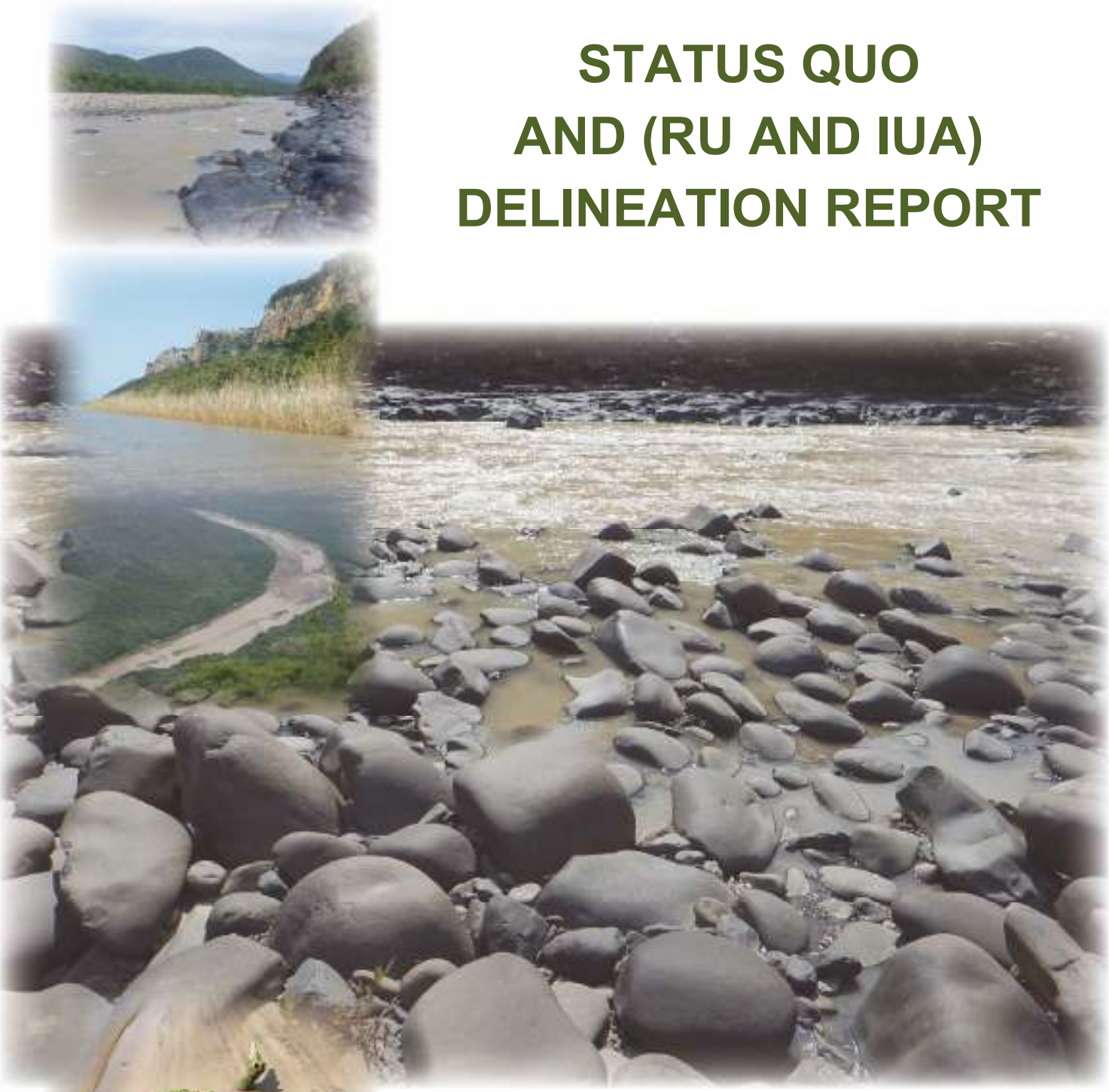
water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

WP 11004

DETERMINATION OF WATER RESOURCE CLASSES AND RESOURCE QUALITY OBJECTIVES FOR THE WATER RESOURCES IN THE MZIMVUBU CATCHMENT



STATUS QUO AND (RU AND IUA) DELINEATION REPORT

March 2017

Report Number: WE/WMA7/00/CON/CLA/0316

Published by

Department of Water and Sanitation
Private Bag X313
PRETORIA, 0001
Republic of South Africa

Tel: +27 (12) 336 7500
Fax: +27 (12) 323 0321

This report should be cited as:

Department of Water and Sanitation (DWS), South Africa, 2017. Determination of Water Resource Classes and Resource Quality Objectives for Water Resources in the Mzimvubu Catchment. Status Quo and (RU and IUA) Delineation Report. Prepared by Rivers for Africa eFlows Consulting (Pty) Ltd. for Scherman Colloty and Associates cc. Report no. WE/WMA7/00/CON/CLA/0316

Compiled by:
Scherman Colloty & Associates cc
22 Somerset Street
Grahamstown
6139

DOCUMENT INDEX

Report name	Report number
Inception Report	WE/WMA7/00/CON/CLA/0116
Survey Report	WE/WMA7/00/CON/CLA/0216
Status Quo and (RU and IUA) Delineation Report	WE/WMA7/00/CON/CLA/0316
River Workshop Report	WE/WMA7/00/CON/CLA/WKSP/0117
River Desktop EWR and Modelling Report	WE/WMA7/00/CON/CLA/0217
BHNR Report (Surface and Groundwater)	WE/WMA7/00/CON/CLA/0317
Estuary Workshop Report	WE/WMA7/00/CON/CLA/WKSP/0417
Scenario Description Report	WE/WMA7/00/CON/CLA/0517
River EWR Report	WE/WMA7/00/CON/CLA/0617
Estuary EWR Report	WE/WMA7/00/CON/CLA/0717
Groundwater Report	WE/WMA7/00/CON/CLA/0817
Wetland EcoClassification Report	WE/WMA7/00/CON/CLA/0917
Scenario Non-ecological Consequences Report	WE/WMA7/00/CON/CLA/1017
Ecological Consequences Report	WE/WMA7/00/CON/CLA/1117
WRC and Catchment Configuration Report	WE/WMA7/00/CON/CLA/0118
River and Estuary RQO Report	WE/WMA7/00/CON/CLA/0218
Wetlands and Groundwater RQO Report	WE/WMA7/00/CON/CLA/0317
Monitoring and Implementation Report	WE/WMA7/00/CON/CLA/0418
Water Resource Classes and RQOs Gazette Template Input	WE/WMA7/00/CON/CLA/0518
Main Report	WE/WMA7/00/CON/CLA/0618a
Close Out Report	WE/WMA7/00/CON/CLA/0618b
Issues and Response Report	WE/WMA7/00/CON/CLA/0718

Bold indicates this report

APPROVAL

TITLE:	Status Quo and (RU and IUA) Delineation Report
DATE:	March 2017
AUTHORS:	Huggins G, Kotze P, Louw D, Mackenzie J, Mullins W, Sami K, Scherman P, Talanda C, Taljaard S and van Niekerk L
EDITOR:	Gowans L
REVIEWERS:	Project Management Team
LEAD CONSULTANT:	Scherman Colloty & Associates cc
REPORT NO:	WE/WMA7/00/CON/CLA/0316
FORMAT:	MSWord and PDF
WEB ADDRESS:	http://www.dws.gov.za

Approved for Scherman Colloty & Associates cc:

_____

Dr Patsy Scherman
Study Leader

Supported by:

_____

Lawrence Mulangaphuma
Project Manager

Recommended by:

_____

Ms Lebogang Matlala
Director: Water Resource Classification

Approved for the Department of Water and Sanitation by:

_____

Ms Ndileka Mohapi
Chief Director: Water Ecosystems

ACKNOWLEDGEMENTS

The following persons contributed to this project.

Project Management Team

Matlala, L	DWS: Water Ecosystems; Classification
Mulangaphuma, L	DWS: Water Ecosystems; Classification
Scherman, P-A	Scherman Colloty & Associates cc
Sauer, J	Scherman Colloty & Associates cc
Weni, E	DWS: Eastern Cape Regional Office
Weston, B	DWS: Water Ecosystems; Surface Water Reserves
Neswiswi, T	DWS: Water Ecosystems; Surface Water Reserves
Kganetsi, M	DWS: Resource Protection and Waste
Molokomme, L	DWS: Water Ecosystems; Groundwater Reserves
Muthraparsad, N	DWS: Environment and Recreation
Thompson, I	DWS: Integrated Water Resource Planning
Matume, M	DWS: Stakeholder Engagement and Coordination
Cilliers, G	DWS: Resource Quality Information Services
Majola, S	DWS: Resource Quality Information Services

AUTHORS

The following persons contributed to this report:

Author	Company
Huggins, G	Nomad Consulting
Kotze, P	Clean Stream Biological Services
Louw, D	Rivers for Africa eFlows Consulting (Pty) Ltd
Mackenzie, J	Mackenzie Ecological and Development Services cc
Mullins, W	Mosaka Economists
Sami, K	WSM Leshika Consulting (Pty) Ltd
Scherman, P	Scherman Colloty & Associates cc
Talanda, C	WRP Consulting Engineers (Pty) Ltd
Taljaard, S	Council for Scientific and Industrial Research
Van Niekerk, L	Council for Scientific and Industrial Research

GIS support: Sandra MacFadyen
Specialist contribution to delineation: Pieter van Rooyen, WRP Consulting Engineers (Pty) Ltd

REPORT SCHEDULE

Version	Date
First draft	November 2016
Second draft	February 2017
Final report	March 2017

EXECUTIVE SUMMARY

INTRODUCTION

This report represents the following volumes of information:

- Volume A: Preliminary status quo of the area
  - This section covers the preliminary status quo of all study components.
- Volume B: Prioritisation
  - This section evaluates importance and prioritises reaches per component, according to a specific set of factors.
- Volume C: Delineation of Resource Units (RUs)
  - Resource Units are delineated for rivers and groundwater. The Mzimvubu estuary is discussed as a single RU. Wetlands are defined as wetland groups.
- Volume D: Delineation of Integrated Units of Analysis (IUAs) and associated status quo of each IUA

VOLUME A: A BROAD STATUS QUO DESCRIPTION OF THE STUDY AREA

Water Resources

The Mzimvubu catchment was divided into six water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. Groundwater use is included in this description. The significant resources of the proposed water resource zones are summarised below.

Catchments	Water resource zone	Major impoundments	Quaternary catchments
Upper Mzimvubu	M-1	None	T31A – T31H
Mzintlava	M-2	None	T32A – T32H
Kinira	M-3	None	T33A – T33K
Thina	M-4	None	T34A – T34K
Tsitsa	M-5	None	T35A – T35M
Lower Mzimvubu	M-6	None	T36A & T36B

Economic analysis

The economic analysis consists of the status quo of the current economic activities as well as the situational analysis of the current prevailing social economic position in the Mzimvubu catchment (T3), concerning the large water users such as irrigation agriculture, commercial forestry, sawmills, laminated board factory as well as the other dependents. Although the tourism sector is neither an indirect nor a large water user, it is often included in the analyses as the value of water to the sector in its natural environment lies in the attraction that the water and environment has for the tourist, which affects the sustainability of the industry. However, in this catchment it is so small that no acceptable values could be sourced and it was therefore not included.

The economic development in the catchment is rather skewed. The main commercial activities are currently restricted to the following sub-catchments:

- T31: The main stream of the Upper Mzimvubu has a very large commercial farming area, small commercial forestry and the two towns of Matatiele and Cedarville. The north-eastern

part of the quaternary catchment is located within the KwaZulu-Natal province and the rest in the Eastern Cape.

- T32: The Mzintlava River with Kokstad as the commercial hub has a large commercial-based farming community.
- The eastern parts of T35 accommodate over 45 000 hectares of commercial forestry with the towns of Maclear and Ugie. In some of the afforestation areas commercial farming is still active. In the lower parts of the Tsitsa River are the identified sites of the proposed Ntabelanga and Lalini dams together with the planned irrigation and hydro-power generation to be established in the sub-catchment.
- The rest of the catchment is rural with subsistence farming and a number of towns and villages acting as commercial, education and health service centres.

Water quality overview

Water quality in this WMA is generally good, with little contamination by nutrients and other toxins, probably due to the dispersed nature of the settlements and their sheer size, and very little industry. There are localised problems related to urban settlements. The most serious form of pollution or water quality impacts in the catchment are high turbidities due to soil erosion. This has reached very serious proportions in the rivers on the eastern side. The cause of this is primarily oversettlement and poor agricultural and overgrazing practices, that are exacerbated by the steep catchments and severe storms that occur. The high silt loads are also due to the numerous road crossings and cultivation along river banks and in the wider catchment. The many mountain streams which arise in mountain areas are of very good quality.

The following water quality hotspots were identified from a desktop assessment of the study area:

SQ reach	River name	Water quality impact (rating)	Water quality issues
T32C-05273	Mzintlava	Large (3)	Pivot irrigation (dairy farming) + sediment impacts
T32D-05352	Mzintlava	Large – Serious (3.5)	Kokstad WWTW + urban pressures; extensive irrigation + an instream dam
T32D-05373	Mzintlava	Large (3)	Irrigation return flows
T32F-05464	Mzintlava	Serious (4)	Discharges from Mount Ayliff WWTW
T33A-04991	Unknown	Large (3)	Extensive erosion; large number of villages; crossings; dryland cultivation; possibly elevated nutrient levels.
T34D-05463	Tokwana	Large (3)	Mount Fletcher WWTW in high risk – so nutrient elevations expected; urban impacts; crossings.
T35F-06020	Inxu	Large (3)	Low risk WWTW in Ugie; urban impacts with irrigation + cultivation downstream.
T35K-06167	Xokonxa	Large (3)	Tsolo WWTW in critical risk; urban impacts; crossings; dryland cultivation

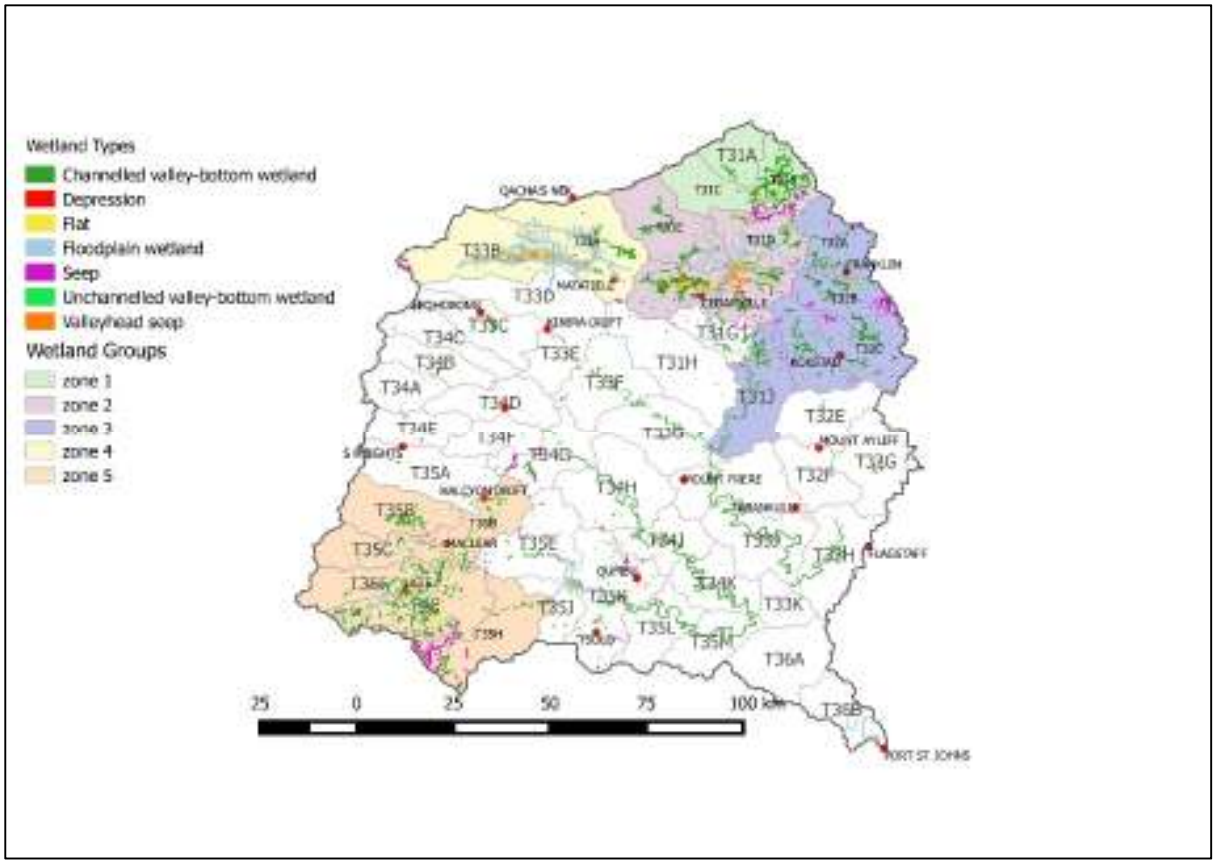
Ecosystem services

Fifteen ecosystem services zones have been generated for the Mzimvubu catchment, based on the output of the Socio-Cultural Importance matrix. The use of this model allows for the development of a spatial matrix that compares sub-quaternary catchments with each other and allows for a profile of the status quo per unit to be developed. This is largely a narrative description based on data available and concentrates on key drivers in terms of socio-economic profiles. The units have been collated into a more limited number of amalgamated sub-quaternary catchments,

or ecosystem services zones, that have similar ecosystem services profiles. Key ecosystem services are described for each zone.

Ecological wetland state

Most wetlands occur within the South Eastern Uplands Level 1 EcoRegion, while the more meandering portions of the Tsitsa, Thina, Mzintlava and Mzimvubu rivers and the estuary occur within the Eastern Coastal Belt. The objective of this step is to define wetland groups and provide a status quo description of each group, including general condition of wetlands/wetland groups. A group represents a homogenous catchment or region based on the similarity of ecological state, system operation and land use. The status quo description provides information at a broad scale to inform the delineation of the wetland groups. Five groups of wetlands were identified and the status quo of each described.

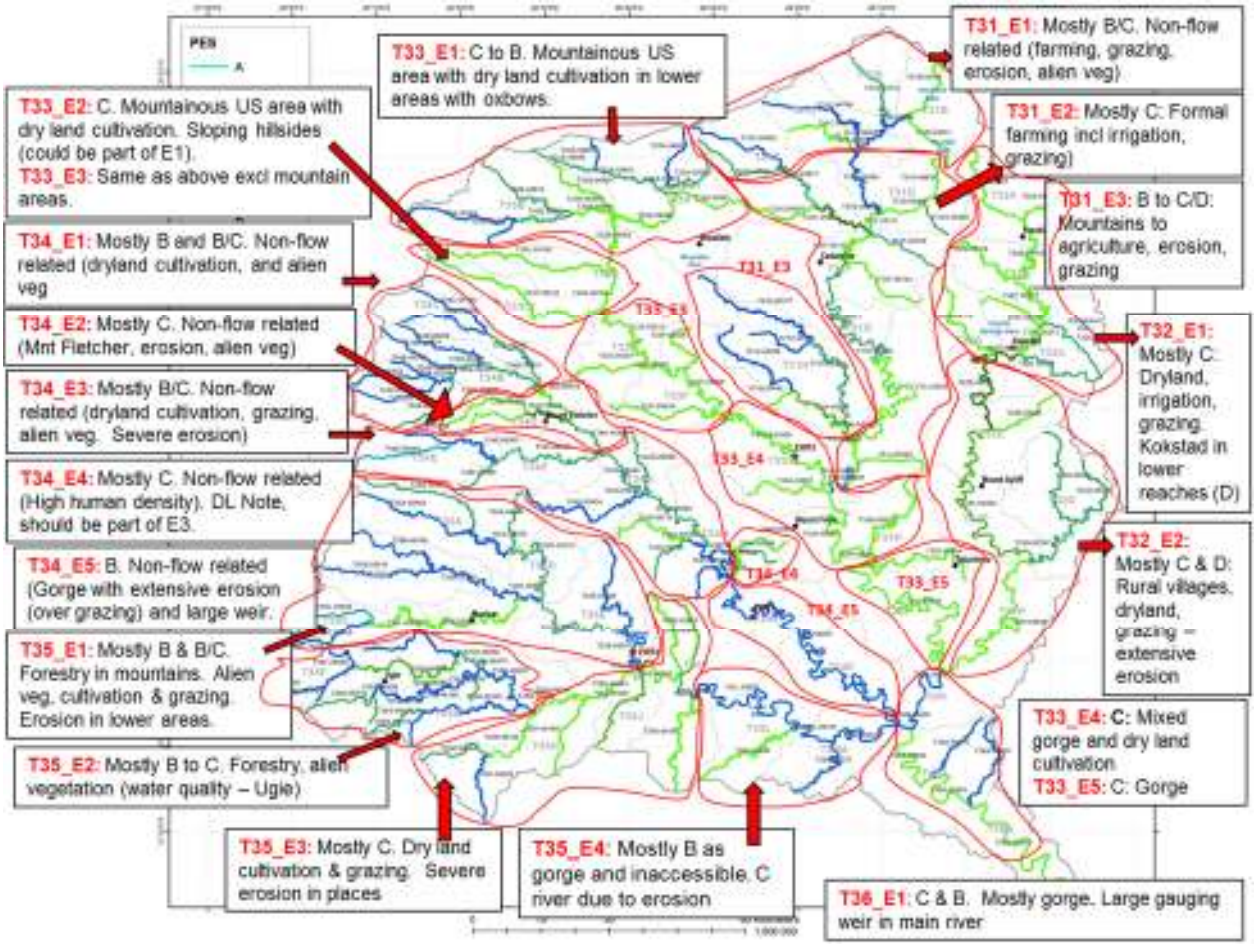


Wetlands were delineated into five groups, indicated by different coloured quaternary catchments

Ecological river state

Determination of the Present Ecological State (PES), which represents the ecological status quo of the rivers, is undertaken as part of the EcoClassification process. The EcoClassification process consists of four levels which refer to increasing complexity and intensity of work from the Level I (Desktop) to Level IV. Date from a countrywide desktop assessment, referred to as the PES/EI/ES or PESEIS project, was used as the baseline for the status quo assessment. The status quo assessment consists of a table and short summary for each tertiary catchment. No key PES drivers are provided for rivers in a B or higher PES as the changes from natural are minor.

A broad description was provided grouped into zones for purposes of providing an ecological status quo description according to the PES. These zones provide input into decision-making regarding the delineation of IUAs.

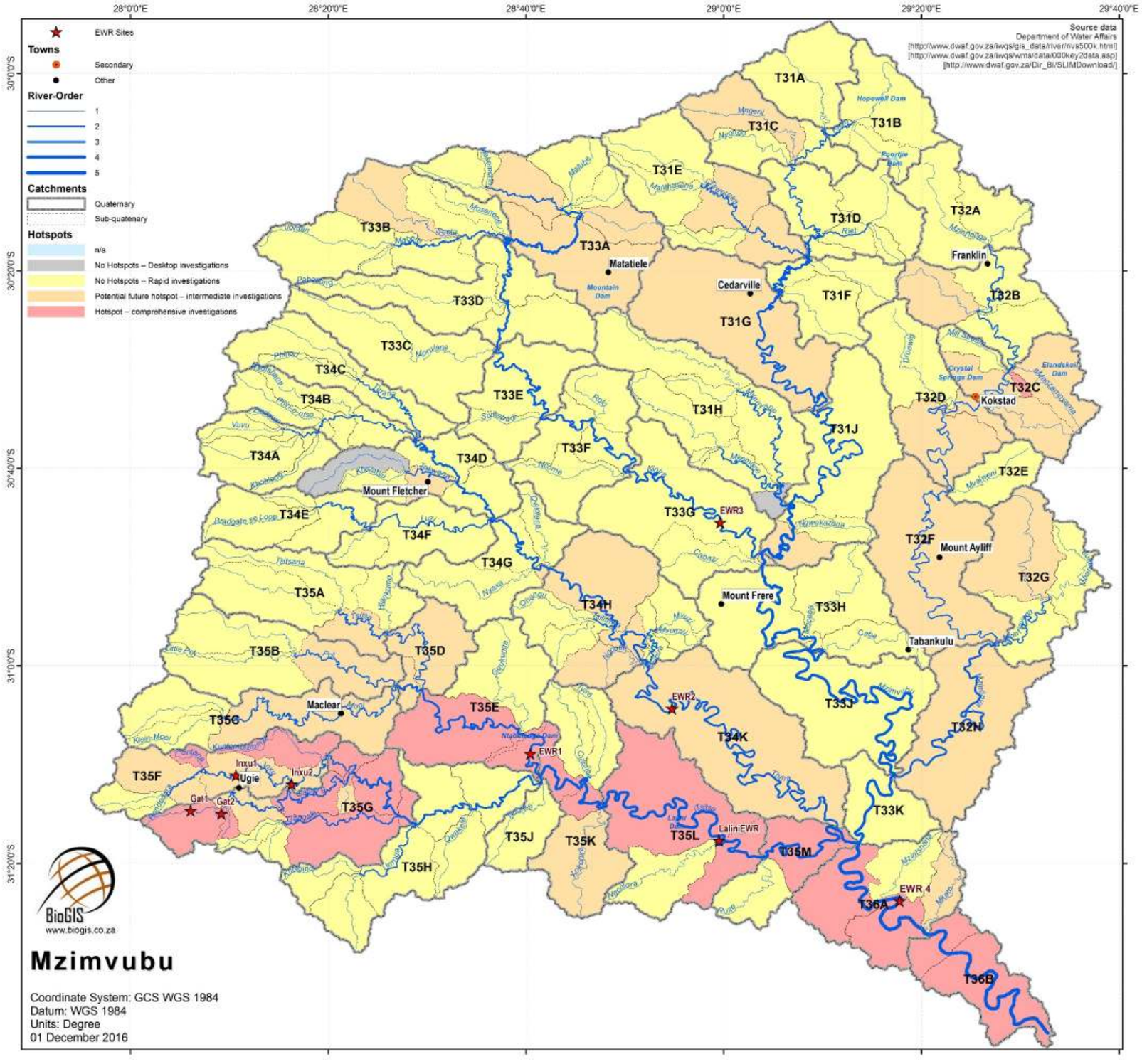


Ecological zones demarcated in terms of land use and similar ecological categories

VOLUME B: PRIORITISATION

In this volume a prioritisation process was followed to identify (1) rivers where SQs of high ecological importance are present, and (2) high priority wetlands. Results of both assessments are shown below.

