this study should have at least chosen an area where the SPOT images were used to verify the level of accuracy associated with the use of NFEPA.	
Yes, but use of these data at a catchment level is questionable – More accurate mapping from imagery (as opposed to modelled which is how NFEPA was generated) should have been the base layer for inclusion in a study that seeks to provide management guidelines at a catchment scale.	The Gouritz WMA is a very large study area and desktop mapping of all wetlands across this enormous area is not within feasible budget allocations. The only place where such largescale mapping has been undertaken, at considerable cost (and with significant joint private funding provided) is in the wetland rich upper Olifants catchment where the high risks of coal mining warrant such an enormous expenditure. The Gouritz is a far larger area, and risks to wetlands are comparatively minor. The author does not believe the situation warrants the magnitude of expenditure being advocated for.
There is not enough detail in this section to explain how these WRU were determined. I struggle with understanding how all wetlands in the WMA can be split into 9 broad areas that group wetlands on similarities in their characterstics and functionality as a basis for providing management guidelines that are anything more than vague and generic	Integrated Units of Analysis are the basis for Classification. The wetland resource units provide a first high level delineation of zones of similar threats and impacts to wetlands across the WMA to enable scaling up from an individualistic site to catchment level approach for water resource management.
I don't understand the logic of this – the reliability of assessing wetlands based on the NFEPA layer does not differ between wetlands of different sizes	Corrected report to indicate that these catchments are likely to not be very important in terms of wetland coverage and they were excluded from further analysis.
I would have thought that the median would have been better than the average for the extrapolation to catchment level because it gives you the "most common" condition which is	We use the mean of the criteria, assessed for each catchment, to indicate the expected average PES/EIS of wetlands. Verification of these estimates using limited field data in KZN yielded very good correlations.

Comment	Response
what you are looking for – not so?	
More could be said about the EIS evaluated. This is a bit thin.	Expanded.
Perhaps low density wetlands are particularly important for their role in performing such functions so catchments with a low density of wetlands may be just as important to those with a high density of wetlands.	Yes, these would be important local scale functions as indicated in the report, but these small wetlands would not be considered important ("significant", in the language of the NWA) at the national scale when compared to, for example, Wilderness Lakes. As an equivalent comparison, rivers below the 1:500 000 mapping scale are not considered in Reserve studies (which is not to say that small streams in the karoo are not locally important … just that we can't examine and manage everything).
Abstraction results in flow reductions and so do dams so need to separate the impact from the effect.	Report changed to reflect this.
It would be nice to have the individual scores provided in an appendix so that the assessment is more transparent and less of a 'black box'	The DWS has previously requested that their reports be more concise, with the Ecostatus models provided electronically only. We have followed those recommendations for this report.
How do you decide this? Is it based on the median? What would the overall be if you had high, moderate and low for the three components?	The EIS is moderate (as scored). The other criteria considered for wetlands (hydrological functions and direct human benefits) can be used to motivate for an alteration to the overall importance (such as moderate EIS wetlands which have high direct human benefits, for example – importance would need to be increased to reflect this dependency).
The description of the system could be more detailed	Expanded section 5.1
What drives this rating? Some detail on why the EIS is moderate is needed.	Explanation of the factors important for the EIS have bene included.
I would add this to the first paragraph of section 5.1 as part of the description of what the system was like under natural condition – this would then form the basis for describing the PES i.e. the extent of deviation from natural. As it stands, the description of natural and impacts don't flow.	Moved this section to the beginning of section 5.1
These two points address my query above but I think it is necessary to clearly state that certain measures should be implemented to "fix" the existing problem, while others should	I have expanded on this in the report.