High Priority SQs (hotspots) are identified by comparing (or overlaying) Integrated Environmental Importance with Water Resource Use Importance. A biodiversity/ecological hotspot is a biogeographic region which is a significant reservoir of biodiversity which is threatened with destruction (http://en.wikipedia. org/wiki/Biodiversity_hotspot). In the context used here, the hotspot represents a river reach with a high Integrated Environmental Importance which could be under threat due to its importance for water resource use. The hotspots are therefore an indication of areas where detailed investigations would be required if development was being considered. These hotspots usually represent areas which are already stressed or will be stressed in future. This assessment can therefore guide decision-making with regard to which areas are in need of detailed EWR and other studies. The results of the assessment are shown on the map below.



SQs and their priority ratings

The purpose of the wetland prioritisation process was to identify priority wetlands or wetland systems within the T3 catchment. This was done at the SQ scale to facilitate comparability with other disciplines and to aid in the identification of hotspots (high priority river, wetland and/or groundwater areas). Prioritisation included an assessment of Present Ecological State (PES), Integrated Ecological Importance (IEI) and Social and Cultural Importance (SCI).

Wetland priority, also showing wetland Ecological Important (EI), Ecological Sensitivity (ES), Integrated Importance and Sensitivity (IIS), PES and IEI per SQ

SQ PESEIS	Name	Wetland EI	Wetland ES	SCI	IIS	PES	IEI	WRUI	PRIORITY
T31A-04712	Mzimvubu	HIGH	LOW	MODERATE	HIGH	C	3	1	2
T31B-04745	Krom	HIGH	MODERATE	LOW	HIGH	B	5	2	3
T31B-04868	Krom	VERY HIGH	MODERATE	LOW	VERY HIGH	B	5	1	2
T31B-04873		VERY HIGH	MODERATE	LOW	VERY HIGH	B	5	2	3
T31C-04796	Mngeni	HIGH	MODERATE	HIGH	HIGH	C	3	2	2
T31C-04866	Mzimvubu	MODERATE	MODERATE	MODERATE	MODERATE	B/C	3	1	2
T31C-04879	Nyongo	MODERATE	VERY HIGH	HIGH	VERY HIGH	C	5	2	3
T31D-04926	Mzimvubu	HIGH	MODERATE	LOW	HIGH	C	3	1	2
T31D-04936	Riet	VERY HIGH	MODERATE	LOW	VERY HIGH	B/C	5	2	3
T31D-05030	Riet	HIGH	LOW	LOW	HIGH	C	3	2	2
T31D-05060		HIGH	MODERATE	MODERATE	HIGH	D	3	1	2
T31D-05076	Mzimvubu	VERY HIGH	VERY LOW	LOW	VERY HIGH	C	5	2	3
T31E-04836	Tswereka	HIGH	MODERATE	HIGH	HIGH	B	5	1	2
T31E-04910	Malithasana	HIGH	MODERATE	HIGH	HIGH	D	3	1	2
T31E-04931	Tswereka	HIGH	HIGH	HIGH	HIGH	C	3	2	2
T31E-05013	Tswereka	HIGH	MODERATE	MODERATE	HIGH	D	3	3	3
T31E-05055		VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	2	3
T31F-05108		VERY HIGH	LOW	LOW	VERY HIGH	B	5	2	3
T31F-05111	Mzimvubu	HIGH	VERY LOW	LOW	HIGH	B	5	2	3
T31F-05112	Mzimvubu	VERY HIGH	LOW	MODERATE	VERY HIGH	C	5	2	3
T31F-05134		VERY HIGH	MODERATE	LOW	VERY HIGH	D	3	2	2
T31G-05071	Mzimvubu	VERY HIGH	MODERATE	HIGH	VERY HIGH	D	3	2	2
T31H-05177	Mvenyane	HIGH	LOW	HIGH	HIGH	B	4	1	2
T31H-05324	Mvenyane	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	1	2
T31J-05257	Mzimvubu	HIGH	MODERATE	MODERATE	HIGH	D	3	2	2
T31J-05551	Mzimvubu	HIGH	VERY LOW	MODERATE	HIGH	D	3	2	2
T31J-05582	Ngwekazana	HIGH	LOW	MODERATE	HIGH	D	3	1	2
T31J-05588	Mzimvubu	HIGH	MODERATE	MODERATE	HIGH	D	3	2	2
T32A-04907	Mzintlanga	VERY HIGH	MODERATE	LOW	VERY HIGH	C	5	2	3
T32A-04965	Mzintlava	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	2	3
T32B-05103	Mzintlava	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C/D	3	2	2
T32B-05116		VERY HIGH	HIGH	MODERATE	VERY HIGH	C	5	3	4
T32B-05184	Mzintlava	VERY HIGH	MODERATE	MODERATE	VERY HIGH	D	3	2	2
T32C-05219	Mill Stream	HIGH	MODERATE	LOW	HIGH	C	3	2	2
T32C-05243	aManzamnyama	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	2	3
T32C-05273	Mzintlava	HIGH	HIGH	LOW	HIGH	D	3	3	3
T32C-05313	Mzintlava	HIGH	MODERATE	MODERATE	HIGH	B	5	3	4
T32C-05378		HIGH	MODERATE	MODERATE	HIGH	C/D	3	2	2
T32D-05172	Droewig	VERY HIGH	MODERATE	LOW	VERY HIGH	C	5	2	3

SQ PESEIS	Name	Wetland EI	Wetland ES	SCI	IIS	PES	IEI	WRUI	PRIORITY
T32D-05352	Mzintlava	HIGH	MODERATE	LOW	HIGH	D	3	3	3
T32D-05373	Mzintlava	HIGH	MODERATE	LOW	HIGH	D/E	3	3	3
T32F-05464	Mzintlava	HIGH	LOW	HIGH	HIGH	D	3	3	3
T32G-05536	Mzintlavana	HIGH	LOW	HIGH	HIGH	C/D	3	2	2
T32G-05609	Mbandana	HIGH	LOW	MODERATE	HIGH	C	3	1	2
T32H-05842	Mzintlava	HIGH	LOW	MODERATE	HIGH	C	3	3	3
T33A-04887	Mafube	HIGH	HIGH	MODERATE	HIGH	C	3	1	2
T33A-04892	Kinira	HIGH	VERY LOW	MODERATE	HIGH	C	3	1	2
T33A-04898	Makomorin	HIGH	LOW	MODERATE	HIGH	B	5	1	2
T33A-04903	Kinira	HIGH	MODERATE	HIGH	HIGH	C/D	3	2	2
T33A-04928		HIGH	MODERATE	MODERATE	HIGH	B/C	4	2	3
T33A-04983	Mafube	HIGH	MODERATE	MODERATE	HIGH	C	3	2	2
T33A-04990	Kinira	HIGH	LOW	HIGH	HIGH	C	3	3	3
T33A-04991		HIGH	VERY LOW	HIGH	HIGH	C	3	3	3
T33A-05011	Kinira	HIGH	LOW	MODERATE	HIGH	C	3	2	2
T33B-04912	Seeta	HIGH	VERY LOW	MODERATE	HIGH	C	3	2	2
T33B-04939	Mabele	HIGH	LOW	LOW	HIGH	C/D	3	1	2
T33B-04956	Mosenene	HIGH	LOW	HIGH	HIGH	D/E	3	2	2
T33B-05005	Jordan	VERY HIGH	VERY LOW	MODERATE	VERY HIGH	D	3	1	2
T33B-05051	Mabele	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	1	2
T33B-05066	Mabele	HIGH	VERY LOW	LOW	HIGH	D	3	1	2
T33B-05072		HIGH	VERY LOW	HIGH	HIGH	C/D	3	1	2
T33C-05131	Morulane	HIGH	LOW	HIGH	HIGH	C/D	3	2	2
T33D-05063	Kinira	VERY HIGH	VERY LOW	HIGH	VERY HIGH	D	3	2	2
T33D-05106	Pabatlong	HIGH	VERY HIGH	HIGH	VERY HIGH	C/D	3	2	2
T33D-05150	Kinira	HIGH	LOW	MODERATE	HIGH	C/D	3	2	2
T33E-05213	Kinira	HIGH	MODERATE	HIGH	HIGH	C/D	3	2	2
T33E-05367	Somabadi	MODERATE	VERY HIGH	HIGH	VERY HIGH	C/D	3	1	2
T33F-05285	Rolo	MODERATE	VERY LOW	HIGH	HIGH	D	3	2	2
T33F-05326	Kinira	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	2	2
T33F-05398	Kinira	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	2	2
T33F-05439	Ncome	MODERATE	VERY LOW	HIGH	HIGH	C/D	3	2	2
T33G-05395	Kinira	HIGH	LOW	HIGH	HIGH	C/D	3	2	2
T33G-05587	Cabazi	MODERATE	HIGH	HIGH	HIGH	C/D	3	1	2
T33G-05659	Mzimvubu	MODERATE	MODERATE	LOW	MODERATE	B	4	2	3
T33H-05638	Mnceba	MODERATE	VERY HIGH	MODERATE	VERY HIGH	C	5	1	2
T33H-05680	Mzimvubu	MODERATE	LOW	HIGH	HIGH	C	3	1	2
T33H-05803	Caba	HIGH	MODERATE	HIGH	HIGH	C/D	3	1	2
T33H-05821	Mzimvubu	MODERATE	MODERATE	LOW	MODERATE	C	3	1	2
T33J-05834	Mzimvubu	MODERATE	LOW	MODERATE	MODERATE	C	3	1	2
T34A-05394	Vuvu	HIGH	HIGH	LOW	HIGH	B/C	4	1	2
T34A-05404	Thina	HIGH	VERY LOW	LOW	HIGH	C	3	1	2
T34A-05408	Khohlong	HIGH	VERY LOW	HIGH	HIGH	C	3	1	2
T34A-05415	Thina	HIGH	VERY LOW	HIGH	HIGH	B/C	4	1	2
T34B-05269	Nxotshana	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	1	2
T34B-05275	Phiri-e-ntso	HIGH	VERY LOW	HIGH	HIGH	B/C	4	1	2
T34B-05351	Thina	HIGH	VERY LOW	HIGH	HIGH	C/D	3	1	2
T34B-05356	Thina	HIGH	LOW	MODERATE	HIGH	C/D	3	1	2

SQ PESEIS	Name	Wetland EI	Wetland ES	SCI	IIS	PES	IEI	WRUI	PRIORITY
T34B-05385	Thina	HIGH	VERY LOW	LOW	HIGH	C/D	3	1	2
T34C-05168	Tinana	HIGH	VERY LOW	LOW	HIGH	B	5	1	2
T34C-05292	Tinana	MODERATE	LOW	HIGH	HIGH	C	3	1	2
T34D-05412	Thina	HIGH	LOW	HIGH	HIGH	C	3	1	2
T34D-05460	Thina	HIGH	LOW	MODERATE	HIGH	D	3	2	2
T34E-05495	Bradgate se Loop	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	0	2
T34E-05503	Luzi	HIGH	VERY LOW	LOW	HIGH	C	3	0	1
T34E-05507	Luzi	HIGH	LOW	MODERATE	HIGH	C	3	1	2
T34F-05512	Luzi	HIGH	VERY LOW	HIGH	HIGH	C	3	1	2
T34G-05543	Thina	HIGH	LOW	MODERATE	HIGH	C	3	2	2
T34G-05634	Nxaxa	VERY HIGH	LOW	HIGH	VERY HIGH	C/D	3	1	2
T34G-05667	Thina	MODERATE	LOW	LOW	MODERATE	B/C	3	2	2
T34H-05598	Thina	HIGH	MODERATE	HIGH	HIGH	D	3	2	2
T34H-05772	Thina	HIGH	LOW	MODERATE	HIGH	B	5	2	3
T34H-05826	Ngcothi	HIGH	LOW	MODERATE	HIGH	B/C	4	2	3
T34K-05835	Thina	HIGH	MODERATE	HIGH	HIGH	B/C	4	2	3
T35A-05596	Tsitsana	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	1	2
T35A-05648	Tsitsa	HIGH	LOW	LOW	HIGH	B	5	1	2
T35A-05750	Tsitsa	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	2	2
T35B-05709	Pot	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	1	2
T35B-05798	Pot	HIGH	LOW	MODERATE	HIGH	C/D	3	2	2
T35B-05815	Little Pot	VERY HIGH	LOW	MODERATE	VERY HIGH	C	5	1	2
T35C-05858	Mooi	HIGH	VERY LOW	MODERATE	HIGH	C	3	1	2
T35C-05874	Mooi	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C/D	3	3	3
T35C-05930	Klein-Mooi	HIGH	VERY LOW	MODERATE	HIGH	C	3	1	2
T35D-05721	Tsitsa	HIGH	LOW	HIGH	HIGH	D	3	2	2
T35D-05844	Mooi	HIGH	MODERATE	LOW	HIGH	B	5	2	3
T35E-05780	Gqukunqa	MODERATE	VERY LOW	MODERATE	MODERATE	B	4	1	2
T35E-05908	Tsitsa	HIGH	MODERATE	MODERATE	HIGH	C	3	4	4
T35E-05977	Tsitsa	MODERATE	HIGH	MODERATE	HIGH	C	3	4	4
T35F-05973	Kuntombizininzi	VERY HIGH	MODERATE	MODERATE	VERY HIGH	B	5	3	4
T35F-05999	Inxu	HIGH	LOW	MODERATE	HIGH	B/C	4	2	3
T35F-06020	Inxu	VERY HIGH	LOW	MODERATE	VERY HIGH	D	3	3	3
T35G-06002	Inxu	HIGH	LOW	LOW	HIGH	C	3	3	3
T35G-06021	Inxu	HIGH	VERY LOW	MODERATE	HIGH	C	3	3	3
T35G-06069	Gatberg	VERY HIGH	LOW	MODERATE	VERY HIGH	B/C	5	3	4
T35G-06074	Gatberg	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	3	4
T35G-06099	Gatberg	VERY HIGH	LOW	MODERATE	VERY HIGH	B/C	5	2	3
T35G-06100		MODERATE	VERY LOW	MODERATE	MODERATE	C	3	2	2
T35G-06108	Inxu	HIGH	LOW	MODERATE	HIGH	B	5	3	4
T35G-06118	Gatberg	VERY HIGH	MODERATE	MODERATE	VERY HIGH	B/C	5	3	4
T35G-06133		HIGH	LOW	MODERATE	HIGH	C	3	3	3
T35G-06135	Gqaqala	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	3	4
T35G-06148		HIGH	VERY HIGH	LOW	VERY HIGH	A	5	3	4
T35G-06169	Gqaqala	HIGH	LOW	MODERATE	HIGH	C	3	1	2
T35G-06179		HIGH	LOW	MODERATE	HIGH	C	3	1	2
T35H-06024	Inxu	MODERATE	LOW	MODERATE	MODERATE	C	3	2	2
T35H-06053	Inxu	MODERATE	MODERATE	MODERATE	MODERATE	C	3	2	2

SQ PESEIS	Name	Wetland EI	Wetland ES	SCI	IIS	PES	IEI	WRUI	PRIORITY
T35H-06186	Umnga	HIGH	HIGH	MODERATE	HIGH	C	3	2	2
T35H-06240	KuNgindi	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	2	3
T35H-06282	Umnga	HIGH	MODERATE	MODERATE	HIGH	B	5	1	2
T35J-06106	Ncolosi	MODERATE	MODERATE	MODERATE	MODERATE	D	2	2	2
T35K-05897	Culunca	MODERATE	HIGH	MODERATE	HIGH	D	3	2	2
T35K-05904	Tyira	MODERATE	HIGH	MODERATE	HIGH	D	3	2	2
T35K-06037	Tsitsa	MODERATE	VERY HIGH	MODERATE	VERY HIGH	C	5	4	4
T35K-06167	Xokonxa	HIGH	MODERATE	MODERATE	HIGH	C	3	3	3
T35L-05976	Tsitsa	VERY HIGH	HIGH	HIGH	VERY HIGH	C	5	4	4
T35L-06190	Tsitsa	HIGH	LOW	MODERATE	HIGH	B	5	4	4
T35L-06226	Ngcolora	HIGH	HIGH	MODERATE	HIGH	D	3	2	2
T35M-06187	Tsitsa	MODERATE	MODERATE	MODERATE	MODERATE	B	4	4	4
T35M-06275	Ruze	HIGH	MODERATE	MODERATE	HIGH	B	5	1	2
T36A-06250	Mzimvubu	MODERATE	LOW	MODERATE	MODERATE	C	3	4	4
T36B-06391	Mzimvubu	VERY HIGH	MODERATE	HIGH	VERY HIGH	C/D	3	4	4

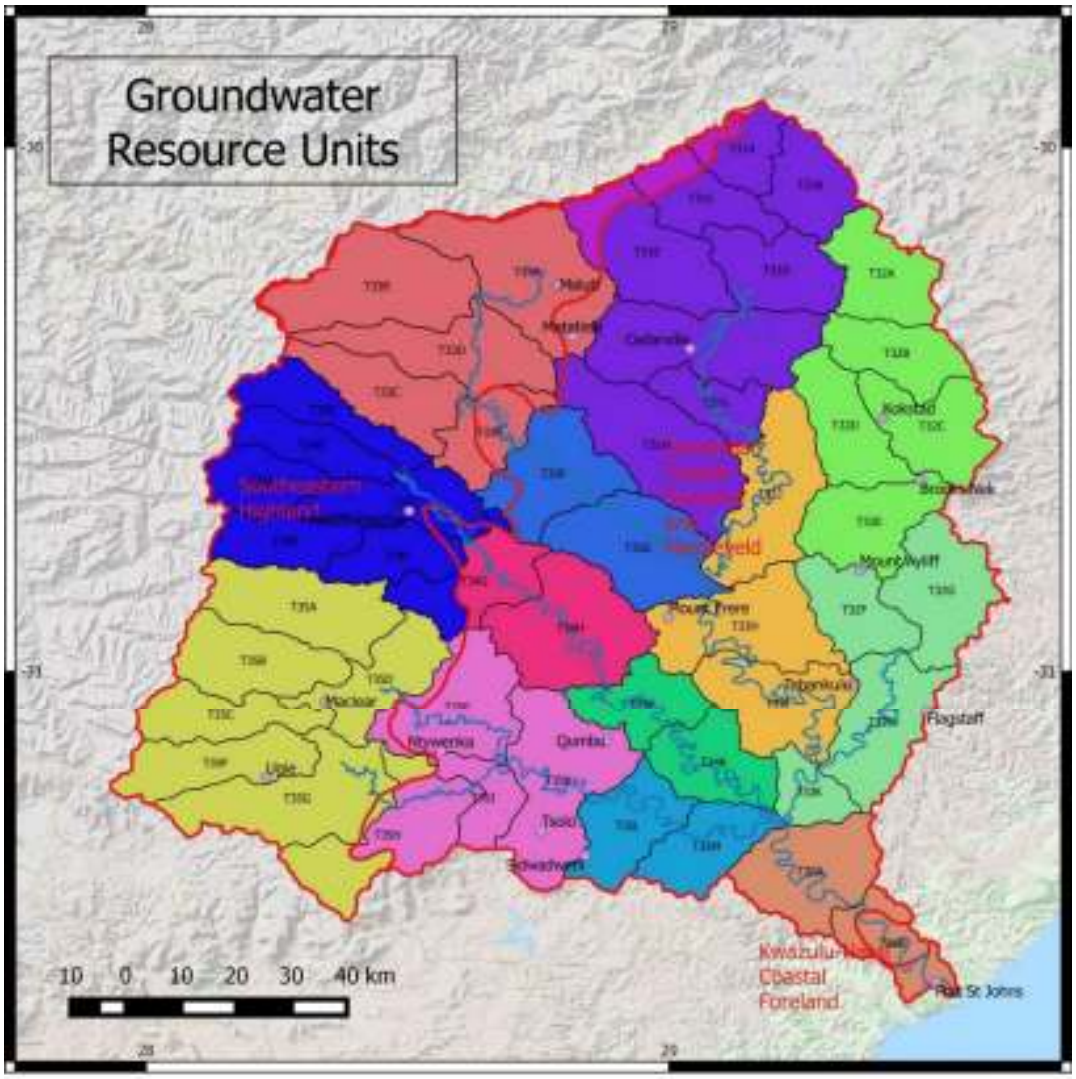
VOLUME C: DELINEATION OF RESOURCE UNITS

If an Ecological Reserve determination is required for a whole catchment, it is necessary to delineate the catchment into Resource Units (RUs). This volume of the report identified river and groundwater RUs for the study area. Note that the Mzimvubu estuary is defined as a single RU.

RUs are each significantly different to warrant their own specification of the Reserve, and the geographic boundaries of each must be clearly delineated, based on a number of factors such as EcoRegion Level II, geomorphological zonation, land cover, system operation, local knowledge and PES for rivers. The rivers where High Priority SQs dominate are the Mzimvubu, Tsitsa, Thina, Inxu, Gatberg and the Mzintlava. EWR sites were selected during the Ntabelanga Dam Feasibility study in the Tsitsa, Thina and Kinira rivers. As future developments and potential future scenarios are part of the reasoning for the selection of the Mzimvubu, Tsitsa and Thina Rivers, Management RUs were delineated for these rivers. Existing EWR sites were selected on the Tsitsa and Thina Rivers. No EWR site existed on the Lower Mzimvubu which is high priority and will be impacted on by the proposed developments. Therefore, an additional EWR site was selected on the Lower Mzimvubu. Historical EWRs exist on the Inxu and Gatberg rivers and will be used as is.

IUAs are homogenous catchments or linear river reaches that can be managed as an entity. IUAs normally represent a catchment or a linear section of river and therefore can differ from RUs which are always linear. Furthermore, an IUA can consist of many different ecological types of rivers (as this does not play a role in IUA selection). IUAs are therefore NOT the same or similar to RUs which are linear stretches of river that each are significantly different to warrant their own specification of the Reserve (DWAF, 1999, Volume 3). RUs are therefore nested within IUAs. The final map of IUAs will also show delineated RUs and their associated PES.

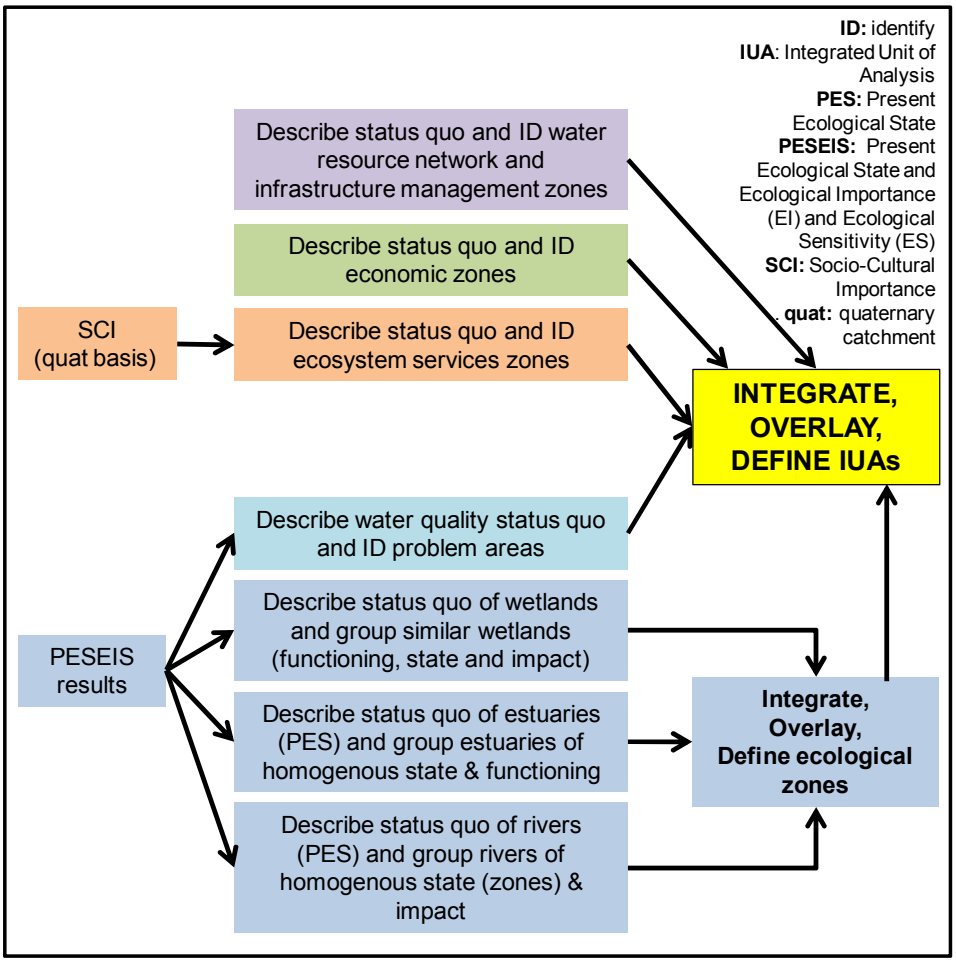
The objective of Groundwater Resource Unit (GRU) delineation is to group areas of similar geohydrological properties. Areas of similar character are grouped and mapped into distinct units, termed GRUs based on quaternary catchment boundaries, aquifer type, and other physical, management and/or functional criteria. GRUs are shown below.