Comment	Response
be implemented to prevent any further damage.	
A bit more information about this system would be useful.	More information on the floodplain has been included in the introduction.
Are you saying that the EIS is moderate because it feeds into an ecologically important system? The reasons behind these ratings need to be more explicitly explained.	The Bitou feeds to the Keurbooms, but its contribution is small and this has been noted in the report.
So, the use of the floodplains for pasture is not considered as a direct human benefit then?	The direct human benefit speaks to basic human needs (Schedule 1 water uses) and excludes commercial uses, but would include rural subsistence uses (but these do not occur at this site).
A lot of this is repetition from Section 2 and can be left out here.	Section has been summarised.
The approach to grouping wetlands into WRU is questionable and does not tie in with general approaches to grouping wetlands used in other studies such as fine scale mapping and development of management objectives for different "types" **B Weston:** I agree; get right down to the point related to the management aspect	The HGM wetland classification you are referring to is a finer-scale level of classification, and the typical types found within each WRU are described in this report. A comparison in classification is that rapids, pools and braided sections of rivers (equivalent to HGM wetland types) would be found across the CMA, but that it is more practical to manage by subcatchment or Resource Unit than by river reach type. We have thus followed the approaches of classification and links to management of large catchment that DWS uses, and this will allow for IUA's to be developed more easily during Classification of the catchment.
These EcoSpecs seem broad and generic.	Available data are limited, but the development of baseline PES for the WMA is believed to be a significant development for the DWS. Numerical EcoSpecs are related to achievement of the REC (provided in Table 3.1) which are specific to each quaternary catchment. The narrative EcoSpecs are relatively generic as the main impacts (invasive vegetation and encroachment) are largely ubiquitous across the WRUs. Narrative EcoSpecs were generated in conjunction with Mondi wetlands based on available information.
General overview comments from Justine Ewart-Smith (external reviewer, letter to AECOM dated 31st July 2015)	
Most of the comments made in this review have been included in track changes within the report. Below are some general comments for consideration.	The comments in the report have been addressed as indicated above.
General comments: I understand and appreciate that reserve determinations at	Most of the impacts affecting wetlands in the study area are indeed non-flow related, and hence many of the recommendations to address these impacts (the key ones being control of invasive alien

Comment	Response
the scale of the Gouritz WMA are limited by the sheer size of the catchment. My understanding of the purpose of this study is that it will form the basis upon which WULAs will be evaluated for developments that potentially impact on wetlands within the catchment. However, at this scale, the project has produced broad and generic EcoSpecs and I question the usefulness of this approach and the ability to inform decisions on wetland management going forward. As indicated in the report, most of the potential impacts to wetlands in this catchment are non-flow related.	vegetation, erosion etc) thus do appear to be broad and, in the sense that these impacts are almost ubiquitous across the study area, relatively generic.
There are a number of studies, particularly the fine-scale planning initiatives would provide a useful framework for generating management guidelines for specific wetland types and I feel that building on such a framework would provide more useful information to guide DWS case officers who are faced with evaluating WULAs.	The fine-scale planning and associated high resolution wetland mapping exercises initiated through DEA are not feasible given the large size of the study area and budget constraints of these studies.
The report does not explicitly state anywhere what the level of the assessment is.	The report is clear that the baseline assessment of quaternary catchments is undertaken at a Desktop level whilst the Ecostatus assessment of the two priority wetlands is undertaken at a Rapid level of assessment.
Data source: Despite the low confidence desktop approach to this study, there are a number of studies that shown just how inaccurate the NFEPA map is in terms of giving a spatial coverage of wetlands.	NFEPA remains the best source of national and large-scale regional coverage of wetlands in South Africa. The TOR and scope of this study was not to duplicate or refine the wetland mapping programme managed by SANBI (DEA). The NFEPA maps have thus been used with caution to indicate areas of relative importance in terms of wetlands across the basin.
NFEPA was undertaken at a national scale and while it may be useful for providing an overview of wetland condition and importance at a national scale, it is not adequate for application at a catchment scale. Perhaps this study should have at least chosen an area and verified the level of accuracy presented by the NFEPA map using SPOT imagery	The Gouritz WMA is a very large study area made up of many large catchments. As indicated above in the earlier comments from the external reviewer, many studies have already noted the inaccuracies of the NFEPA maps and expensive high resolution mapping to verify/reiterate existing findings was not deemed to be an efficient spend of the small available budget.