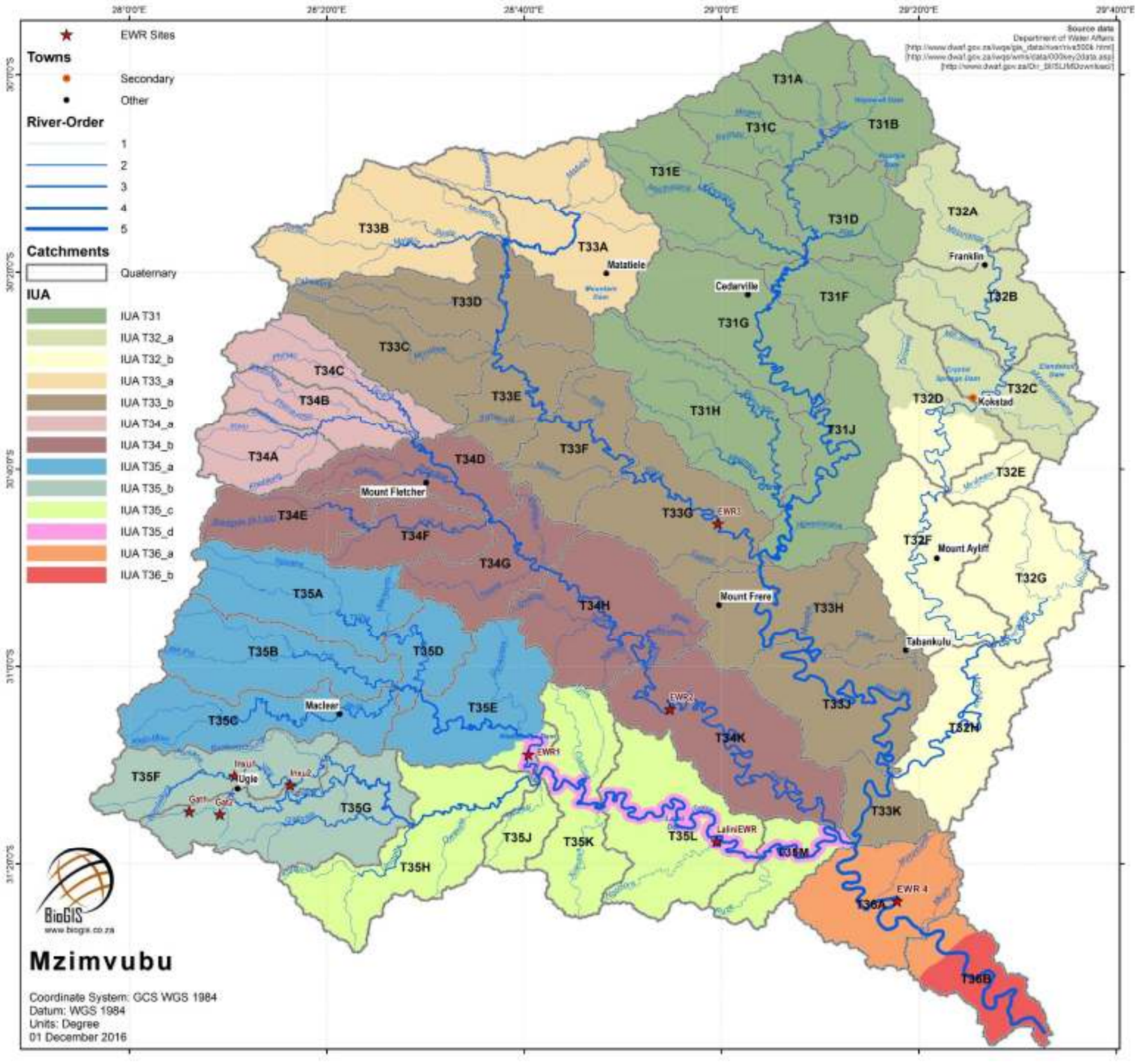


VOLUME D: DELINEATION OF INTEGRATED UNITS OF ANALYSIS AND STATUS QUO

The objective of defining IUAs is to establish broader-scale units for assessing the socio-economic implications of different catchment configuration scenarios and to report on ecological conditions at a SQ scale under these scenarios. Zones were established for water resource use, economics, ecosystem services and ecology. All of these zones are based on the concept of identifying areas that are similar in terms of these specific components, have similar land use (and resulting impacts), and can be managed as a logical entity. Overlaying these zones leads to the identification of IUAs that have similar components and can be managed as an entity, and are thus a logical unit for which scenarios can be designed and evaluated. The process of IUA delineation is

summarised in the flow diagram below, with the results of the delineation also shown. The status quo for all the different components is also described for each IUA in the report.





IUA delineation

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AsgiSA-EC	Accelerated and Shared Growth Initiative for South Africa-Eastern Cape
CSA	Conservation South Africa
CERN	Consortium for Estuarine Research and Management
DSS	Decision Support System
DEAT	Department of Environmental Affairs and Tourism
DWA	Department Water Affairs (name change from DWAF after April 2009)
DWAF	Department Water Affairs and Forestry
D:RQIS	Directorate: Resource Quality and Information Services
DM	District Municipality
DWS	Department of Water and Sanitation (name change from DWA after May 2014)
EC	Ecological Category
EGSA	Ecological Goods and Services Attributes
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
ES	Ecological Sensitivity
EWR	Ecological Water Requirements
ER	Economic Region
ERS	Environmental and Rural Solutions
FEPA	Freshwater Ecosystem Priority Area
GIS	Geographic Information System
GDP	Gross Domestic Product
GRU	Groundwater Response Unit
ha	hectares
HGM	Hydrogeomorphic
IEI	Integrated Environmental Importance
IIS	Integrated Importance and Sensitivity
IUA	Integrated Unit of Analysis
IS	Importance Score
ISP	Internal Strategic Perspective
IAP	Invasive Alien Plant
KZN	KwaZulu-Natal
LM	Local Municipality
MC	Management Class
MM	Metropolitan Municipality
MEA	Millennium Ecosystem Assessment
MMTS	Mooi-uMngeni Transfer Scheme
MRU	Management Resource Unit
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Area
NRU	Natural Resource Unit
NWRCS	National Water Resource Classification System
PES	Present Ecological State
PESEIS	Present Ecological State Ecological Importance and Sensitivity
PSP	Professional Service Provider
Quat	Quaternary catchment
REC	Recommended Ecological Category
RDM	Reserve Determination Methods

RQO	Resource Quality Objectives
RU	Resource Unit
SCI	Socio-Cultural Importance
SANBI	South African National Biodiversity Institute
SQ	Sub-Quaternary
TTG	Technical Task Group
WWTW	Waste Water Treatment Works
WR2012	Water Resources of South Africa 2012
WMA	Water Management Area
WRCS	Water Resource Classification System
WRUI	Water Resource Use Importance
WRYM	Water Resource Yield Model
WTP	Water Treatment Plant

GLOSSARY

Aquifer	An aquifer is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a well or borehole.
Biophysical Node	A point in the river which can be a survey site or a hypothetical point ("site"). Survey sites are EWR sites or Key Biophysical Nodes. Hypothetical points are Desktop Biophysical Nodes.
EcoClassification	EcoClassification (or the Ecological Classification process) refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various physical attributes of rivers relative to the natural reference condition. A range of models are used during EcoClassification, each of which relate to the indicators assessed.
Ecological Importance and Sensitivity (EIS)	Key indicators in the ecological classification of water resources. Ecological importance relates to the presence, representativeness and diversity of species of biota and habitat. Ecological sensitivity relates to the vulnerability of the habitat and biota to modifications that may occur in flows, water levels and physico-chemical conditions.
Ecological Water Requirements (EWR)	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.
Economic analysis	The economic analysis consists of the status quo of the current economic activities as well as the situational analysis of the current prevailing socio-economic position.
EcoRegions	Ecological regions (or EcoRegions) are regions within which there is relative similarity in the mosaic of ecosystems and ecosystem components (biotic and abiotic, aquatic and terrestrial). EcoRegion classification is a hierarchical procedure that involves the delineation of EcoRegions with a progressive increase in detail at each higher level of the hierarchy, i.e. essentially the same characteristics are used at the various levels but with more detail as one moves to a higher level in the hierarchy.
EcoStatus	EcoStatus is defined as the totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and is capacity to provide a variety of goods and services.
Ecosystem services	Ecosystem services are a product that emerges from processes or features within largely natural environments, that enhances human wellbeing and is directly used by people.
Estuarine Functional Zone (EFZ)	The EFZ is that area around the estuary that encapsulates not only the estuary water body but also supporting physical and biological processes and habitats necessary for that estuarine function and health. It therefore includes the open water area, estuarine habitat (sand and mudflats, rock and plant communities), and floodplain area.
EWR sites	Specific points on the river as determined through the 'hotspot' and site selection process. An EWR site consists of a length of river which may

	consist of various cross-sections assessed for both hydraulic and ecological purposes. These sites provide sufficient indicators to assess environmental flows and assess the condition of biophysical components (drivers such as hydrology, geomorphology and physico-chemical conditions) and biological responses (*viz*. fish, macroinvertebrates and riparian vegetation).
Groundwater Resource Units (GRUs)	GRUs are areas of similar geohydrological properties or distinct units based on quaternary catchment boundaries, aquifer type, and other physical, management and/or functional criteria.
HydroGeomorphic (HGM) unit	A single reach, segment or unit of a particular HGM wetland type.
Integrated Unit of Analysis (IUAs)	An IUA is a homogeneous area that can be managed as an entity. It is the basic unit of assessment for the Classification of water resources, and is defined by areas that can be managed together in terms of water resource operations, quality, socio-economics and ecosystem services.
Management Resource Units (MRUs)	Resource Units can be further delineated into homogenous river reaches from a biophysical basis under present circumstances. These delineations are referred to as Management Resource Units.
Present Ecological State (PES)	The current state or condition of a water resource in terms of its biophysical components (drivers) such as hydrology, geomorphology and water quality and biological responses *viz*. fish, invertebrates, riparian vegetation). The degree to which ecological conditions of an area have been modified from natural (reference) conditions.
Recommended Ecological Category (REC)	The Recommended Ecological Category is the future ecological state (Ecological Categories A to D) that can be recommended for a resource unit depending on the EIS and PES. The REC is determined based on ecological criteria and considers the EIS, the restoration potential of the system and attainability thereof.
Resource Quality Objectives (RQOs)	The RQOs for a water resource are a numerical or descriptive (narrative) statement of the conditions which should be met in the receiving water resource, in terms of resource quality, in order to ensure that the water resource is protected. They might describe, amongst others, the quantity, pattern and timing of instream flow; water quality; the character and condition of riparian habitat, and the characteristics and condition of the aquatic biota.
Resource Units (RUs)	RUs are delineated during an Ecological Reserve determination study, as each will warrant its own specification of the Reserve, and the geographic boundaries of each must be clearly delineated. These sections of a river frequently have different natural flow patterns, react differently to stress according to their sensitivity, and require individual specifications of the Reserve appropriate for that reach. RUs are nested within IUAs and may contain an Ecological Water Requirement site.
Sub-Quaternary (SQ) catchments	A finer subdivision of the quaternary catchments (the catchment areas of tributaries of main stem rivers in quaternary catchments), to a Sub-Quaternary or quinary level.

Water Resource Classification System (WRCS)	The Water Resource Classification System is a defined set of guidelines and procedures for determining the different classes of water resources (South African National Water Act (Act 36 of 1998) Chapter 3, Part 1, Section 2(a)). The outcome of the Classification Process will be the setting of the class, Reserve and Resource Quality Objectives by the Minister or delegated authority for every significant water resource (river, estuary, wetland and aquifer) under consideration. This class, which will range from Minimally used to Heavily used, essentially describes the desired condition of the resource, and concomitantly, the degree to which it can be utilised.
Wetland	Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (National Water Act (NWA), Act No. 36 of 1998).

1 INTRODUCTION

1.1 BACKGROUND

The Mzimvubu catchment has been prioritised for implementation of the Water Resource Classification System (WRCS) in order to determine appropriate Water Resource Classes (WRC) and Resource Quality Objectives (RQOs) in order to facilitate the sustainable use of water resources without impacting negatively on their ecological integrity. These activities will guide the management of the T3 Mzimvubu primary catchment toward meeting the departmental objectives of maintaining, and if possible, improving the present state of the Mzimvubu River and its four main tributaries, namely the Tsitsa, Thina, Kinira and Mzintlava. This project is driven by threatened ecosystem services in the Mzimvubu catchment, due to the variety of inappropriate land uses and alien plant infestation that result in extensive erosion and degradation. Degradation can be observed in soil erosion, damage to infrastructure, water supply shortages and loss of grazing.

The Department of Water and Sanitation (DWS) has initiated a study to determine Classes and associated RQOs for the Mzimvubu catchment in Water Management Area (WMA) 7.

The main aims of the project, as defined by the Terms of Reference (ToR), are to undertake the following:

- Coordinate the implementation of the WRCS as required in Regulation 810 in Government Gazette 33541 dated 17 September 2010, by classifying all significant water resources in the Mzimvubu catchment, and
- determine RQOs using the DWS's procedures to determine and implement RQOs for the defined classes.

An additional aim is to consolidate and undertake additional work as required to improve the work previously done on Ecological Water Requirements (EWR) and the Basic Human Needs Reserve (BHNR) for the purposes of Classification.

1.2 STUDY AREA OVERVIEW

The study area is represented by the Mzimvubu catchment which consists of the main Mzimvubu River, the Tsitsa, Thina, Kinira and Mzintlava main tributaries and the estuary at Port St Johns. The river reaches sizeable proportions after the confluence of these four tributaries in the Lower Mzimvubu area, approximately 120 km from its source, where the impressive Tsitsa Falls can be found near Shawbury Mission. The Mzimvubu catchment and river system lies along the northern boundary of the Eastern Cape and extends for over 200 km from its source in the Maloti-Drakensberg watershed on the Lesotho escarpment to the estuary at Port St Johns. The catchment is in Primary T, comprises of T31–36 and stretches from the Mzimkhulu River on the north-eastern side to the Mbashe and Mthatha river catchments in the south. The Mzimvubu river catchment is found in WMA7, i.e. the Mzimvubu to Tsitsikamma WMA.

1.3 MZIMVUBU CLASSIFICATION/RQO STUDY PROJECT PLAN

The study will be run according to the following Project Plan for Classification and RQO studies, which is based on the gazetted and guideline steps for Classification and RQO studies – see **Figure 1.1**. This report pertains to Steps 1 and 2.

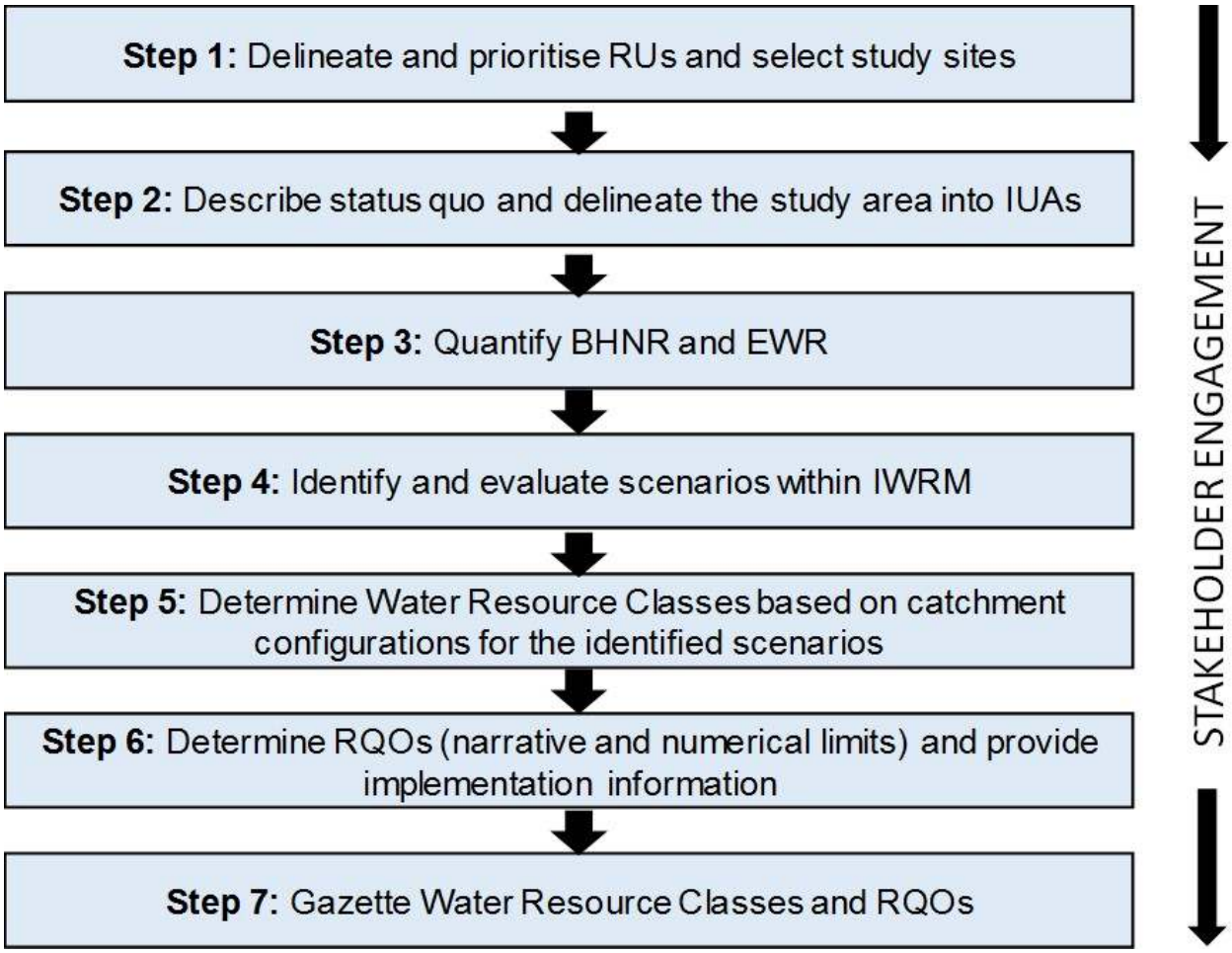


Figure 1.1 Project Plan for the Mzimvubu Classification study

1.4 PURPOSE AND OUTLINE OF THIS REPORT

Due to the volume of information covered in this report, it has been divided into volumes and associated chapters according to defined tasks, as follows:

- Volume A: Preliminary status quo of the area
  - This section covers the preliminary status quo of all study components.
- Volume B: Prioritisation
  - This section evaluates importance and prioritises reaches per component, according to a specific set of factors.
- Volume C: Delineation of Resource Units (RUs)
  - Resource Units are delineated for rivers and groundwater. The Mzimvubu estuary is discussed as a single RU. Wetlands are defined as wetland groups (see **Chapter 6.2** for more information).
- Volume D: Delineation of Integrated Units of Analysis (IUAs) and associated status quo of each IUA
  - The process of delineation is described, the IUAs presented and the status quo finalised.
- References are listed in **Chapter 21** and biophysical nodes presented in **Appendix A**. **Appendix B** is the Comments Report for the document and lists reviewer comments and responses.

VOLUME A: BROAD STATUS QUO DESCRIPTION OF THE STUDY AREA

2 STATUS QUO ASSESSMENT: WATER RESOURCES

2.1 INTRODUCTION

This section deals with the status quo assessment of both the available Decision Support Systems (DSS) for the Mzimvubu catchment.

2.2 APPROACH

2.2.1 Decision Support System

The status quo of the available Decision Support Systems (including the hydrological database used by the DSS) from both past and present studies in the study area were assessed, in order to obtain the most appropriate DSS for conducting the water resource analyses required for this study.

2.2.2 Water resources

The Mzimvubu catchment was divided into water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. Each of the water resources zones was assessed.

2.3 DESCRIPTION OF WATER RESOURCES

The Mzimvubu catchment which consists of the main Mzimvubu River, the Tsitsa, Thina, Kinira and Mzintlava main tributaries and the estuary at Port St Johns. The river reaches sizeable proportions after the confluence of these four tributaries in the Lower Mzimvubu area, approximately 120 km from its source.

The Mzimvubu catchment and river system lies along the northern boundary of the Eastern Cape and extends for over 200 km from its source in the Maloti-Drakensberg watershed on the Lesotho escarpment to the estuary at Port St Johns. The catchment is in Primary T, comprises of T31–36 and stretches from the Mzimkhulu River on the north-eastern side to the Mbashe and Mthatha river catchments in the south. The Mzimvubu river catchment is found in WMA7, i.e. the Mzimvubu to Tsitsikamma WMA.

No major instream dams occur along the main rivers, with the only dams of any significant size being the dams of Belford (on the Mafube River north of Matatiele) and Ntenetyana (on a small tributary of the Kinira north of Mount Frere). Some remnant catchment dams exist in the Ongeluksnek valley and on the commercial farms in the Cedarville flats margins, but this is not a common practice in traditional farming systems.

2.4 STATUS QUO ASSESSMENT

2.4.1 Decision Support System

A review of the various past and current studies in the study area was conducted in order to confirm the availability and status of both the hydrology and water resource models available.

The DWS Water Resources Yield Model (WRYM) was configured for the entire Mzimvubu catchment by the AsgiSA-EC (Accelerated and Shared Growth Initiative for South Africa-Eastern Cape) Mzimvubu Development Project, which was conducted prior to the feasibility study. The study made use of the WR2005 hydrology.

The WRYM model and hydrological data was updated in the recent DWS Feasibility Study for the Mzimvubu Water Project, and the confidence of the WRYM and hydrological data was improved through a detailed hydrological assessment including rainfall analysis, rainfall-runoff modelling and stochastic streamflow analysis of both the Kinira and Tsitsa rivers.

This latest WRYM configuration will be used for the Kinira and Tsitsa river catchments and will be integrated with the AsgiSA-EC Mzimvubu Development Project WRYM configuration (WR2005 hydrology) for the remaining portion of the Mzimvubu catchment.

Further updates from the OR Tambo District Municipality (DM) on the proposed Mzimvubu–Ntsonyini Off-Channel Storage Dam (Ntsonyini Ngqongweni Regional Water Supply Scheme Phase 2 and 3) investigation on the Kuzeke River (small tributary of the Mzimvubu River) will also be incorporated.

2.4.2 Water resources

The Mzimvubu catchment was divided into six water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. The significant resources of the proposed water resource zones are summarised in **Table 2.1**.

Table 2.1 Mzimvubu catchment water resource zones

Catchments	Water resource zone	Major impoundments	Quaternary catchments
Upper Mzimvubu	M-1	None	T31A – T31H
Mzintlava	M-2	None	T32A – T32H
Kinira	M-3	None	T33A – T33K
Thina	M-4	None	T34A – T34K
Tsitsa	M-5	None	T35A – T35M
Lower Mzimvubu	M-6	None	T36A & T36B

UM1 – Upper Mzimvubu Zone (T31A – T31B)

The Upper Mzimvubu Zone includes quaternaries T31A – T31B. There are no major dams in this zone and smaller dams include the following:

- Hopewell (T31B)
- Poortjie (T31B)
- Bon Accord (T31F)
- Mountain Lake: Supplies water to Matatiele (T31H)

The land use in this sub-catchment includes moderate to intense agriculture (dryland cultivation as well as irrigation) and some subsistence farming. There are numerous minor instream and off-channel farm dams located in the zone, particularly in T31 B, D, E and F as presented in **Table 2.2**. Cedarville Town is located in T31F which has a population of 4 412 people (Census 2011).

Table 2.2 Existing minor farm dams in the UM1 – Upper Mzimvubu Zone (DWA, 2009)

Quaternary	Number of dams	Capacity (million m^3)	Surface area (km^2)
T31A	5	0.09	0.031
T31B	106	10	3.333
T31C	25	0.86	0.285
T31D	41	2.92	0.975
T31E	37	1.04	0.346
T31F	49	3.65	1.218
T31G	19	0.37	0.122
T31J	47	0.98	0.328

The total registered groundwater abstraction and groundwater harvest potential for the zone is presented in **Table 2.3**. The registered groundwater abstraction is very low and it is suspected that unregistered groundwater abstractions are taking place in the area. More detailed groundwater information is presented at a quaternary level in **Chapter 17**.

Table 2.3 Groundwater harvest potential and registered abstractions

Zone	Harvest potential (million m^3/a)	Abstraction (million m^3/a)
T31A-T31J	58.391	1.860

UM2 – Mzintlava Zone (T32A – T32H)

The Mzintlava Zone includes quaternaries T32A – T32H. There are no major dams in this zone and smaller dams include the following:

- Crystal Springs: Supplies water to Kokstad (T32C)
- Elandskuil (T32C)

The land use of the upper portion of this zone (T32A–D) includes moderate to intense agriculture (dryland cultivation as well as irrigation), with numerous minor instream and off-channel farm dams located in the zone as presented in **Table 2.4**. Return flows from the Kokstad Waste Water Treatment Works (WWTW) enter the river system in T32D. The lower portion of the zone (T32E – T32H) is characterised by rural villages and dryland subsistence farming. Erosion and sedimentation is prominent as a result of poor land use practices in the zone.