Comment	Response
for verification.	
The NFEPA map for the Gouritz WMA includes both fine scale mapped data and that generated by the modeling protocols used to identify wetlands at a National scale where no wetland map previously occurred. The Fine scale information which was generated for the Riversdale Coastal plain was mapped from 1:10000 orthophotos. Thus the disparity in generation of wetland information for the WMA as a whole was different and the high concentration of wetlands along the coast is somewhat skewed by the difference in the source of information. While the comparison of data collected at different scales is may not be that much of an issue at a national scale, at the catchment scale, this makes a huge difference in terms of considering the spread of wetlands through the catchment.	This is true, but this only accounts for a few of the quaternary catchments along the coast where high wetland presence was noted. Although the disparity in underlying data mapping is a factor, the far higher rainfall of the coastal areas, together with geologies which tend to favour wetland development, would be much stronger factors in explaining expected wetland distribution acros the study area. In the comparatively dry interior catchments, where rainfall can be less than 200 mm per annum, then even with mapping limitations that may occur in these direr areas, one can assume that wetland presence is likely to be far lower simply because there is no available regular precipitation to allow for the extensive development of wetlands.
Wetland Resource Units: As stated in the report, the delineation of wetlands according to WRUs provides a means of grouping wetlands according to similar characteristics for application of management guidelines such as EcoSpecs. Based on the structure and function of wetlands, wetlands identified by 'type' as per the classification system which identifies similarities in their hydro-geomorphological characteristics would be a better approach to identifying resource units. I cannot see how one can place valley bottom wetlands and depressions in the Great karoo, for example, into one resource unit because their characteristics and functioning are so different.	The HGM wetland types which you refer to are akin to the river geomorphic units of rapids pools and riffles or small reaches (features 100's of metres to a few kilometres in length). Whilst riffle features in Mpumalanga and the Western Cape share similar underlying processes, it would be impractical to recommend to the DWS to manage these together as one unit rather than nesting these features within their respective catchments, EcoRegions or resource units. The latter suite of spatial scales are more appropriate administrative and management units subject to similar development, regulatory and biophysical characteristics. Moreover, the implementation of the WRCS depends on an ability to recognise such Resource Units across WMAs to enable similar risks, sensitivities and water resource demands to be recognised and grouped together. Both Valley bottom and seep wetlands in the Great Karoo for example, would be subject to similar agricultural pressures but not to the afforestation pressures or same type and degree of invasive alien vegetation pressure that occurs in coastal wetlands.

Comment	Response
Approach: I don't understand the logic behind exclusion of quaternary catchments with less than 0.5% coverage of wetland habitat, particularly considering that the NFEPA layer grossly underestimates wetland area, particularly in arid areas.	The baseline Ecostatus assessment is a desktop approach which relies on the ability to locate and assess known wetlands using desktop data sources. When the incidence of wetlands in a catchment becomes extremely low, it is no longer possible to examine many wetlands in order to estimate average conditions of wetlands in that catchment since the few "wetlands" indicated in such arid catchments are often farm dams or other modelling artefacts. Due to the unreliable underlying data sources, the baseline assessments are not possible to undertake with any reasonable degree of confidence.
Does this approach mean that the wetland reserve undertaken as part of this study does not refer to the wetlands that were excluded? In other words, would separate reserve determination processes be necessary for wetland within those quaternary catchments that are excluded in this study?	No, this is where the value of the WRUs comes in. Whilst one may not know the exact location and average condition of wetlands in the quaternary catchment, the WRUs denote areas of similar wetland types and the ecological specifications for the relevant WRU can be used to advise WULAs where wetlands need to be considered.
Finally, while there is some appreciation for the reasons why the EcoSpecs are broad and generic for the wetlands not visited, I would expect much more detailed EcoSpecs to have been developed for the set of priority wetlands that were visited during this assessment.	Site assessments were rapid and the main impacts of both priority wetlands are non-flow related. The EcoSpecs to achieve stabilised or improved conditions are directed at these main impacts (erosion, invasive vegetation and/or landuse encroachment). Admittedly, these are broad objectives to address, but if these cannot be corrected, setting fine-scale monitoring requirements around water quality and small-scale habitat monitoring (the normal higher resolution EcoSpecs for rivers etc.) would be a complete waste of resources and provide very misleading indications that these small-scale improvements can counteract the major impacts on these systems.