The following towns/villages are located in the zone:

- Franklin, T32A (Census 2011 population: 2 018)
- Kokstad, T32C/D (Census 2011 population: 51 561)
- Flagstaff, T32H (Census 2011 population: 4 821)
- Mount Ayliff (Census 2011 population: 5 367)
- Various rural villages, T32E

Table 2.4 Existing minor farm dams in the UM1 – Mzintlava Zone (DWA, 2009)

Quaternary	Number of dams	Capacity (million m^3)	Surface area (km^2)
T32A	109	3.34	1.113
T32B	39	1.24	0.414
T32C	28	0.72	0.529
T32D	41	1.53	0.509

The total registered groundwater abstraction and groundwater harvest potential for the zone is presented in **Table 2.5**. The registered groundwater abstraction is very low and it is suspected that unregistered groundwater abstractions are taking place in the area. More detailed groundwater information is presented at a quaternary level in **Chapter 17**.

Table 2.5 Groundwater harvest potential and registered abstractions

Zone	Harvest potential (million m^3/a)	Abstraction (million m^3/a)
T32A-T32H	40.527	0.827

UM3 – Kinira Zone (T33A – T33K)

The Kinira Zone includes quaternaries T33A – T33K. There are no major dams in this zone and smaller dams include the following:

- Mountain Dam: Supplies water to Matatiele (T33A)
- Belfort Dam: Supplies water to the Maluti Scheme (T33A)
- Ntentyana Dam: Supplies water to the Kwa Bacha Scheme (T33G)
- Forest Dam: Supplies water to Tabankulu (T33H)

The land use in the zone is characterised by dryland cultivation, grazing, rural villages as well as the Matatiele town. There are a small number of minor farm dams located in the zone as presented in **Table 2.6**. Return flows from the Matatiele WWTW enter the river system in T33A. High levels of erosion and sedimentation are prominent throughout the zone as a result of poor land use practices in the lower portion of the zone.

The following towns/villages are located in the zone:

- Maluti, T33A (Census 2011 population: 7 223)
- Matatiele, T33A (Census 2011 population: 12 466)
- Mount Frere, T33K (Census 2011 population: 5 252)
- Tabankulu, T33H (Census 2011 population: 3 266)
- Various smaller rural villages

Table 2.6 Existing minor farm dams in the UM3 – Kinira Zone (DWA, 2009)

Quaternary	Number of dams	Capacity (million m^3)	Surface area (km^2)
T33H	11	0.01	0.003
T33J	1	0.01	0.004

The total registered groundwater abstraction and groundwater harvest potential for the zone is presented in **Table 2.7**. There are no registered groundwater abstractions and it is suspected that

unregistered groundwater abstractions are taking place in the area. More detailed groundwater information is presented at a quaternary level in **Chapter 17**.

Table 2.7 Groundwater harvest potential and registered abstractions

Zone	Harvest potential (million m^3/a)	Abstraction (million m^3/a)
T33A-T33K	68.259	0.000

UM4 – Thina Zone (T34A – T34K)

The Thina Zone includes quaternaries T34A – T34K. There are no major dams in this zone but the smaller Mount Fletcher Dam, which supplies water to the Mount Fletcher town is located in T34C.

The land use in the zone is characterised by moderate and extensive dryland cultivation, some grazing, a few plantations, numerous rural villages as well as the Mount Fletcher town in T34D (Census 2011 population: 11 488). There are a small number of minor farm dams located in the zone as presented in **Table 2.8**. Return flows from the Mount Fletcher WWTW enter the river system in T34D. High levels of erosion and sedimentation are prominent throughout the zone as a result of poor land use practices in the lower portion of the zone.

Table 2.8 Existing minor farm dams in the UM4 – Thina Zone (DWA, 2009)

Quaternary	Number of dams	Capacity (million m^3)	Surface area (km^2)
T34H	4	0.02	0.008
T34J	16	0.08	0.031

The total registered groundwater abstraction and groundwater harvest potential for the zone is presented in **Table 2.9**. There are no registered groundwater abstractions and it suspected that unregistered groundwater abstractions are taking place in the area. More detailed groundwater information is presented at a quaternary level in **Section 19**.

Table 2.9 Groundwater harvest potential and registered abstractions

Zone	Harvest potential (million m^3/a)	Abstraction (million m^3/a)
T34A-T34K	56.299	0.000

UM5 – Tsitsa Zone (T35A – T35M)

The Tsitsa Zone includes quaternaries T35A – T35M. There are no major dams and smaller dams include the following:

- Ugie Dam: Supplies water to Ugie (T35F)
- Maclear Dam: Supplies water to Maclear (T35D)
- Nquadu Dam: Supplies water to the Sidwadeni Scheme (T35K)

The land use in the zone is characterised by commercial farming operations, forestry and urban centres such as Maclear in T35D (Census 2011 population: 10 521) and Ugie in T35F (Census 2011 population: 13 467) in the upper portion of the zone. Return flows from the Maclear and Ugie WWTW enter the river systems in T35D and T34F respectively. The land use in the lower portion of the zone include some forestry plantations, cultivation, grazing, the towns of Tsolo in T35K

(Census 2011 population: 7 7964) and Qumba in T35K (Census 2011 population: 4 928) as well as numerous rural villages. Return flows from the Tsolo WWTW enter the river system in T35K. High levels of erosion and sedimentation are prominent throughout the zone as a result of poor land use practices in the lower portion of the zone.

There are a small number of minor farm dams located in the zone, especially in T35D, T35G, T35H and T35K as presented in **Table 2.10**.

Table 2.10 Existing minor farm dams in the UM5 – Tsitsa Zone (DWA, 2009)

Quaternary	Number of dams	Capacity (million m^3)	Surface area (km^2)
T35B	8	0.28	0.092
T35C	5	0.13	0.043
T35D	58	0.62	0.208
T35E	8	0.29	0.095
T35F	13	0.43	0.144
T35G	139	3.8	1.268
T35H	25	0.62	0.249
T35J	9	0.11	0.044
T35K	68	0.71	0.285
T35L	13	0.14	0.057

The proposed Ntabelanga and Lalini Dam sites located on the Tsitsa River in T35E and T35L are for water supply to regional settlements, proposed irrigation schemes and hydropower generation and will impact on the downstream water resources.

The total registered groundwater abstraction and groundwater harvest potential for the zone is presented in **Table 2.11**. There are very few registered groundwater abstractions and it is suspected that unregistered groundwater abstractions are taking place in the area. More detailed groundwater information is presented at a quaternary level in **Chapter 17**.

Table 2.11 Groundwater harvest potential and registered abstractions

Zone	Harvest potential (million m^3/a)	Abstraction (million m^3/a)
T35A-T35M	114.934	0.001

UM6 – Lower Mzimvubu Zone (T36A and T36B)

The Lower Mzimvubu Zone includes quaternaries T36A and T36B. There are no major dams in this zone but the smaller Majola Dam that supplies water for irrigation is located in T36B. There are no further minor farm dams in this zone.

The land use in the zone is characterised by some cultivation, some forestry plantations, rural villages and Port St Johns town is partly located in T36B (Census 2011 population: 6 441). High sediment loads occur in the river as a result of upstream erosion and sedimentation.

The proposed Ntabelanga and Lalini Dam sites located upstream on the Tsitsa River will impact on this zones water resources. The Port St Johns estuary is located at the outlet of T36B.

The total registered groundwater abstraction and groundwater harvest potential for the zone is presented in **Table 2.12**. There are no registered groundwater abstractions and it is suspected that unregistered groundwater abstractions are taking place in the area. More detailed groundwater information is presented at a quaternary level in **Chapter 17**.

Table 2.12 Groundwater harvest potential and registered abstractions

Zone	Harvest potential (million m^3/a)	Abstraction (million m^3/a)
T36A-T36B	10.180	0.000

3 STATUS QUO ASSESSMENT: ECONOMICS

3.1 INTRODUCTION

The economic analysis consists of the status quo of the current economic activities as well as the situational analysis of the current prevailing social economic position in the Mzimvubu catchment (T3), concerning the large water users such as irrigation agriculture, commercial forestry, sawmills, laminated board factory as well as the other dependents. Although the tourism sector is neither an indirect nor a large water user, it is often included in the analyses as the value of water to the sector in its natural environment lies in the attraction that the water and environment has for the tourist and this affects the sustainability of the industry. However, in this catchment it is so small that no acceptable values could be sourced and it was therefore not included.

The catchment is divided into geographical areas which take into consideration water resource uses, economics, ecological goods and services, ecology, and other topographic issues. These units are based on the concept of identifying areas that are similar in terms of specific components, have similar land use (and resulting impacts), and can be managed as a logical entity. For the delineation of the IUAs and status quo see **Volume D** of this report. The economic value of water use for each of the units is determined.

The IUAs then provide a tool to create an appropriate economic baseline against which to measure the possible impact of changes in water availability by means of possible identified scenarios. Thereby the macro-economic impact of any possible water reduction on the individual producers, the community and the economy in the Mzimvubu catchment can be determined.

3.2 APPROACH

The important factor in the economic *status quo* is the dependence of some of the major secondary industries in the Mzimvubu catchment (T3) on the primary production sector:

- Crop production
- Commercial forestry
    - Sawmills
    - Laminated board factory.

The economic development in the catchment is rather skewed. The main commercial activities are currently restricted to the following sub-catchments:

- T31 – The main stream of the Upper Mzimvubu has a very large commercial farming area, small commercial forestry and the two towns of Matatiele and Cedarville. The north-eastern part of the quaternary catchment is located within the KwaZulu-Natal (KZN) province and the rest in the Eastern Cape.
- T32 – The Mzintlava River with Kokstad as the commercial hub has a large commercial-based farming community.
- The eastern parts of T35 accommodate over 45 000 hectares of commercial forestry with the towns of Maclear and Ugie. In some of the afforestation areas commercial farming is still active. In the lower parts of the Tsitsa River are the identified sites of the Ntabelanga and Lalini dams together with the planned irrigation and hydro-power generation to be established in the sub-catchment.

The rest of the catchment is still very rural with subsistence farming, with a number of villages and towns acting as commercial, education and health service centres. The fact that the catchment

extends over two provincial management areas results in Kokstad in the Greater Kokstad municipal centre housing KZN provincial government regional offices, and Mount Ayliff as the local Mzimvubu municipal centre also housing Eastern Cape provincial government units.

Once the water use per sector data are available, a group of economic multipliers will be developed for comparing different water use scenarios in terms of Gross Domestic Product (GDP/m^3), employment creation (number/million m^3) and the low-income households.

3.3 DESCRIPTION OF ECONOMIC ACTIVITIES IN THE CATCHMENT

3.3.1 Land use

The economic significance of water uses in the Mzimvubu catchment is dominated by primary sectors such as irrigated agriculture and commercial forestry, subsequently by secondary industries in particular sawmills, as well as pulp and laminated board factories.

The Mzimvubu catchment has distinct socio-economic characteristics. The catchment covers the important economic hubs of Matatiele/Cedarville, Maclear/Ugie (Eastern Cape Province) and Kokstad (KZN Province) which together represent more than 80% of the industrial and commercial output of the Mzimvubu catchment.

It is a very diverse catchment hosting intensive commercial maize and dairy production areas in the north-eastern regions in the area of Cedarville and Kokstad, and commercial forestry with accompanying sawmills in the south-western regions of Maclear and Ugie. A large variety of other agricultural products are produced including maize, vegetables, beef, dairy and mutton. Most irrigators along the Tswereka and Mzimvubu rivers and along the Droewig and Mzintlava rivers down to Mount Ayliff, utilise centre pivots. However it must be stated that centre pivots are not the only irrigation systems used. Alternatives include hosepipe systems and in a few cases flood systems. Commercial forestry is found in the sub-catchments T35D (along the Tsitsa River) and T35G (along the Inxu River). Limited commercial forestry is also found between Mount Ayliff and Tabankulu on the eastern boundary of the catchment.

The proposed construction of the Ntabelanga and Lalini dams in the lower Tsitsa River main stream will add the irrigated area south of Qumbu to the commercial crop-producing land of the catchment. Also, the planned hydro-electricity generation at the Tsitsa Falls will add economic value to the area. The rest of the catchment area consists of subsistence farming with dryland crops and cattle grazing. A mayor domestic water supply system also forms part of the scheme to outlying areas.

This area also includes some past popular tourist and holiday areas varying from the coastal holiday town of Port St Johns and a few inland game parks. The major inland towns within the catchment area are Matatiele, Cedarville, Kokstad, Maclear and Ugie with the only coastal holiday town being Port St Johns.

Although the Mzimvubu catchment (T3) is, in terms of the Eastern Cape region, an important component, the sub-catchments all make an important contribution to the catchment economy.

- T31 includes Cedarville as the farm input supply hub of the area. This sub-catchment is a very important irrigation area and is complemented by some dryland farming. Geographically this sub-catchment is located in the Matatiele Local Municipality (LM) area of the Eastern

Cape. Though Matatiele is located in sub-catchment T33, it is the major commercial centre of T31.

- T32 includes Kokstad, the economic hub of the area and the smaller town Franklin in the north, a wood-loading rail service centre. The sub-catchment is an important irrigation area complemented by dryland farming throughout the area. Geographically the area is located in the Greater Kokstad LM area in KZN. It also includes the service centres of Mount Ayliff and Flagstaff which is in the Eastern Cape Province.
- T33 includes the Kinira River and several tributaries up to the confluence of the Kinira and Morulane rivers with the Mzimvubu River. Matatiele is the economic hub of the area. The area is mountainous with limited dryland farming and is mainly a cattle grazing area with subsistence farming. The area is located in the western area of the Matatiele LM and northern area of the Elundini LM (T33), all in the Eastern Cape Province. The area was transferred to the Transkei in 1976 and a number of irrigation schemes were established. Presently all schemes are abandoned and the area is used for grazing.
- T34 includes the upper Thina River with tributaries to the confluence of the Thina and Tinana rivers. Mount Fletcher is the only urban service centre in the sub-catchment. The area is mountainous with very limited dryland farming and is mainly a cattle and grazing area with subsistence farming. Several villages are present in the mountain areas. The sub-catchment is located in the Elundini LM in the Eastern Cape Province.
- T35 includes the Tsitsa River with tributaries from source to the proposed site of the Ntabelanga Dam in the Tsitsa River. The urban service centres of Maclear, Ugie and Tsolo are included in this sub-catchment. The area is mountainous with irrigation to the north east of Maclear and east of Ugie. Extensive commercial forestry occurs in the central and western area of the catchment with dryland farming and irrigation in the eastern part of the sub-catchment along the Tsitsa River. Several villages are present in the mountains, with mainly cattle grazing and subsistence dryland farming. The sub-catchment is located in the Elundini LM in the Eastern Cape Province.
- T36 includes the Mzimvubu catchment downstream of all the tributaries to the estuary and the estuary itself. The sub-catchment is located in the Port St Johns LM in the Eastern Cape.

3.3.2 Socio-economic situational analysis

To have a complete understanding of the Mzimvubu catchment (T3) it is necessary that an analysis be provided of the socio-economic situation. This is also important when assessing the impact of the water-based economic activities and possible impact of identified scenarios at a later stage of the project.

- The Eastern Cape Province is divided into six district municipalities and two metropolitan municipalities. The three district municipalities represented in the catchment area are:
  - Alfred Nzo
  - Joe Gqabi
  - OR Tambo
- The Harry Gwala District Municipality (DM) of the KZN Province is divided into four local municipalities, of which only the Greater Kokstad LM is represented in the Mzimvubu catchment (T3).

The following graph (**Figure 3.1**) provides an analysis of the population distribution in the 10 local municipalities within the catchment. However, some of the local municipalities fall only partially within the catchment.

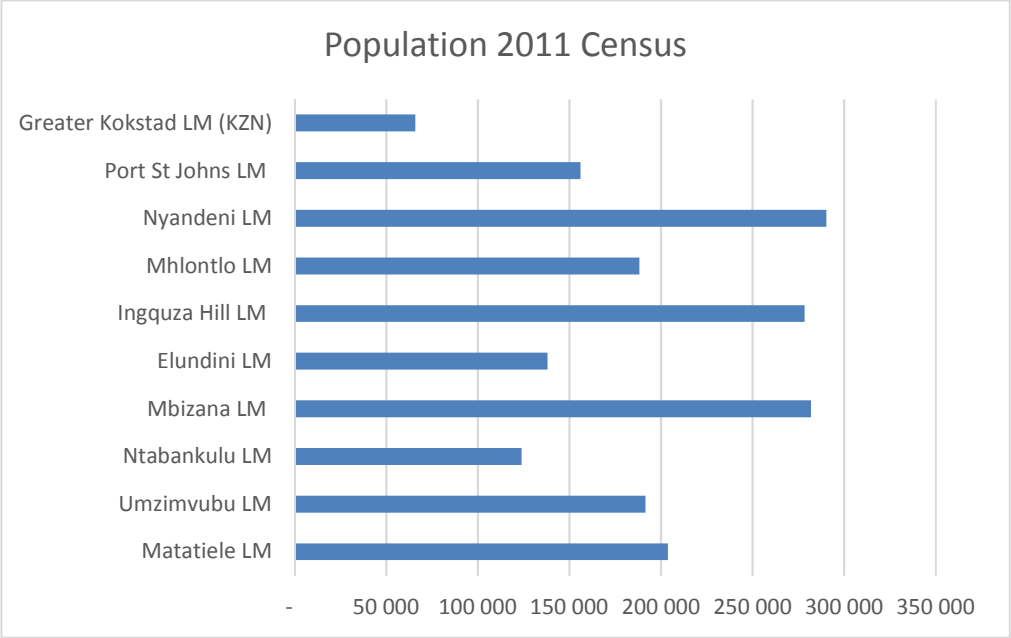


Figure 3.1 Distribution of the population per district municipality in the catchment (T3)[1]

From **Figure 3.1** it appears that about 50% of the population live in the Nyandeni, Ingquza and Mbizana municipal areas. These municipal areas, together with Port St Johns, are only partially located within the catchment area. Out of the total population of 1 918 699 within the local municipal boundaries, approximately 58% are resident within the catchment area.

According to Statistics South Africa[2] the average Eastern Cape Province official provincial unemployment rate for January–March 2016 is around 28.6%, which converts to approximately 357 345 individuals. The expanded unemployment rate, which includes persons not looking for employment although they qualify in terms of age[3], for the same period is 44.5%. Although no exact figures are available it is generally assumed that the unemployment rate in the rural areas is higher than in the urban areas. It must be borne in mind that published demographic and economic statistics are given for local, district municipal and provincial administrative areas.

It is of course primarily the socio-economic features of a province that shape the developmental challenge. In the Eastern Cape, despite the concerted efforts of the provincial government to address the twin challenges of poverty and unemployment in the first two decades of democracy, poverty and unemployment rates have remained chronic and rising. The Eastern Cape remains a predominantly rural province, with dependency ratios and poverty levels highest in the rural areas.

The following table provides an indication of the household sizes and number of female-headed households in the ten district municipality areas falling in the catchment area.

[1] Statistics South Africa (2012).

[2] Statistics South Africa (2016).

[3] SA Reserve Bank. According to the *strict definition* only those people who take active steps to find employment, but fail to do so, are regarded as unemployed. The *expanded definition*, on the other hand, includes everyone who desires employment, irrespective of whether or not they actively tried to obtain a job.

Table 3.1 Number of members per household and female headed households

Local municipality	Average household size	Percentage female-headed households
Alfred Nzo		
Matatiele LM	3.7	55.30%
Umzimvubu LM	3.8	58.70%
Tabankulu LM	4.6	60.40%
Mbizana LM (10%)	5.0	61.70%
Joe Gqabi		
Elundini LM	3.5	52.10%
O.R. Tambo		
Ingquza Hill LM (Old Qaukeni) (25%)	4.7	59.10%
Mhlontlo LM	4.2	56.90%
Nyandeni LM	4.6	57.60%
Port St Johns LM (35%)	4.5	60.10%
Harry Gwala DM (KZN)		
Greater Kokstad LM	3.1	41.60%

Table 3.1 shows that the households with the smallest number of members are found in the Greater Kokstad LM, being an important economic urban centre surrounded by commercial agriculture. The higher household size numbers are in the O.R. Tambo DM and Mbizana LM (of which only about 10% is located within the catchment area). An indication of the poor state of households is the large number headed by females, varying between 41.6% and 61.7% (in the case of Mbizana LM). According to a 2005 estimation, 54% of the population can be classified as poor, with 23% of these below the defined poverty line. In terms of household income, the catchment area compares negatively with the average provincial figure, the catchments average annual household income according to 2011 census is R42 031 compared to the provincial figure of R64 550[4]. According to Section 3 of the 2016 Division of Revenue Act, the provincial division is based on the state old-age pension for two people. According to the latest statistics 59% of households nationally are below that income level. Table W1.19 (page 82) in the Act estimates the number of the households in the Eastern Cape on a household budget below two old-age pensions, are 52%. The number in Mzimvubu region may be even higher, but no official statistics are available to support this opinion.

The above socio-economic realities of the region must be taken into account when evaluating the dependency on water-based economic activities in terms of employment and payments to households, specifically low-income households. This applies for the baseline situation as well as the evaluation of scenarios.

3.3.3 Economic baseline

The economic baseline for the Mzimvubu catchment (T3) is defined as the economic contribution of the available and 'out-of-river-use' of surface water and groundwater to the total economic activities in the region, without any water restrictions. It will therefore necessitate the identification and quantification of the direct economic contribution of each user and then using this to calculate the indirect and induced impacts.

[4] Statistics South Africa (2012).

As an example, the production of wood is directly dependent on the availability of water which has a backward linkage to the suppliers of required commodities, and forward linkages to the sawmill products, some of which are to be used in the manufacturing of various wood products. These in turn have backward linkages.

The land use of the different sectors to be assessed is discussed below.

3.3.4 Physical data

Irrigation area

The irrigation data used were obtained from a number of sources. The total irrigated hectares were sourced from Google Earth images and compared with sourced data such as Water Resources of South Africa 2012 (WR 2012) data. The reason for re-measuring the irrigated areas is the very large discrepancy between the official database and the observed Google Earth images. **Table 3.2** provides an indication of the differences for the sub-catchments T31 to T36.

Table 3.2 Comparison of official data versus Google Earth measurements

Sub-catchment	Official data (ha)	Google Earth measurement (ha)
T31	DWAF (2009) - 4 184 WR 2012 - 1142	6 227
T32	DWAF (2009) – 3 113 WR 2012 - 524	4 919
T33	DWAF (2009) – 706 WR 2012 – 706 DWS (2014f) - 28	0
T34	DWAF (2009) - 72 WR 2012 - 72	0
T35	DWAF (2009) – 1 748 WR 2012 – 1 314 DWS (2014f) – 2 020	1 680 excluding the proposed Ntabelanga Scheme
T36	DWAF (2009) – 700 WR 2012 - 123	648

Regarding the Google Earth images, the surface of the pivots and other irrigation systems shown on the images were measured and the hectares calculated. The latest images were consulted (dated from March 2012 to July 2016). Most of the agriculturally active areas were reflected in images taken during 2016. The earlier images covered areas of low agricultural activities.

The economic contribution was calculated using the Mosaka Economists' internal database (2015 figures) and production budgets updated to 2016 prices.

In **Table 3.3** the total irrigation hectares, as used in the analysis for the Mzimvubu catchment (T3) are presented. The identified irrigation hectares to be irrigated by the proposed Ntabalenga Dam are included in the table. The different crops to be produced were taken from the EIA report (DWS, 2014a). The actual projected physical area is 2 868 hectares, but because of anticipated double cropping, it was increased to 3 015 hectares in the EIA report.

As irrigation agriculture is very dynamic and the crop and product composition differs from year to year, it was necessary to group some of the crops and make assumptions on the utilisation of the irrigated area. The most important crops produced are maize for both harvesting and silage utilisation, clover/rye grass mixtures for grazing, some winter vegetables and a number of apple orchards. The most common products produced from the silage and rye grass grazing is milk and mutton.

In the EIA report, certain areas have been proposed for certain crops for the proposed irrigation from the Ntabelanga Dam. However, because of estimated marketing restrictions, these were amended and some eliminated. An example is the recommendation to produce lettuce on a sizeable scale. Although the product will grow well in the area, no market for the estimated volumes could be identified,.

Table 3.3 Summarised areas under irrigation in the catchment [adapted by Mosaka Economists (2016)]

Sub-catchment	Total irrigated area (ha)
T31	6 228
T32	4 935
T33	28
T34	72
T35	2 020
T36	648
Total	**13 931**

The total of 13 931 excludes the area that will be added once the Ntabalenga dam is constructed and new areas are developed.

Commercial forestry

Different sources show different areas being under commercial plantation in the Mzimvubu catchment (T3), specifically sub-catchment T35, as areas are harvested and replanted (**Table 3.4**).

The wattle plantations appear currently not to be commercially managed and were therefore not included, except in T36.

Table 3.4 Commercial afforestation areas (hectares)

Tree species	T31	T32_a	T33	T34	T35	T36	Total
Pine	90	241	832	2 464	5 035	72	**8 735**
Gum	810	2 169	208	616	39 978	9	**43 790**
Wattle	–	–	–	–	–	9	**9**
Total	**900**	**2 510**	**1 040**	**3 081**	**45 013**	**90**	**52 444**

The following average annual growth per hectare was applied to estimate the production over the total catchment as provided by Mondi[5] sources:

- Pine – 11.15 tons/ha/annum

[5] Mondi would not provide us with the source of the data.

- Gum – 12.91 tons/ha/annum
- Wattle – 10.90 tons/ha/annum

As the current measured weighted growth in younger plantations in T35 could not be accessed, the original projected figures were used as stated above.

Sawmills

During the research it became clear that the sawmills in the catchment differ in size, but more importantly it was very difficult to isolate the region that acted as the source for a specific sawmill, as saw logs are moved from one mill to the other and across boundaries. A theoretical sawmill model per sub-catchment was therefore developed to accommodate the wood produced per specific region. The average growth per hectare per annum was multiplied with the number of hectares per economic region, which was then used as the input for the sawmill model; an average recovery rate was used together with the average mill door price to establish a turnover per region.

PG Bison board plant

In 2008 PG Bison's parent company, Steinhoff, bought a 67% stake in the Ugie and Maclear area plantations from Mondi and constructed a laminated board plant at Ugie. In the original announcement the plan was that the 33 000 bought hectares would supply roughly 1 300 tons of timber per day with the intention that the plant would produce 1 000m^3 particle board per day. The claim was that at full production, 2 700 direct jobs would be created.

Production started in 2008, however, the Steinhoff share was taken over in 2012 by KAP Industrial Holdings and according to the latest 2015 annual report and local data sources, the production is around 600m^3 per day and the total direct employment is around 1 200 at the plant.

A slow-growing economy has contributed to this. It may be necessary to visit the Ugie plant to confirm the data.

4 STATUS QUO ASSESSMENT: WATER QUALITY

4.1 INTRODUCTION

The purpose of this step of the process is to provide a broad overview of water quality status in the study area, relying on available literature and information sources. Information will be updated during the study for other purposes, e.g. input data to assess consequences of scenarios on non-ecological or user water quality, and user water quality input to RQOs. Some of this information will be sourced from stakeholders at the Technical Task Group (TTG) meeting proposed for water quality.

Additional outputs of the status quo and delineation steps are preliminary inputs to the following:

- Identify water quality role players, including non-ecological e.g. irrigation, rural settlements.
- Start identifying driving variables (e.g. elevated phosphate levels) associated with indicator water quality role players and metrics (e.g. nutrients as a driver linked to stock-watering).
- Identify water quality priority areas, which may be:
  - pollution priority areas, i.e. areas of high pollution levels; or
  - priority protection areas, i.e. areas of sensitive water quality or those requiring protection on a water quality basis.

4.2 APPROACH

The approach taken for a *status quo assessment* is to use literature and available information to provide an overview or general picture of water quality status for the study area. Information such as the following is included for use:

- Land use data: Land use data as used for the WMA12 and 15 (now WMA7) component of the national PES/EI/ES (Present Ecological State/Ecological Importance/Ecological Sensitivity; also referred to as PESEIS) project conducted for the DWS and Water Research Commission (DWS, 2014b). The type of data built into the land use data (as at 2012) were as follows:
  - Built-up (formal, informal industrial and rural)
  - Cultivation (dryland and irrigated)
  - Vegetation (plantations within the whole catchment, exotic vegetation within the riparian zone, and exotic aquatic macrophytes)
  - Dams (in-channel and off-channel within the whole catchment)
  - Degradation (overall within the whole catchment, vegetation trampling within the riparian zone)
  - Bridges and roads (low-level bridges and gravel roads within 100m of the riverbank)
  - Flow modification (overall PES-metric and inter-basin transfers)
  - Physico-chemical modification (overall PES-metric rating and meat processing facilities)
  - Mining and sand quarrying (quarrying within 500m of the river and other mining in the catchment)
  - Natural cover (within 500m of the river)
  - Natural areas (protected and informal within the whole catchment)
- A literature review (but not yet data analysis at this stage), using the following types of available data:
  - Reserve data, as received from the DWS Chief Directorate: Water Ecosystems, Surface Water Reserve division

- Outputs [Present Ecological State (PES) maps and Fact Sheets] of the national PES/EI/ES project for Primary catchment T3
- The water quality scores of the Water Resource Use Importance (WRUI) conducted for the Classification study
- Information sources such as reports by organisations such as Environmental and Rural Solutions (ERS) and Conservation South Africa (CSA) (ERS/CSA, 2011)
- Information from the Ntabelanga-Lalini Dam Feasibility Study (DWS, 2014a; c and d) and Environmental Impact Assessment (EIA) (DWS, 2014e)

- Information from DWS's Green Drop programme for municipal wastewater management facilities of the Eastern Cape. The Green Drop programme was introduced as a regulatory tool by the DWS in 2008 to identify and develop the core competencies needed to improve the level of wastewater management in the country. Whilst the Green Drop assessment focuses on the entire value chain (reticulation, pumping, treatment, discharge) of the wastewater business within the municipal (or other) wastewater services business, the Cumulative Risk assessment focuses on the wastewater treatment function specifically. The latter approach allows the Regulator to have insight into the treatment component of the municipal business, which is one of the high risk components within the wastewater value chain. Risk-based regulation allows the municipality to identify and prioritise the critical risk areas within its wastewater treatment process and to take corrective measures to abate these (taken from the Executive Summary to the 2013 DWS Green Drop Report).

  The 2012 Green Drop Report for the Eastern Cape (DWA, 2012) and information as available for subsequent years, was used to assess the level of wastewater management and the potential impact on water resources in the Mzimvubu catchment. The two main outputs from the Green Drop assessment for the 2013 cycle were:
  - A weighted Green Drop score for each municipal system; and
  - A Cumulative Risk Rating for each municipal wastewater treatment works.

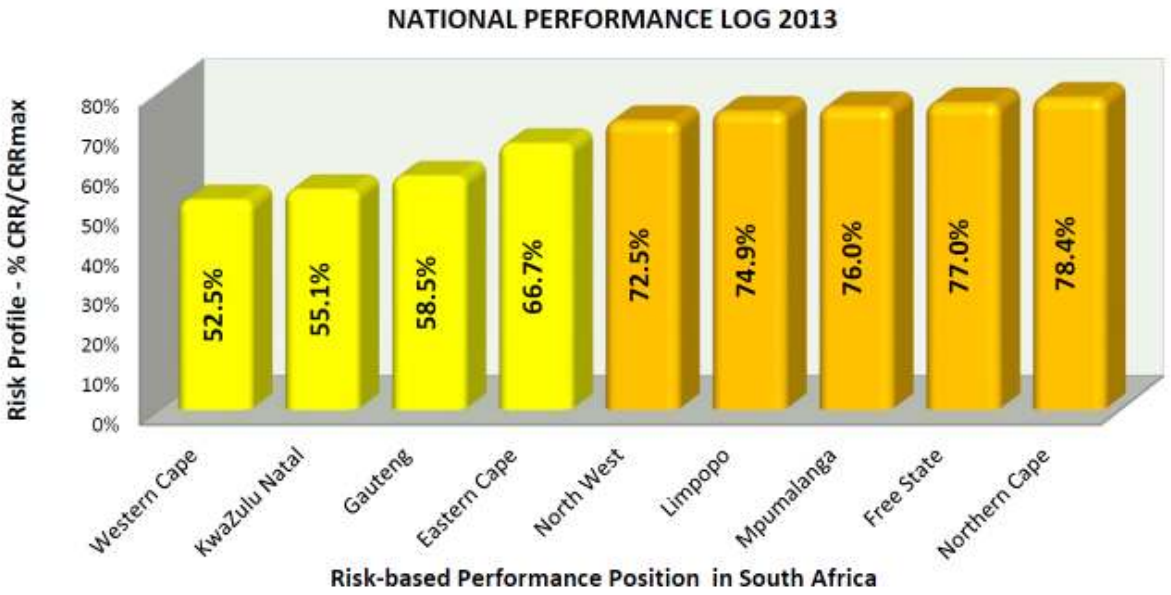
  An explanation for these terms is shown below:

% Deviation = CRR/CRR(max) TREND	
	90 – 100% Critical risk WWTPs
	70 - <90% High Risk WWTPs
	50-<70% Medium risk WWTPs
	<50% Low Risk WWTPs

$\%CRR/CRR_{max}$ = Wastewater Risk Rating

WWTP: Waste Water Treatment Plant; CRR: Cumulative Risk Rating (in terms of potential impact of water resources)

The province-based performance for 2012/2013 is shown below, with the Eastern Cape scored as average performers:



The identification of water quality pollution sites is based on a water quality impact rating (0-5) assigned to problem areas, i.e. from 3 (Large) to Critical (5).

4.3 WATER QUALITY OVERVIEW

Water quality in this WMA is generally good (DWS, 2014e), with little contamination by nutrients and other toxins, probably due to the dispersed nature of the settlements and their sheer size, and very little industry. Economically the Mzimvubu catchment is dominated by primary sectors such as irrigated agriculture and commercial forestry, and subsequently by secondary industries such as sawmills and pulp and laminated board factories. There are localised problems related to urban settlements. The most serious form of pollution or water quality impacts in the WMA are high turbidities due to soil erosion. This has reached very serious proportions in the rivers on the eastern side. The cause of this is primarily oversettlement and poor agricultural and overgrazing practices, which are exacerbated by the steep catchments and severe storms that occur (CMA Business Case, May 2015). The high silt loads are also due to the numerous road crossings and cultivation along river banks and in the wider catchment. The many mountain streams which arise in mountain areas are of very good water quality, and therefore provide gravity-reticulated water supply to many villages requiring little treatment before use (ERS/CSA, 2011).

Activities impacting on water quality include the following:

- Discharge of industrial wastewaters: this impact is limited as little industry occurs
- Informal settlements
- Proliferation of water weeds due to eutrophication
- Non-point source discharge of diffuse agricultural waste
- Inefficient wastewater treatment works and inadequate sewage treatment facilities, leading to microbiological pollution and eutrophication: The aging sewerage infrastructure and sanitation systems have not kept pace with the rate of expansion of many of the rural towns and have resulted in untreated or partially treated wastewater entering the river systems. Water quality problems have also been identified in areas such as Port St Johns, with inadequate sewage treatment resulting in water quality problems in the towns of Ugie, Maclear and Tsolo (DWAF, 2004a). Poor maintenance and vandalism of the wastewater

infrastructure has also contributed to this problem. This has resulted in health risks to local residents and downstream users.

- Suspended sediment loads due to high levels of erosion: Degradation and overgrazing of communal lands have resulted in high sediment loads during flood events. This has lead to silting up of structures and smothering of aquatic habitats. The impact of these activities is severe.
- Location and poor management of solid waste disposal sites: Concerns have been raised about leaching of wastewater high in organics from poorly designed solid waste sites in rural towns and villages. The concern relates to increased organic loads and the impacts on dissolved oxygen concentrations and heavy metal pollution. This is not regarded as a significant problem at a WMA scale, but rather a localised issue.

The main threats to the provision of ecosystem services within the catchment come from a variety of inappropriate land uses and alien plant infestation, resulting in degradation and the inability of the catchment to provide these services.

4.4 WATER QUALITY ASSESSMENT PER TERTIARY CATCHMENT

4.4.1 T31

Background

The main river in T31 is the Upper Mzimvubu River, which is largely undeveloped but becoming increasingly vulnerable with respect to sustaining water supply services and other ecosystem services. The main town is Cedarville. This area is part of the Uplands zone identified by ERS and CSA.

Water quality issues in this tertiary catchment are related to the commercially farmed areas around Cedarville (and down to Matatiele). The establishment of *dairy pastures* have had a major impact in terms of transforming indigenous grasslands to perennial rye grass lands with year-round irrigation and fertiliser addition. These dairy pastures result in long term trampling, increased water use and nutrient run-off into adjacent water bodies, resulting in eutrophication (ERS/CSA, 2011). There is also intensive *commercial maize production* in the area. A large variety of other agricultural products are produced from vegetables to mutton. Most irrigators utilise centre pivots along the Tswereka and Mzimvubu rivers.

Subsistence farming with dryland crops and cattle grazing is also prevalent in T31. Water quality issues can therefore be summarised as solid and liquid waste treatment and the use of agri-chemicals.

Green Drop ratings

The 2012 Green Drop report for Wastewater Treatment Works (WWTW) in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings:

Cedarville WWTW: High Risk – Lack of influent monitoring, poor effluent compliance, non compliance with R2934 for operating and maintenance staff

Water quality hotspots

No water quality hotspots were identified in T31.

4.4.2 T32

Background

The main river in T32 is the Mzintlava River. Main towns are Kokstad and Mount Ayliff and the hamlets of Franklin and Flagstaff.

Cattle farming is prevalent from Matatiele in T31 down to the Kokstad area in T32. There are productive abattoirs in Kokstad (Meadow Meats Kokstad Abattoir and Greenlands Abattoir cc.), as well as a goat processing unit/abattoir in Mount Ayliff (established by the Alfred Nzo Municipality in 2007) which is currently not functional due to supply and management problems. Intensive *commercial maize* and *dairy* production areas are located around Kokstad. A large variety of other agricultural products are produced varying from vegetables to mutton. Most irrigators utilise centre pivots along the Droewig and Mzintlava rivers down to Mount Ayliff. Limited *commercial forestry* is also found between Mount Ayliff and Tabankulu on the eastern boundary of the catchment, with subsistence farming with dryland crops and cattle grazing in the rest of T32.

Several commercial farmers have been exploring ways to improve grazing productivity through changing fire and seasonal grazing regimes, and have increased carrying capacity and stocking rates. AsgiSA-EC has an initiative to support communal beef farmers with improved breeding stock to increase livestock resilience and productivity (ERS/CSA, 2011).

In summary, the area north of Mount Ayliff has irrigation and dryland farming along the Mzintlava River, with an industrial hub at Kokstad, while the mountainous area to the south of Mount Ayliff up to the confluence of the Mzintlava and Mzimvubu rivers has limited irrigation and dryland farming only. Water quality impacts would therefore be related to elevated nutrients and turbidities, and urban pollution around Kokstad.

Green Drop ratings

The 2012 Green Drop report for WWTW in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings:

Kokstad WWTW: Medium Risk
Mount Ayliff WWTW: Medium Risk
Flagstaff WWTW: Critical Risk – No operating and design capacity, non-compliance with R2834 for operating and maintenance staff, no effluent compliance monitoring. Note this WWTW is located a distance from the river.

Water quality hotspots

The following water quality hotspots were found in T32:

SQ reach	River name	Water quality impact (rating)	Water quality issues
T32C-05273	Mzintlava	Large (3)	Pivot irrigation (dairy farming) + sediment impacts
T32D-05352	Mzintlava	Large – Serious (3.5)	Kokstad WWTW + urban pressures; extensive irrigation + an instream dam
T32D-05373	Mzintlava	Large (3)	Irrigation return flows
T32F-05464	Mzintlava	Serious (4)	Discharges from Mount Ayliff WWTW

4.4.3 T33

Background

The main river in T33 is the Kinira River, with the main towns being Matatiele, Mount Frere and Tabankulu. Several villages are present in the mountains. According to ERS/CSA (2011) T31 and T33 is described as part of the Uplands zone of the Mzimvubu catchment. It is rated by the Agricultural Research Council as 50% moderately degraded. The Uplands zone population is approximately 250 000 people, mostly living in rural settlements with a density of 15 people per square kilometre. Unemployment is higher than the national average, with most rural dwellers dependent upon grants, remittances and the landscape for their livelihoods. ERS and CSA have committed to a 20-year catchment conservation programme, which is currently in the first phase and focusing on the Uplands zone (ERS/CSA, 2011). The area is mountainous with limited *dryland farming*, with cattle grazing and subsistence farming. Only a number of small sawmill activities are active.

The *beef industry* in East Griqualand (the Upper Mzimvubu region of Matatiele to Kokstad) is well developed, with most farmers, both commercial and communal, free range grazing.

Water quality impacts would therefore be related to elevated nutrients and turbidities, with extensive erosion.

Green Drop ratings

The 2012 Green Drop report for WWTW in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings:

Mount Frere WWTW: Medium Risk
Tabankulu WWTW: Medium Risk
Matatiele WWTW: Medium Risk

Water quality hotspots

The following water quality hotspot is found in T33:

SQ reach	River name	Water quality impact (rating)	Water quality issues
T33A-04991	Unknown	Large (3)	Extensive erosion; large number of villages; crossings; dryland cultivation; possibly elevated nutrient levels.

4.4.4 T34

Background

The main river in T34 is the Thina River, with the main town being Mount Fletcher. The area is mountainous with very limited dryland irrigation. Some *commercial forestry with associated sawmill* activities is found in this area.

Water quality impacts would therefore be related to elevated nutrients and turbidities, primarily around Mount Fletcher.

Green Drop ratings

The 2012 Green Drop report for WWTW in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings:

Mount Fletcher WWTW: High Risk – Lack of influent monitoring, poor effluent compliance

Water quality hotspots

The following water quality hotspot is found in T34:

SQ reach	River name	Water quality impact (rating)	Water quality issues
T34D-05463	Tokwana	Large (3)	Mount Fletcher WWTW in high risk – so nutrient elevations expected; urban impacts; crossings.

4.4.5 T35

Background

The main rivers in T35 are the Tsitsa and Inxu rivers. Main towns are Ugie, Maclear, Qumbu and Tsolo. Aandrus and Barbeque Brits abattoirs are located in Maclear, but their current level of functionality is unknown. A poultry breeding facility, Inxu Agric Cooperation was located in Ugie but it is no longer operating. Ugi Chicks is also located in Ugie, but its functionality is unknown at present.

Extensive *commercial forestry* occurs in the central area of the catchment with dryland farming and irrigation along the rivers. PG Bison and its associated commercial forestry activities is located outside Ugie. Several villages are present in the mountains, with mainly *cattle grazing* and *subsistence dryland farming*.

The proposed irrigation area around Ntabelanga Dam and hydropower linked to the proposed Lalini Dam, are found in this tertiary catchment.

Water quality impacts would therefore be related to elevated nutrients, primarily around Tsolo and irrigation return flows around Ugie. Erosion and elevated turbidities are also prevalent.

Green Drop ratings

The 2012 Green Drop report for WWTW in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings:

Ugie WWTW: Low Risk – Due to evaporation of effluent rather than release to the environment

Maclear WWTW: Low Risk – Due to evaporation of effluent rather than release to the environment

Qumbu WWTW: Medium Risk

Tsolo WWTW: Critical Risk – No operating and design capacity, no effluent compliance monitoring

Water quality hotspots

The following water quality hotspots were found in T35:

SQ reach	River name	Water quality impact (rating)	Water quality issues
T35F-06020	Inxu	Large (3)	Low risk WWTW in Ugie; urban impacts with irrigation + cultivation downstream.
T35K-06167	Xokonxa	Large (3)	Tsolo WWTW in critical risk; urban impacts; crossings; dryland cultivation

4.4.6 T36

Background

The main river in T36 is the Lower Mzimvubu River. The main town is Port St Johns. *Irrigation* of vegetables, some *commercial forestry* and *tourism* are the main land use activities in the area.

Water quality issues include high instream turbidities from erosion and possible point source pollution risks from the canalised creek that flows from the town of Port St Johns.

Green Drop ratings

The 2012 Green Drop report for WWTW in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings:

Port St Johns WWTW: Medium Risk

Water quality hotspots

No water quality hotspots were identified in T36.

5 STATUS QUO ASSESSMENT: ECOSYSTEM SERVICES

5.1 INTRODUCTION

Based on Census 2011 (Statistics South Africa, 2012), a total population of approximately 2 500 000 is in the districts completely or partially within the Mzimvubu catchment. Census 2011 is the most recent national census with the next census due in 2021. There are no large centres of urban/industrial demand within easy reach of the Mzimvubu River.

A prominent feature is the extent of dryland cultivation. Some of the basin is being used for commercial agriculture, mainly livestock farming in the western part around Ugie and Maclear and in the portion of the basin in KwaZulu-Natal (KZN). Most of the agricultural activity in the former Transkei is based on subsistence cultivation (maize and vegetables) and rearing livestock. A very large part of this portion of the basin can be classified as degraded, mainly because of overgrazing that has caused severe soil erosion.

The Mzimvubu catchment, because of the nature of the communities that it intersects, plays an important role in maintaining important ecosystem services on-site as well as other users. Ecosystem services are a product that emerges from processes or features within largely natural environments, that enhances human wellbeing and is directly used by people. Natural capital and associated ecosystem services are now becoming scarce and the Millennium Ecosystems Assessment (MEA) partitions ecosystems services into four broad categories:

- Provisioning services are the most familiar category of benefit, often referred to as ecosystem 'goods', such as foods, fuels, fibres, bio-chemicals, medicine, and genetic material, that are in many cases: directly consumed; subject to reasonably well-defined property rights (even in the case of genetic or biochemical material where patent rights protect novel products drawn from ecosystems); and are priced in the market. These services are often provided directly by the environment and the integrity and nature of the environment and its ability to support these services is of critical importance to many households.[6]
- Cultural services are the less familiar services such as religious, spiritual, inspirational and aesthetic well-being derived from ecosystems, recreation, and traditional and scientific knowledge that are: mainly passive or non-use values of ecological resources (non-consumptive uses); that have poorly-developed markets (with the exception of ecotourism); and poorly-defined property rights (most cultural services are regulated by traditional customs, rights and obligations); but are still used directly by people and are therefore open to valuation.
- Regulating services are services, such as water purification, air quality regulation, climate regulation, disease regulation, or natural hazard regulation, that affect the impact of shocks and stresses to socio-ecological systems and are: public goods (globally in the case of disease or climate regulation) meaning that they "offer non-exclusive and non-rival benefits to particular communities" (Perrings, 2006); and are thus frequently undervalued in economic

[6] The direct use of water for domestic purposes is important but not considered here as it is the subject of a separate study that examines the Basic Human Needs. Ecosystem services is in effect concerned with water that adds value as it remains in the system and is not extracted. Small scale irrigation is part of the economic considerations, even if used for subsistence purposes, and is strictly speaking not part of ecosystem services considerations.

markets; many of these are indirectly used being intermediate in the provision of cultural or provisioning services.

- Supporting services are an additional set of ecosystem services referred to in the MEA, such as nutrient and water cycling, soil formation and primary production, that capture the basic ecosystem functions and processes that underpin all other services and thus: are embedded in those other services (indirectly used); and are not evaluated separately (DWAF, 2004b).

5.2 APPROACH

In terms of generating data for this report the most important step was to provide an integrated assessment of the current population of all three areas. Analysis was undertaken using three primary tools. These were:

- Geographic Information System (GIS) overlays of quaternary catchments and the census. This allows for the population for each quaternary to be calculated and a profile of the population for each unit to be analysed. A second level of analysis based on the typology of settlements in the area and their likely associated dependence on goods and services for livelihoods was undertaken for this report. This was sourced from information available from Statistics South Africa and cross referenced with an examination of aerial photography, largely provided by Google Earth™. This allowed for an analysis of land use types associated with the settlement typology.
- Cross check of the GIS data sets with available mapping to determine likely livelihood styles and profiles.
- Limited site visits to likely “hot spots”.

Further, each quaternary catchment of the Mzimvubu has been examined in detail via the analysis of socio-cultural importance. The Socio-Cultural Importance (SCI) was determined from analysis of mapping and cross referencing to secondary sources where available.

A key component of the SCI model is the category “Resource Dependence”. This refers to the goods and services delivered by the river system and people’s dependence on these components and is largely aligned with the ecosystem services category of “Provisioning Services”. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. The categories “Recreational Use” and “Ritual Use” were also examined. The SCI model was compared to the evaluation of likely areas of importance regarding goods and services.

5.3 STATUS QUO ASSESSMENT

The production of the SCI model allows for the development of a spatial matrix that compares Sub-Quaternary catchments with each other and allows for a profile of the status quo per unit to be developed. This is largely a narrative description based on data available and concentrates on key drivers in terms of socio-economic profiles. The units have been collated into a more limited number of amalgamated Sub-Quaternary catchments, or ecosystem services zones, that have similar ecosystem services profiles. For the Mzimvubu catchment, 15 such ecosystem services zones (**Figure 5.1**) have been generated. Each of these zones is discussed briefly in the sections below.

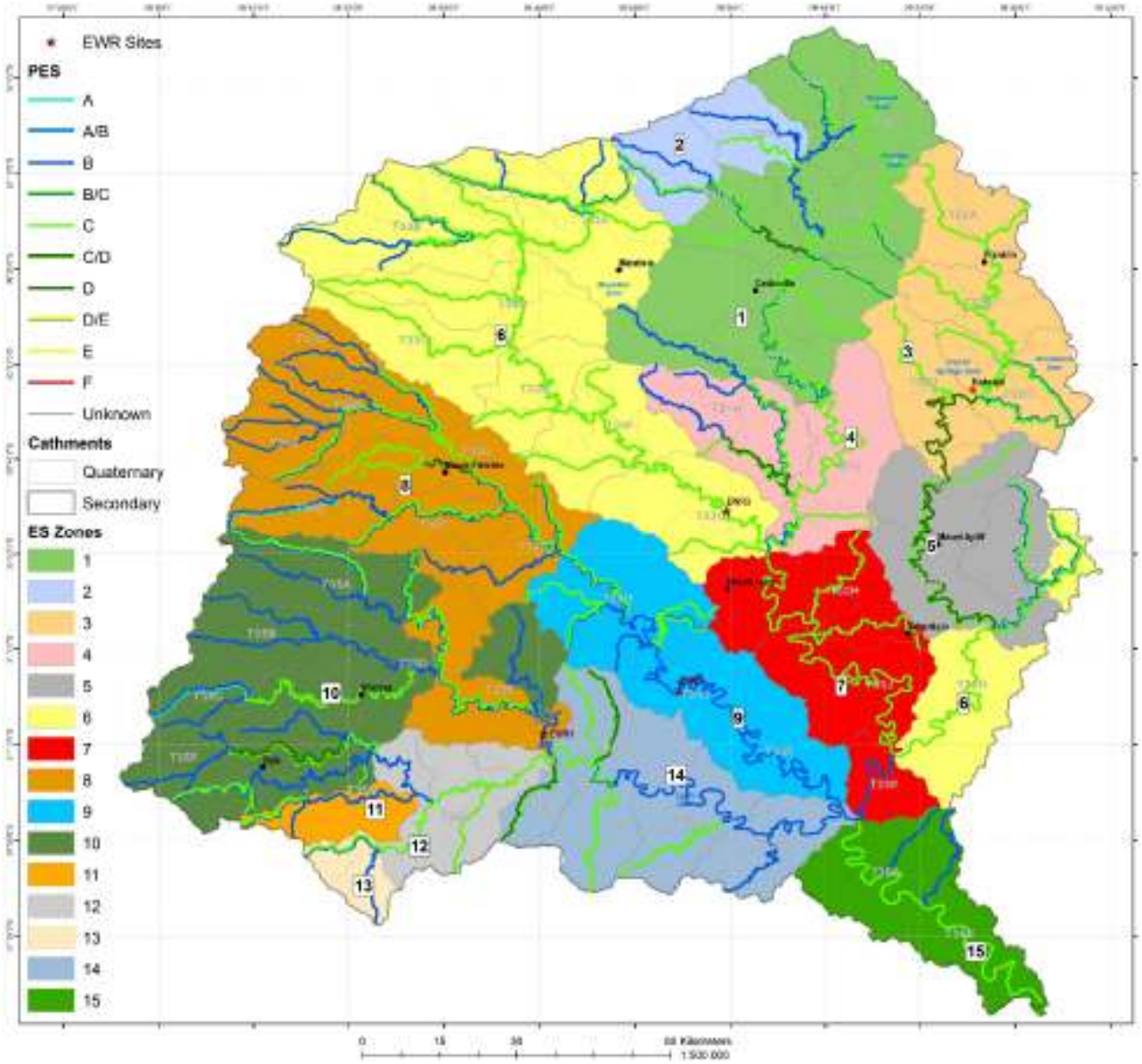


Figure 5.1 Ecosystem services zones

5.3.1 Zone 1

This zone is made up of the whole of, or parts of, T31A, T31B, T31C, T31D, T31E, T31F, T31G and T31H. The bulk of the area is given over to commercial farming. The zone includes the main stream of the Upper Mzimvubu that has a very large commercial farming area, small commercial forestry and the town of Cedarville. The north-eastern part of the zone is located within the KZN province and the rest in the Eastern Cape. Key ecosystem services important in the zone include the following:

- Recreational fishing
- Some limited subsistence fishing and other recreational aspects associated with the rivers
- Waste water dilution
- The aesthetic value of the river and associated aquatic systems in their intersection with the recreation value of the upper catchment areas

5.3.2 Zone 2

Zone 2 is made up of parts of T31C and T31E. The dominant land use is for subsistence farming and the area includes part of the former Transkei. The area is largely highland and borders on the southern portions of Lesotho. There are few towns and most settlement is rural or closer rural village. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.3 Zone 3

Zone 3 is made up of the whole or parts of T32A, T32B, T32C, T32D. The zone includes the town of Kokstad and the smaller satellite area of Franklin. Kokstad is the most developed urban area in the eastern portion of the Mzimvubu catchment and is closely connected to the agricultural sector. The zone is given over for the most part to commercial farming with irrigation a particular component. The key ecosystem services important in the zone include the following:

- Recreational fishing and other recreational usage
- Waste water dilution
- The aesthetic value of the river and associated aquatic systems in their intersection with the recreation value of the upper catchment areas

5.3.4 Zone 4

Zone 4 is made up of T31H and T31J. The area is hilly with scattered rural populations and some closer settlement associated with the extended village of Colona. Land use is almost exclusively given over to subsistence farming. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.5 Zone 5

Zone 5 is made up of T32E, T32F, T32G and T32H. The administrative centre is the town of Mount Ayliff that is included in this zone. Land use is almost exclusively given over to subsistence farming although there are pockets of small scale forestry. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.6 Zone 6

Zone 6 is made up of T33A, T33B, T33C, T33D, T33E, T33F, T33G. The town of Matatiele is on the eastern-most part of the zone. In addition to Matatiele and the satellite settlements of Maluti, Dengwane and Newlands, there are several dense rural villages. These villages are a dominant feature of the northern portions of the zone and this means that population density in these areas is relatively high for a zone that is predominately rural. Land use is almost exclusively given over to subsistence farming although there are pockets of small scale forestry. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.7 Zone 7

Zone 7 is made up of T33H, T33J, T33K. The zone is similar in many respects to Zone 5 but is characterised by deeply incised valleys with most settlement clustered around villages and points

of closer rural settlement on the plateaus that overlook the valleys. Notable settlements include, Rwantsana, Sipetu, Sidakeni and Mangqa. Land use is almost exclusively given over to subsistence farming although there are pockets of small scale forestry. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.8 Zone 8

Zone 8 is made up of all, or parts of, T34A, T34B, T34C, T34D, T34E, T34F, T34G and T35E. The most notable town is Mount Fletcher. Although the remainder of the area would be classified as rural there are pockets of high density closer settlement. Land use is predominantly subsistence agriculture and extensive degradation due to overgrazing is evident. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.9 Zone 9

Zone 9 is made up of all, or parts of, T34H, T35J, T35K. There are pockets of forestry developed by the old Transkei authorities but for the main part it is subsistence agriculture that is the dominant land use. As with Zone 8 extensive degradation due to overgrazing is evident. There are few major settlements but there are several pockets of high rural densities associated with the settlements of Cabane, Mpemba, Barkerville, eMarhambeni, eDangwane, Lwandlana and Lucingweni. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.10 Zone 10

Zone 10 is made up of T35A, T35B, T35C, T35D, T35F, and forested sections of T35G. Land use is predominantly for commercial agriculture and particularly forestry. The town of Ugie and Maclear are the most important settlements and these are heavily dependent on both agriculture and forestry-related industry. The upper part of the zone is mountainous. Key ecosystem services important in the zone include the following:

- Recreational fishing
- Some limited subsistence fishing and other recreational aspects associated with the rivers
- Waste water dilution
- The aesthetic value of the river and associated aquatic systems in their intersection with the recreation value of the upper catchment areas

5.3.11 Zone 11

Zone 11 is made up of the non-forestry parts of T35G. Land use is predominantly for commercial agriculture and is similar to Zone 10 except that forestry does not play a role in this zone. Key ecosystem services important in the zone include the following:

- Recreational fishing
- Some limited subsistence fishing and other recreational aspects associated with the rivers
- Waste water dilution

5.3.12 Zones 12 and 13

Zones 12 and 13 are made up of parts of T35G as well as T35H and T35J. There are no major towns but the most notable settlements include Mbidlana, eLalini, Ncembu and Lathuthu. For the

main part subsistence agriculture is the dominant land use. As with Zones 8 and 9, extensive degradation due to overgrazing is evident. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.13 Zone 14

Zone 14 is made up of all, or parts of, T35J, T35K, T35L, T35M. The towns and urban centres of Qumbu and Tsolo are the most important settlements. There are pockets of forestry developed by the old Transkei authorities but for the main part it is subsistence agriculture that is the dominant land use. As with Zone 8 extensive degradation due to overgrazing is evident. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important in some areas.

5.3.14 Zone 15

This zone includes the Mzimvubu catchment downstream of all the tributaries to the estuary and is made up of T36A and T36B. Parts are very inaccessible but there are some areas where access is available and where provisioning services are important. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture and limited sand mining is also evident. Ritual use is also deemed to be important in some areas. Port St Johns is the major settlement and this is a relatively popular tourist destination. Recreational aspects are key ecosystem services for the Mzimvubu estuary.

6 STATUS QUO ASSESSMENT: ECOLOGICAL WETLAND STATE

6.1 INTRODUCTION

The status quo assessment of wetlands in the Mzimvubu catchment (T3) comprised two steps: First, the spatial distribution and extent of wetlands was explored in order to define and delineate areas of wetland groups (this chapter). Secondly, wetlands were prioritised based on a matrix of various wetland characteristics and properties, which facilitated the ranking of wetlands in order to produce a list of high priority wetlands (**Chapter 11**). Previous assessments of wetlands in portions of the T3 catchment (e.g. Job and Walters, 2013) were incorporated into the current assessment, and data from the PES/EI/ES (DWS, 2014b) were used to supplement prioritisation. All assessments were desktop.

6.2 DESCRIBE STATUS QUO AND DELINEATE WETLAND GROUPS

The objective of this step is to define wetland groups and provide a status quo description of each group, including general condition of wetlands/wetland groups. A group should represent a homogenous catchment or region based on the similarity of ecological state, system operation and land use. The status quo description provides information at a broad scale to inform the delineation of the wetland groups. Specific actions include:

- Identifying the spatial distribution and extent of wetlands: The identification was based on National Freshwater Ecosystem Priority Area (NFEPA) spatial and metadata (Nel *et al.*, 2011).
- Typing wetlands in terms of EcoRegions and Hydrogeomorphic (HGM) types: The typing of wetlands was based on EcoRegions and HGM types used from the National Wetland Classification System.
- Determine wetland groups based on position, type and general condition: Wetland groups will likely include wetlands of different type, and general condition refers to “wetcon” data within the NFEPA metadata.

6.3 STATUS QUO ASSESSMENT

The spatial distribution of wetlands in the T3 catchment in relation to EcoRegions and quaternary catchments is shown in **Figure 6.1**. Most wetlands occur within the South Eastern Uplands Level 1 EcoRegion, while the more meandering portions of the Tsitsa, Thina, Mzintlava and Mzimvubu rivers and the estuary occur within the Eastern Coastal Belt. The estuary, while noted here as an important wetland, will be dealt with in detail in the estuary section and so is not covered here.

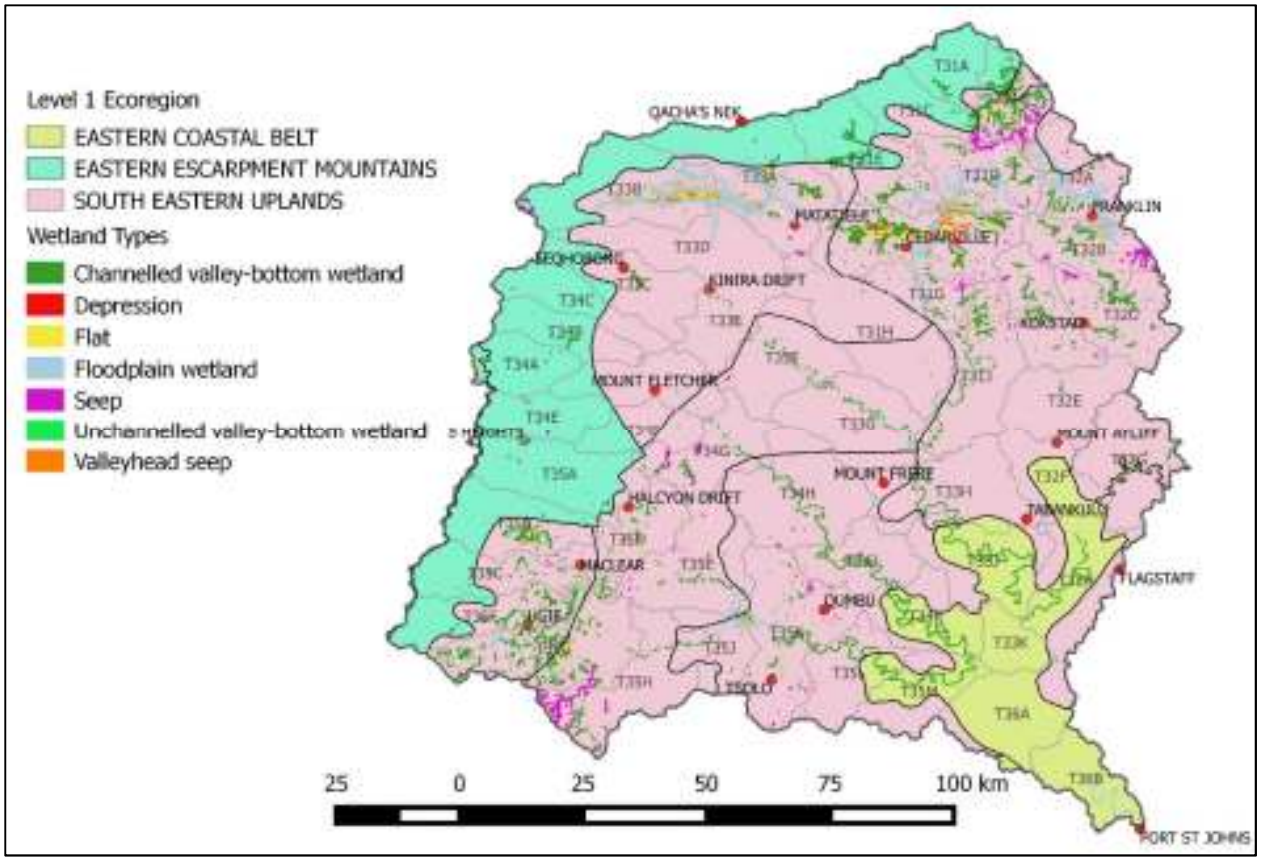


Figure 6.1 Spatial distribution of wetland types in the T3 catchment in relation to Level 1 and 2 EcoRegions and quaternary catchments (Level 2 EcoRegions are shown but not coloured)

The distribution of wetlands within the South-eastern Uplands Level 1 EcoRegion was used to broadly delineate five (5) groups of wetlands (**Figure 6.2**). The first group of wetlands is represented by extensive high density channelled valley-bottom wetlands and seeps in quaternary catchment T31B in the vicinity of Riversdale and Fettercairn, but also includes small portions of T31A and T31C. These wetlands were delineated separately from wetlands in adjacent quaternary catchments due to typing, i.e. apart from floodplain and depressional wetlands. The second group of wetlands comprises an extensive complex of floodplain, depressional and channelled valley-bottom wetlands, together with flats and valleyhead seeps in the regions surrounding Cedarville, within the T31D, E and F quaternary catchments. The third group represents a large area in the vicinity of Franklin and Kokstad, with extensive floodplain wetlands upstream of Franklin in the T32A quaternary catchment, and extensive channelled valley-bottom and seep wetlands in quaternary catchments T32B, C, D and T31J. There is potential to divide this grouping into two separate groups based on wetland type. The fourth group represents an extensive complex of floodplain and channelled valley-bottom wetlands, flats and valleyhead seeps in the vicinity of Matatiele and incorporates T33A and B quaternary catchments. The fifth group comprises an extensive and dispersed array of various wetland types (channelled valley bottoms, depressions, flats, floodplains and seeps) in the Ugie, Maclear and Halcyon Drift region, and includes quaternary catchments T35B, C, D, F, G and H. Wetland complexes only occur within the upper catchments, which is related to the regions topography, i.e. the coastal plain catchments are too incised to allow for wetland development and only sporadic depressions occur. The extensive, meandering, lower portions of the Tsitsa, Thina, Mzintlava and Mzimvubu rivers are denoted as channelled valley-

bottom wetlands (NFEPA, **Figure 6.2**) but these areas are incised and confined channels where the rivers flow through gorge or kloof areas, and were not included as a wetland group.

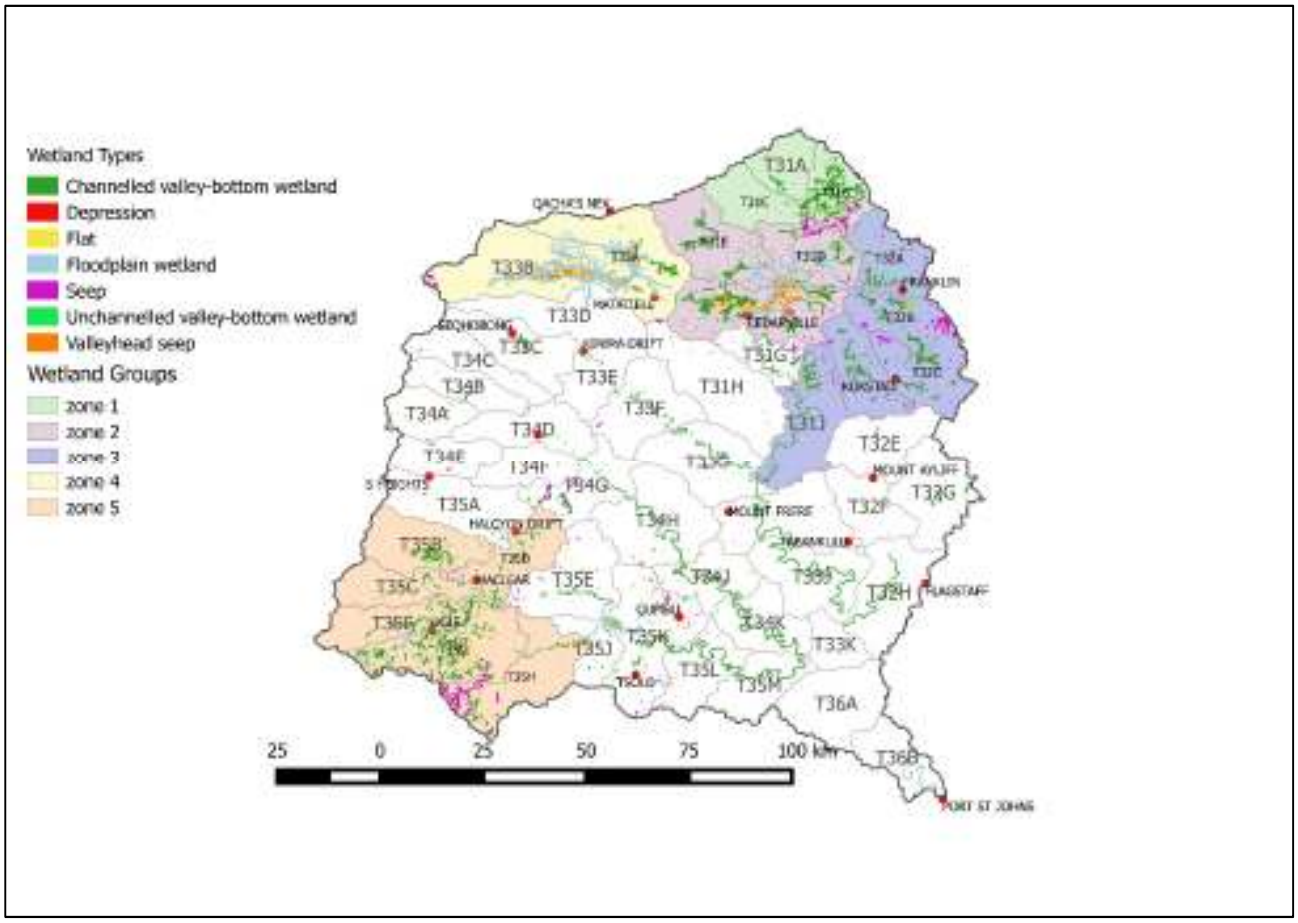


Figure 6.2 Wetlands were delineated into five groups, indicated by different coloured quaternary catchments above

6.3.1 Group 1: Status Quo (T31A, B, C)

This grouping is dominated by channelled valley-bottom and seep wetlands (**Figure 6.3**, **Table 6.1**). The area is generally largely impacted by farming activities, notably agriculture and the construction of farm dams (**Figure 6.4**), often with associated clumps of alien plant species such as wattle or gum. It is evident from aerial satellite data that wetland integrity in the area is generally moderate to low, but wetland proximity is mostly high. NFEPA data show most wetlands in this group as near natural or with moderate condition (**Figure 6.5A**), with many of these denoted as wetland FEPAs (**Figure 6.5B**). All wetlands in this group are important for cranes (**Figure 6.5C**) but none for endangered amphibians (**Figure 6.5D**).

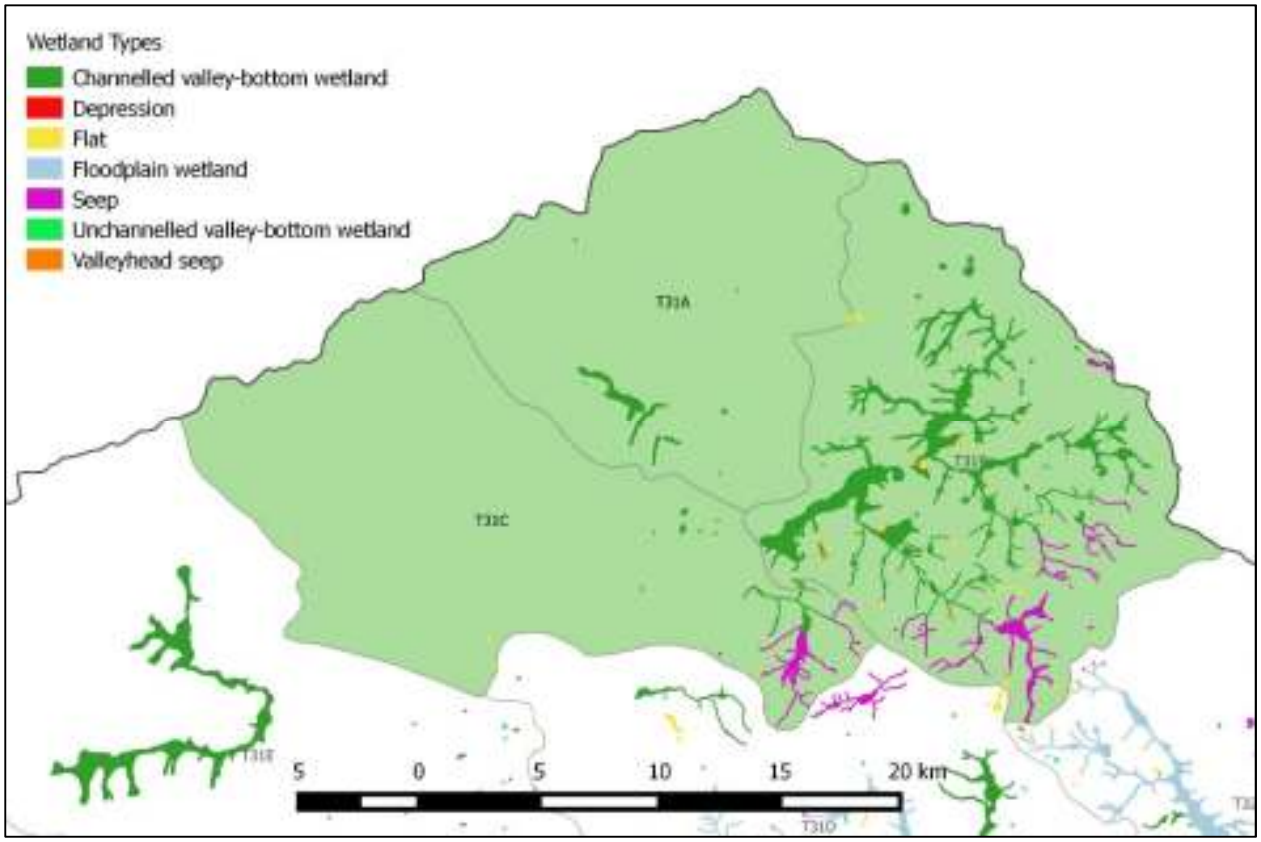


Figure 6.3 Wetland types and their distribution and extent within Group 1

Figure 6.4 Example of the predominant land use in Group 1 showing farm dams and agriculture (Red delineations indicate NFEPA coverage)

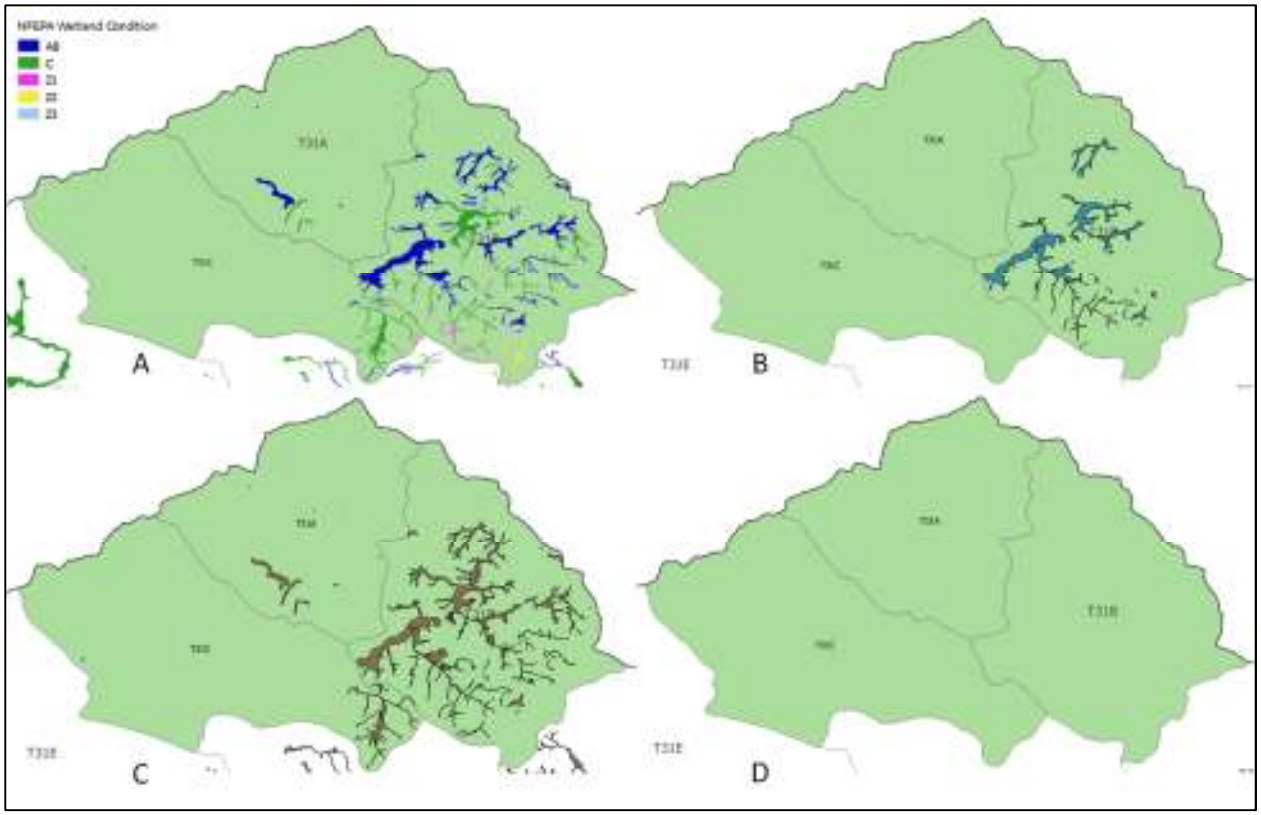


Figure 6.5 NFEPA criteria of wetlands in Group 1 (after Nel *et al.*, 2011). (A) NFEPA wetland condition; (B) Wetland FEPAs; (C) Wetlands important for cranes; (D) Wetlands important for endangered amphibians

6.3.2 Group 2: Status Quo (T31D, E, F)

The second group of wetlands comprises an extensive complex of floodplain, depressional and channelled valley-bottom wetlands, together with flats and valleyhead seeps in the regions surrounding Cedarville, commonly known as the Cedarville Flats, within the T31D, E and F quaternary catchments (**Table 6.1**). In places there is extensive meandering with variously sized oxbow lakes common on floodplains (**Figures 6.6** and **6.7**). Predominant impacts in the area include agricultural activities, farm dams and scattered centre pivots (see example in **Figure 6.7**). Grazing on wetlands is also a common use. In most places, alien willows line the active channel, with scattered clumps of poplars or gum in places, but most wetlands seem to be mostly alien free and dominated by the grassland that they should be. Almost all of the wetlands in the area have been denoted a condition of AB, i.e. near natural (NFEPA data; **Figure 6.8A**), with most also being wetland FEPAs (**Figure 6.8B**). All wetlands in this group are important for cranes (**Figure 6.8C**) but none for endangered amphibians (**Figure 6.8D**).

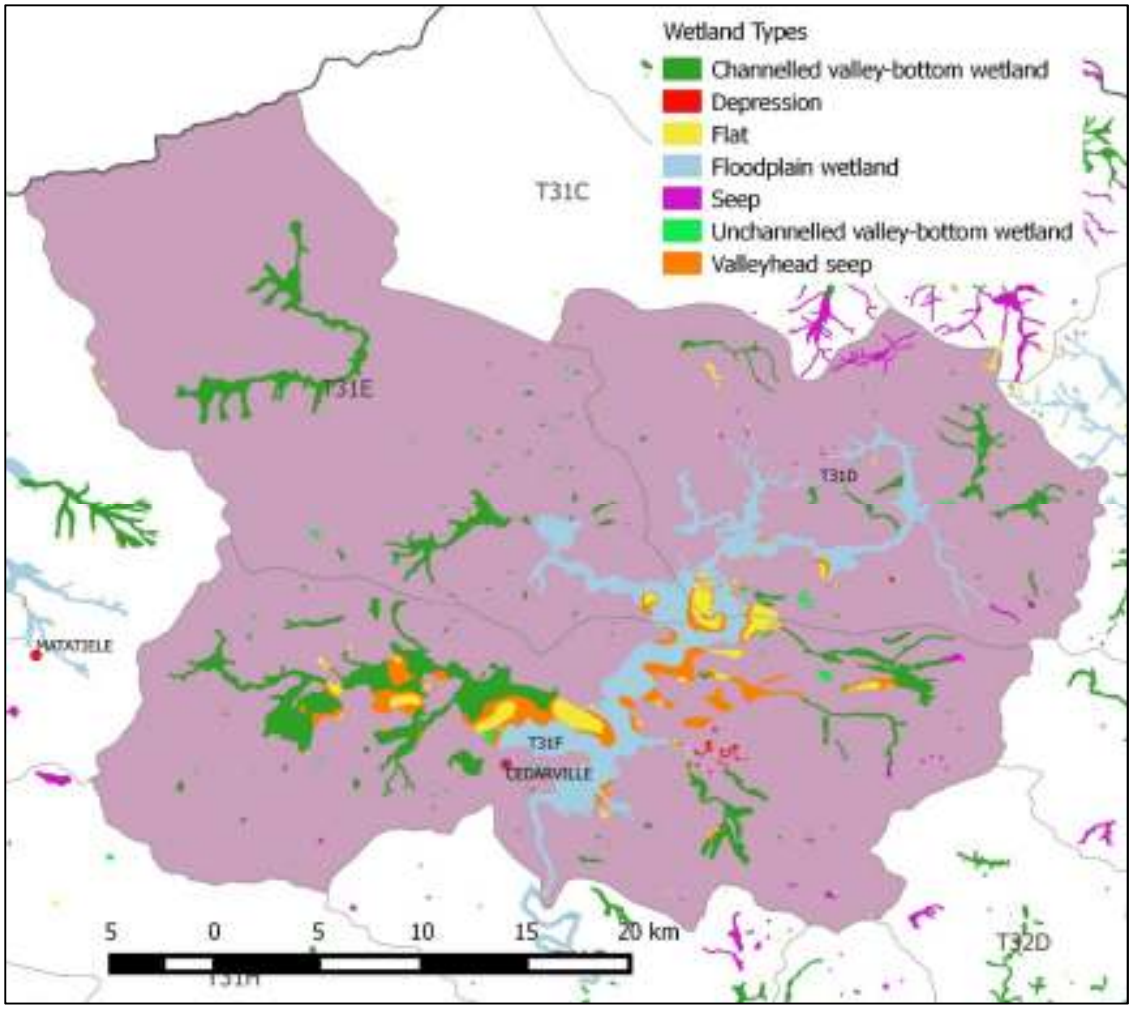


Figure 6.6 Wetland types and their distribution and extent within Group 2

Figure 6.7 Example of the predominant land use in Group 2 showing farm dams, centre pivots and agriculture (Red delineations indicate NFEPA coverage)

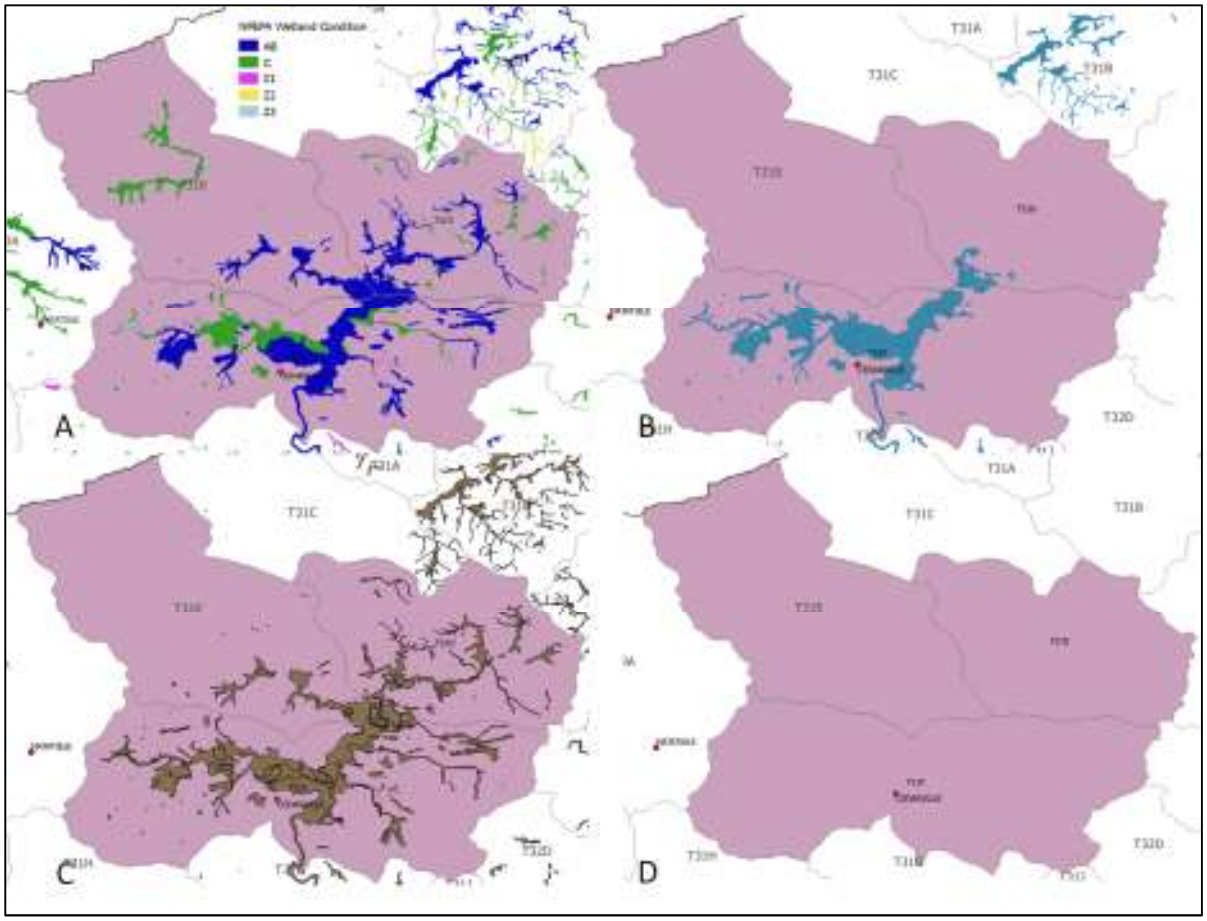


Figure 6.8 NFEPA criteria of wetlands in Group 2 (after Nel *et al.*, 2011). (A) NFEPA wetland condition; (B) Wetland FEPAs; (C) Wetlands important for cranes; (D) Wetlands important for endangered amphibians

6.3.3 Group 3: Status Quo (T32A, B, C, D, T31J)

The third group represents a large area in the vicinity of Franklin and Kokstad, with extensive floodplain wetlands upstream of Franklin in the T32A quaternary catchment, and extensive channelled valley-bottom and seep wetlands in quaternary catchments T32B, C, D and T31J (**Figures 6.9** and **6.10**, **Table 6.1**). There is potential to divide this grouping into two separate groups based on wetland type. The area is mostly dominated by agricultural activities with a high degree of disturbance of wetland areas, with scattered farm dams and some centre pivots. Clumps of alien tree species occur, with some of them lining the active channel in places (**Figure 6.10**). Most wetlands in the area have a NFEPA condition of C, i.e. moderately modified (**Figure 6.11A**), and are also wetland FEPAs (**Figure 6.11B**). All wetlands in the area are important for cranes (**Figure 6.11C**) with only a small portion of seep wetlands in the western part of T32B denoted as important for endangered amphibians (**Figure 6.11D**).

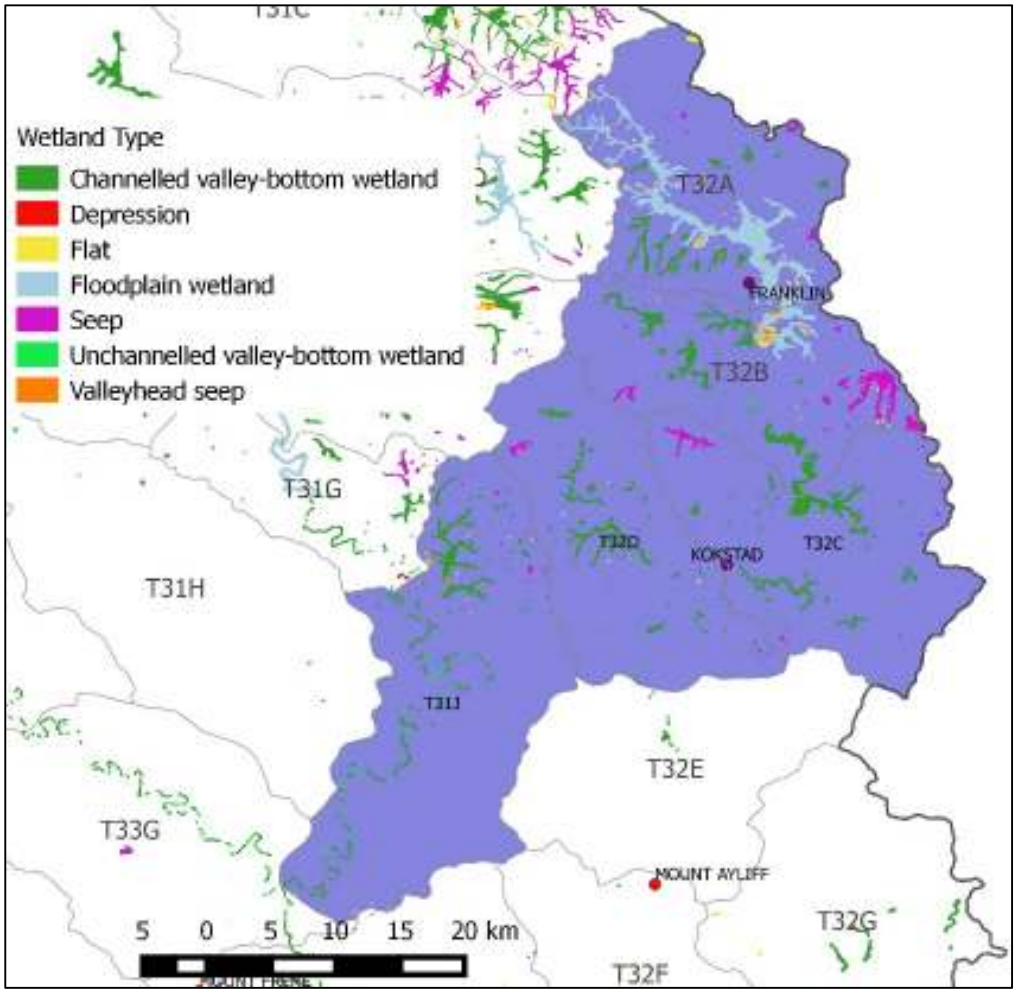


Figure 6.9 Wetland types and their distribution and extent within Group 3

Figure 6.10 Example of the predominant land use in Group 3 showing disturbance and agricultural activities. Some alien tree species are visible along the main channel (Red delineations indicate NFEPA coverage)

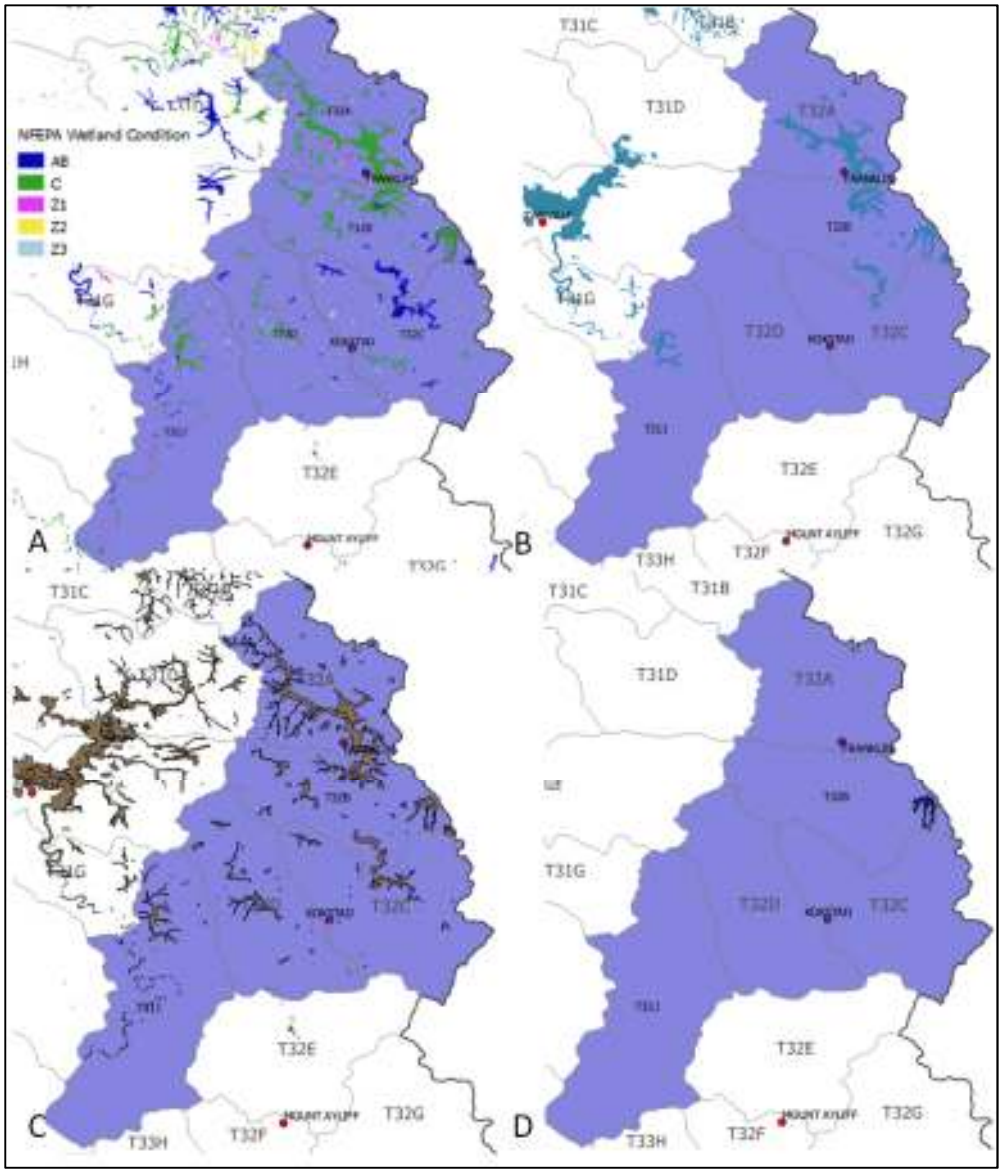


Figure 6.11. NFEPA criteria of wetlands in Group 3 (after Nel *et al.*, 2011). (A) NFEPA wetland condition; (B) Wetland FEPAs; (C) Wetlands important for cranes; (D) Wetlands important for endangered amphibians

6.3.4 Group 4: Status Quo (T33A, B)

The fourth group represents an extensive complex of floodplain and channelled valley-bottom wetlands, flats and valleyhead seeps in the vicinity of Matatiele and incorporates T33A and B quaternary catchments (**Figure 6.12**, **Table 6.1**). Predominant impacts to wetlands in this area are agricultural activities and physical disturbance, and roads within wetlands in places (**Figure 6.13**). Alien tree species are common along the main channel, mostly alien willows (*Salix fragilis*). An extensive review of wetlands in this region was conducted by Job and Walters (2013) and outlines detailed baseline wetland information. Most of the wetlands in this area are moderately modified according to the NFEPA condition of C (**Figure 6.14A**), but with some areas classified as near natural. Despite this, not many wetlands are denoted as wetland FEPAs (**Figure 6.14B**) and very few are important for either cranes (**Figure 6.14C**) or endangered amphibians (**Figure 6.14D**).

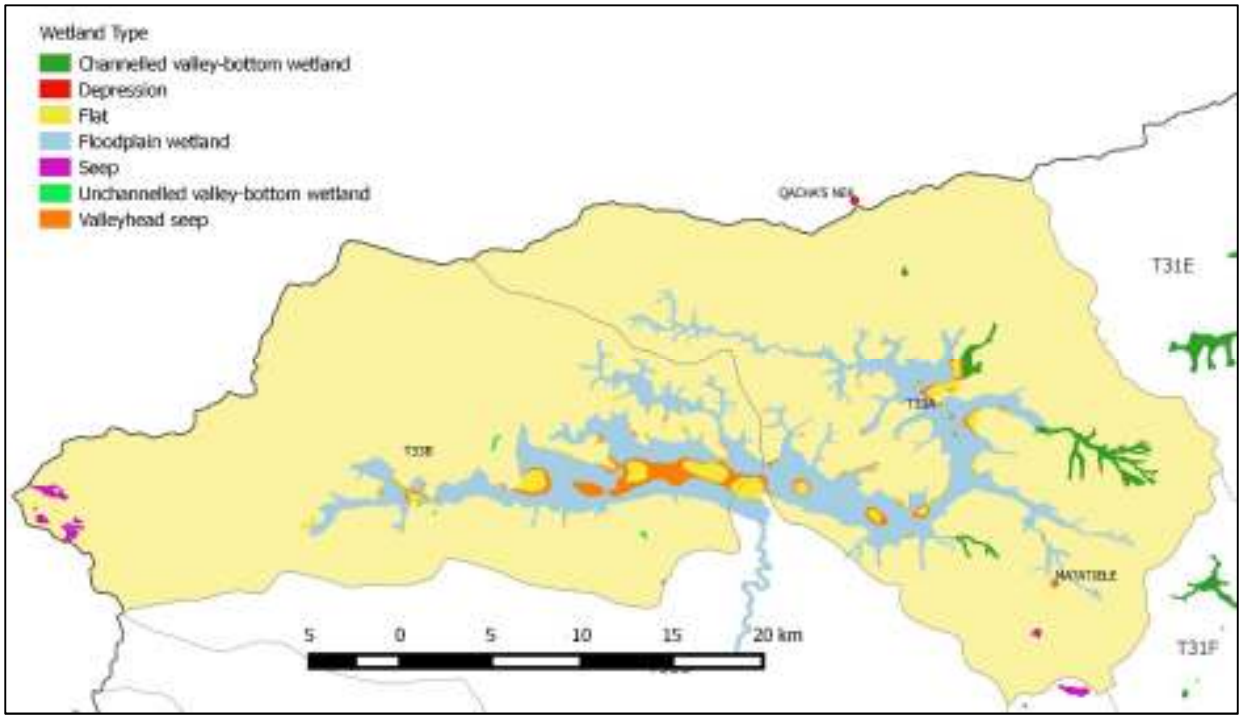


Figure 6.12 Wetland types and their distribution and extent within Group 4

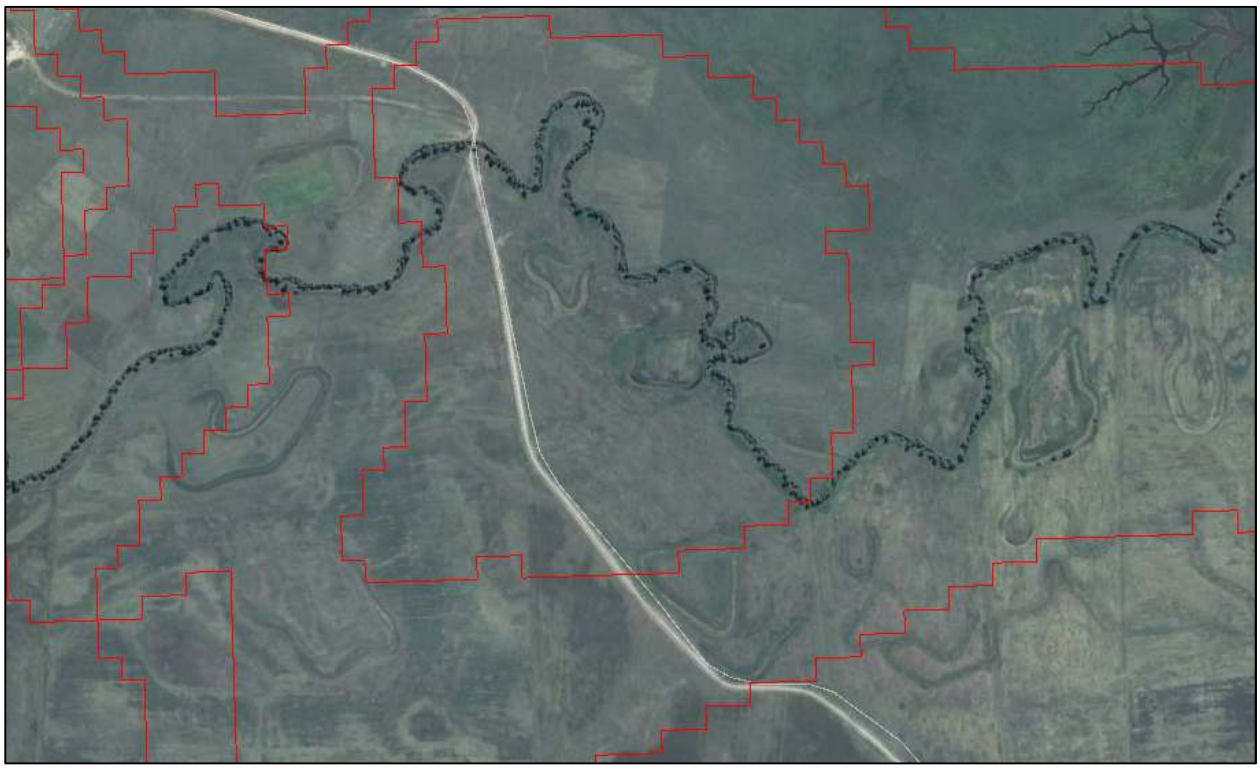


Figure 6.13 Example of the predominant land use in Group 4 showing some disturbance and agricultural activities, and roads within wetlands. Alien tree species are visible along the main channel (Red delineations indicate NFEPA coverage)

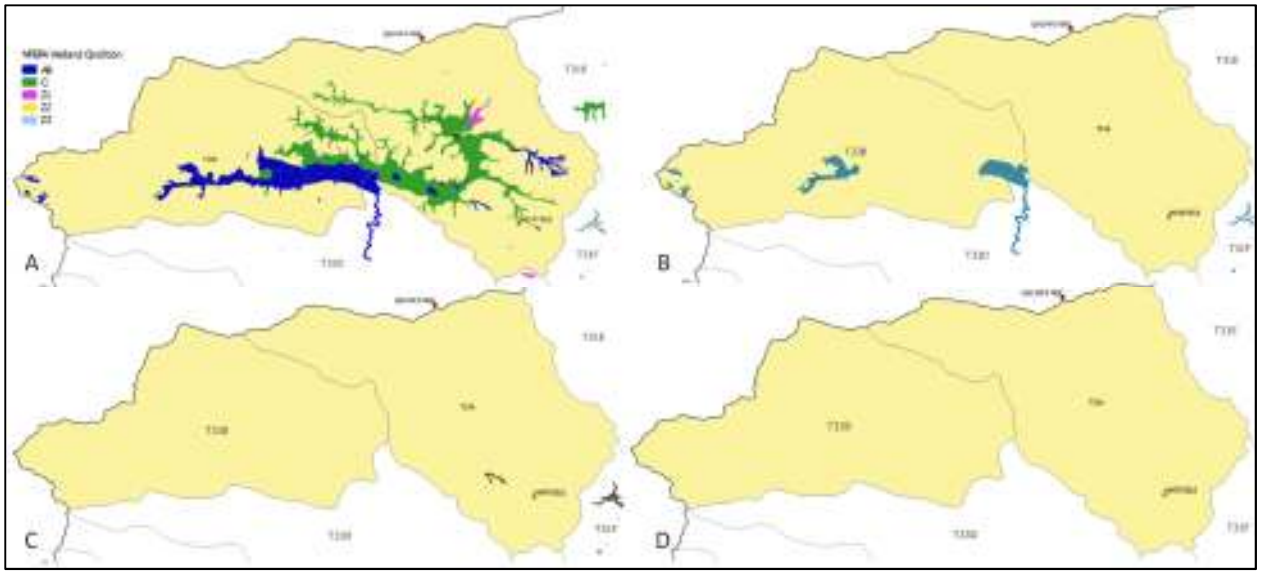


Figure 6.14 NFEPA criteria of wetlands in Group 4 (after Nel *et al.*, 2011). (A) NFEPA wetland condition; (B) Wetland FEPAs; (C) Wetlands important for cranes; (D) Wetlands important for endangered amphibians

6.3.5 Group 5: Status Quo (T35B, C, D, F, G, H)

The fifth group comprises an extensive and dispersed array of various wetland types (channelled valley bottoms, depressions, flats, floodplains and seeps) in the Ugie, Maclear and Halcyon Drift region, and includes quaternary catchments T35B, C, D, F, G and H (**Figure 6.15, Table 6.1**). There is potential to divide this group into two, with wetlands in T35B, C and D forming a group associated with the Tsitsa River and its tributaries, and wetlands in T35F, G and H forming a group associated with the Inxu (Wildebeest) River and its tributaries. The predominant land use in the area is forestry, particularly in the Ugie and Maclear regions (**Figure 6.16**; MacKenzie, 2010), while agricultural activities are more dominant along the Gatberg River wetlands. Most grasslands have been manipulated in some way and are subject to annual fires. Alien tree species (such as *S. fragilis*) frequently line the active channel, but are limited in wetland areas. The NFEPA wetland condition associated with wetlands in this region is mixed but mostly moderately modified (**Figure 6.17A**), with only wetlands along the Gatberg River with wetland FEPA status (**Figure 6.17B**). All wetlands in the area are important for cranes (**Figure 6.17C**) while none of them support endangered amphibians (**Figure 6.17D**).

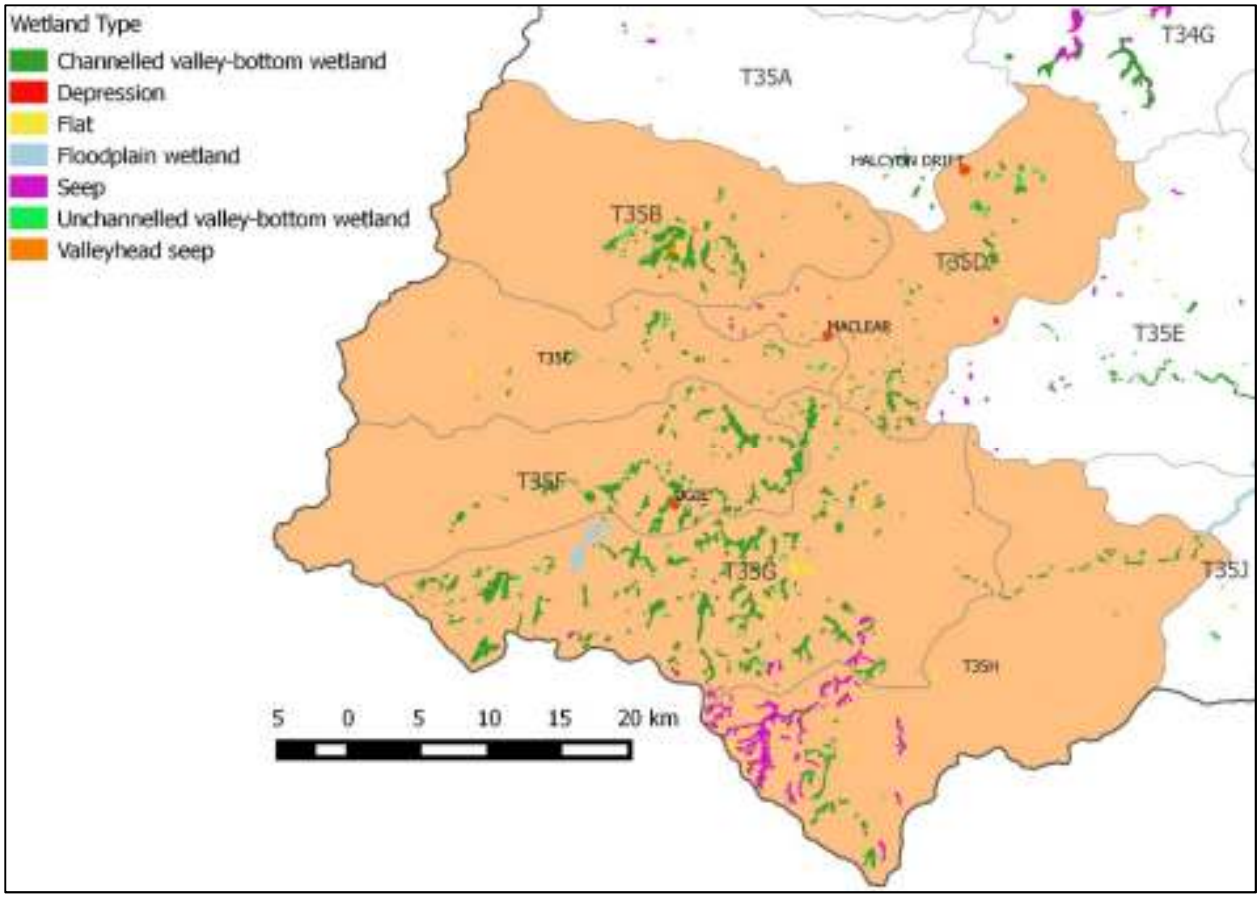


Figure 6.15 Wetland types and their distribution and extent within Group 5

Figure 6.16 Example of the predominant land use in Group 5 showing some disturbance but mainly forestry (Red delineations indicate NFEPA coverage)

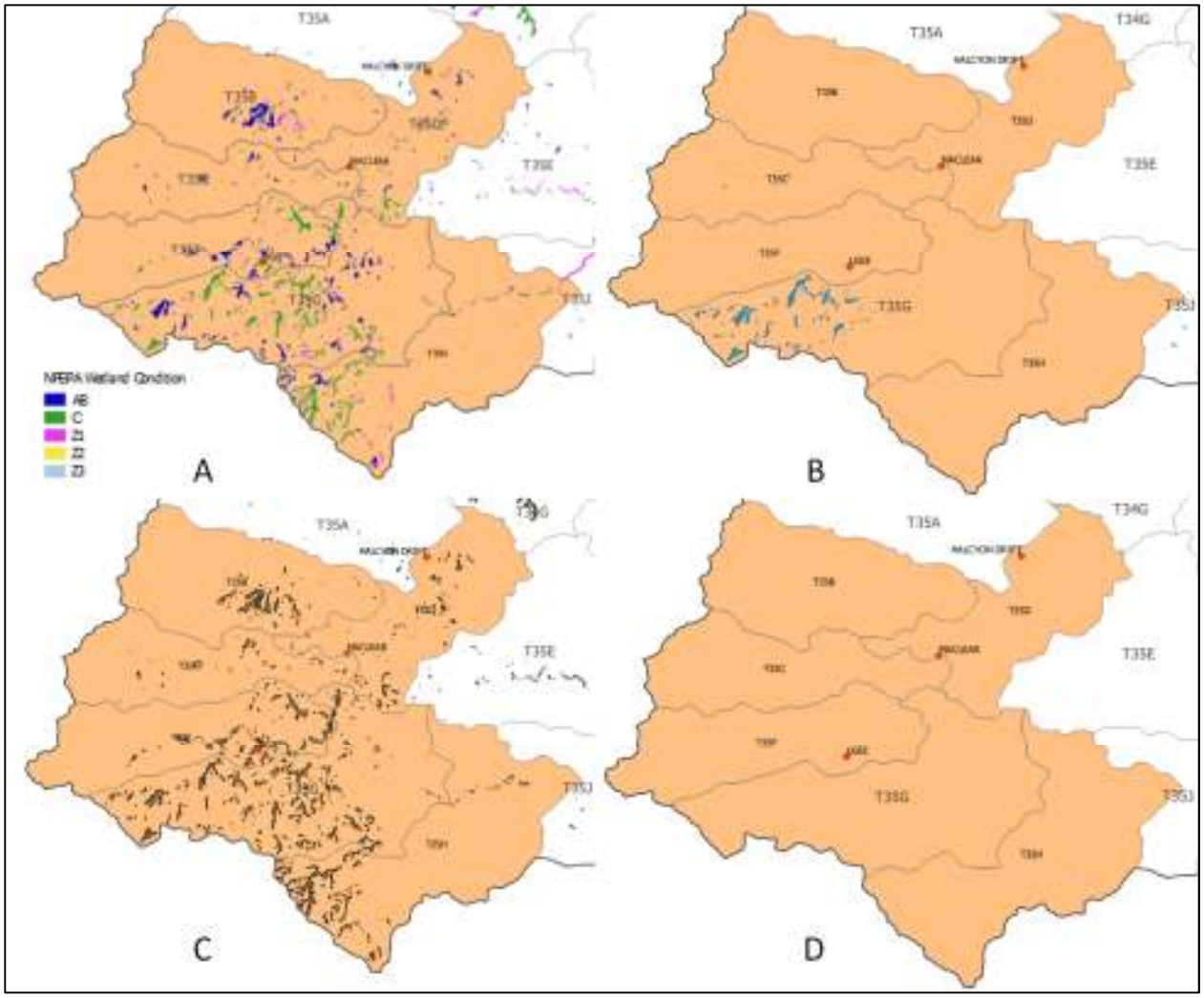


Figure 6.17 NFEPA criteria of wetlands in Group 5 (after Nel *et al.*, 2011). (A) NFEPA wetland condition; (B) Wetland FEPAs; (C) Wetlands important for cranes; (D) Wetlands important for endangered amphibians

Table 6.1 Photographic examples of wetland groups

Wetland group	Example
Group 1 (T31A, B, C)	
Group 2 (T31D, E, F)	
Group 3 (T32A, B, C, D, T31J)	
Group 4 (T33A, B)	

Wetland group	Example
Group 5 (T35B, C, D, F, G, H)	

7 STATUS QUO ASSESSMENT: ECOLOGICAL RIVER STATE

7.1 INTRODUCTION

Determination of the Present Ecological State (PES), which represents the ecological status quo of the rivers, is undertaken as part of the EcoClassification process (Kleynhans and Louw, 2007). The EcoClassification process consists of four levels which refer to increasing complexity and intensity of work from the Level I (Desktop) to Level IV. An additional level, also Desktop, was developed by Dr Kleynhans (DWS, 2014b) with the specific purpose of building up a country-wide database of PES and Ecological Importance (EI) – Ecological Sensitivity (ES). This project is referred to as the PES/EI/ES or PESEIS project, and this data was used as the baseline for the status quo assessment.

7.2 APPROACH

7.2.1 PES model (modified from Kleynhans and Louw, 2007)

The PES of a river is expressed in terms of various components, i.e. drivers (physico-chemical variables, geomorphology, hydrology) and biological responses (fish, riparian vegetation and aquatic macroinvertebrates), as well as in terms of an integrated state, the EcoStatus. Different processes are followed for each component to assign a category from A to F (where A is natural, and F is critically modified) (**Table 7.1**). Ecological evaluation against the expected reference conditions, followed by integration of the categories of each component, provides a description of the Ecological Status or EcoStatus of a river. Thus, the EcoStatus can be defined as the totality of the features and characteristics of the river (instream and riparian zones) that influence its ability to support an appropriate natural flora and fauna (modified from Iversen *et al.*, 2000). This ability relates directly to the capacity of the system to provide a variety of goods and services.

Table 7.1 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.

It must be emphasised that the A→F scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. Therefore there may be cases where there is uncertainty as to which category a particular entity belongs. This situation falls within the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes (Robertson *et al*., 2004). For practical purposes, these situations are referred to as boundary categories and are denoted as B/C, C/D etc. The B/C boundary category, for example, is indicated as the dark-blue to light-green area in **Figure 7.1**.

Figure 7.1 Illustration of the distribution of Ecological Categories on a continuum

The Desktop level EcoClassification was modified for use in the PESEIS project to deal with numerous Sub-Quaternary (SQ) river reaches and the relationship between the Desktop Level EcoClassification and the modified desktop level used within the PESEIS project is illustrated in **Figure 7.2**.

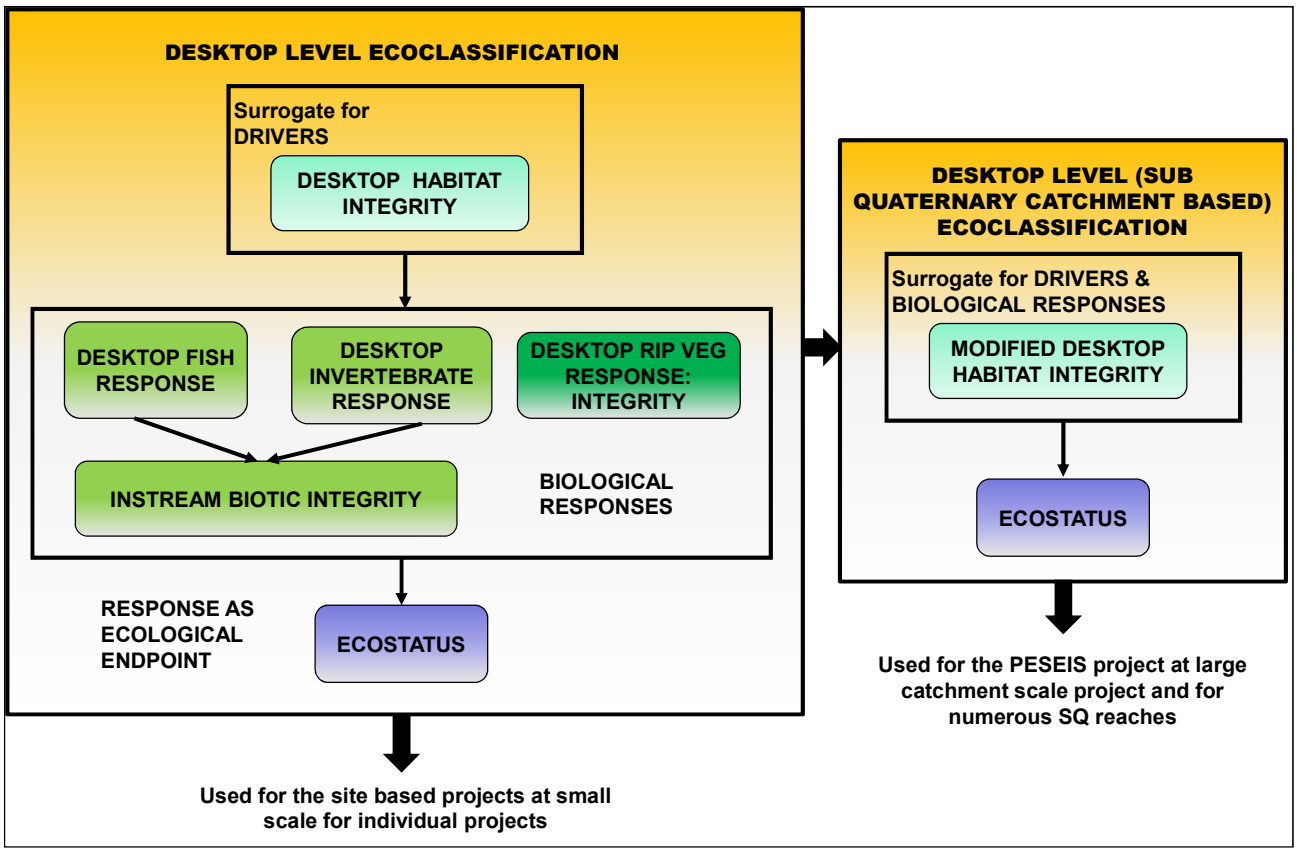


Figure 7.2 Relationship between the Desktop Level EcoClassification and the PESEIS approach to determine the PES

The PES is assessed according to six metrics that represents a very broad qualitative assessment of both the instream and riparian components of a river. The metrics used in the PES model and

an explanation of what they refer to is explained in **Table 7.2** (DWA, 2013). Each metric is scored from zero to five.

Table 7.2 PES metrics and explanations (DWA, 2013)

Metrics	Comment
Potential instream habitat continuity modification	Modifications that indicate the potential that instream connectivity may have been changed from the reference. *Indicators:* Physical obstructions (e.g. dams, weirs, causeways). Flow modifications (e.g. low flows, artificially high velocities, physico-chemical "barriers").
Potential riparian/wetland habitat continuity modification	Modifications that indicate the potential that riparian/wetland connectivity may have been changed. *Indicators:* Physical fragmentation, e.g. inundation by weirs, dams; physical removal for farming, mining, etc.
Potential instream habitat modification activities.	Modifications that indicate the potential of instream habitats that may have been changed from the reference. Includes consideration of the functioning of instream habitats and processes, as well as habitat for instream biota specifically. *Indicators:* Derived likelihood that instream habitat types (runs, rapids, riffles, pools) may have changed in frequency (temporal and spatial). Assessment is based on flow regulation, physical modification and sediment changes. Land use/land cover (erosion, sedimentation), abstraction etc. may indicate the likelihood of habitat modification. The presence of weirs and dams are possible indicators of causes of instream habitat change. Certain introduced biota (e.g. carp, crustaceans and molluscs) may also cause habitat modification. Eutrophication and resulting algal growth as well as macrophytes may also result in substantial changes in habitat availability.
Potential riparian/wetland zone modifications	Modifications that indicate the potential that riparian/wetland zones may have been changed from the reference in terms of structure and processes occurring in the zones. Also refers to these zones as habitat for biota. *Indicators:* Derived likelihoods that riparian/wetland zones may have changed in occurrence and structure due to flow modification and physical changes due to agriculture, mining, urbanisation, inundation etc. Based on land cover/land use information. The presence and impact of alien vegetation is also included.
Potential flow modification	Modifications that indicate the potential that flow and flood regimes have been changed from the reference. *Indicators:* Derived likelihood that flow and flood regimes have changed. Assessment based on land cover/land use information (urban areas, interbasin transfers), presence of weirs, dams, water abstraction, agricultural return flows, sewage releases, etc.
Potential physico-chemical modification activities	Activities that indicate the potential of physico-chemical conditions that may have changed from the reference. *Indicators:* Presence of land cover/land use that implies the likelihood of a change of physico-chemical conditions away from the reference. Activities such as mining, cultivation, irrigation (i.e. agricultural return flows), sewage works, urban areas, industries, etc. are useful indicators. Algal growth and macrophytes may also be useful response indicators.

7.2.2 PES supporting information

Comments summarising the activities that result in the PES were provided for each SQ. Additionally, the WRUI summary per SQ was also utilised to identify what the impacts are and whether they are flow or non-flow (including water quality) related. This study team also viewed each SQ using Google Earth™ to provide the flow and non-flow impact assessment and to identify the key PES drivers.

7.2.3 Database for PES information in an Excel spreadsheet

The relevant secondary catchment which represents the Mzimvubu (T3) consists of 187 SQ reaches. The final modelled information in the front end model for each secondary is available from DWS (https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx). Information was extracted in a master spreadsheet that incorporates all the PESEIS results, modifications to the PES results, as well as the additional information required for this project. The spreadsheets will be available on the final data CD for this project and the columns of the PES sheet (called PES) is described below. Note the PES_raw sheet is a copy of the data as provided from the PESEIS project without any adjustments.

Any colour coding in cells of column D to K indicates changes that were made to the original scoring (DWS, 2014b).

PES sheet column descriptions in the master spreadsheet:

- **Column A**: SQ number. Individual code provided for each SQ by DWA and based on the codes used in the NFEPA assessment.
- **Column B**: River. River name where available.
- **Column C**: Length km. River length of SQ.
- **Columns D–I**: A PES metrics with completed ratings (0 - 5) from the PESEIS study (DWS, 2014b). The values in yellow indicate values that were refined during this study.
- **Column J**: Comments. Comments copied from the front end model providing a summary of activities in the SQ. Coloured or bold text indicates comments added during this review.
- **Column L**: PES median of all metrics. PES value generated using the metrics as provided in Columns D–I.
- **Column M**: PES category based on median of PES metrics. PES as an EC.
- **Column N**: Flow. The word 'flow' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a flow impacts.
- **Column O**: WQ. The word 'WQ' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a WQ impact.
- **Column P**: Non-flow. The word 'non-flow' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a non-flow impact.
- **Column Q**: Summary. Concatenates the information in columns AJ, AK and AL.
- **Column R**: Indication of the key causes and sources of the primary PES driver.
- **Column S**: Primary PES driver. An indication is provided whether the key PES driver that is mostly responsible for the changes from natural reference condition is flow, non-flow or water quality dominated, or a combination of both.
- **Column T**: River PES (value) (2012). PES value copied from the PESEIS front end model.
- **Column U**: River PES (EC) (2012). PES as an EC copied from the PESEIS front end model.
- **Column V**: PES (revised) (2016). PES revised during this study. PES value as a median.
- **Column W**: PES (revised) EC (2016). PES as an EC relating to column AR.
- **Column X**: Final PES (value). This column is now superfluous as it repeats column V. It has been kept however as links in other sheets are made to this.
- **Column Y**: Final PES (EC). This column is now superfluous as it repeats column V. It has been kept however as links in other sheets are made to this.

7.3 STATUS QUO ASSESSMENT

The status quo assessment consists of a table and short summary for each tertiary catchment. No key PES drivers are provided for rivers in a B or higher PES as the changes from natural are minor. Maps are provided of the IUAs (once delineated) which also include the PES results (**Chapter 19**).

Table 7.3 River PES and key drivers resulting in modification from natural (T31)

SQ number	River	River PES (EC)	Key PES driver
T31A-04712	Mzimvubu	B/C	Non-flow.[7]
T31B-04745	Krom	C	Flow, non-flow.
T31B-04868	Krom	B	Flow,
T31B-04873		C	Flow, non-flow.
T31C-04796	Mngeni	B	Non-flow.
T31C-04866	Mzimvubu	B	Non-flow.
T31C-04879	Nyongo	C	Non-flow.
T31C-04929	Mzimvubu	C	Non-flow.
T31D-04926	Mzimvubu	B	Non-flow.
T31D-04936	Riet	C	Flow, non-flow.
T31D-05030	Riet	C	Flow, non-flow.
T31D-05060		B/C	Non-flow.
T31D-05076	Mzimvubu	C	Non-flow.
T31E-04836	Tswereka	B	Non-flow.
T31E-04910	Malithasana	B/C	Non-flow.
T31E-04931	Tswereka	B/C	Non-flow.
T31E-05013	Tswereka	D	Flow, non-flow.
T31E-05055		C	Flow, non-flow.
T31F-05108		B/C	Non-flow.
T31F-05111	Mzimvubu	B	Flow.
T31F-05112	Mzimvubu	C	WQ, non-flow.
T31F-05134		C	Non-flow.
T31G-05071	Mzimvubu	B/C	Non-flow.
T31G-05382		B/C	Non-flow.
T31H-05177	Mvenyane	B	Non-flow.
T31H-05296	Mkemane	B	Non-flow.
T31H-05304		B	Non-flow.
T31H-05324	Mvenyane	B/C	Non-flow.
T31H-05437	Mkemane	C/D	WQ, non-flow.
T31H-05445		C	WQ, non-flow.
T31H-05516	Mvenyane	C/D	WQ, non-flow.
T31J-05257	Mzimvubu	C	Non-flow.

[7] The bulk of the reasons for 'non-flow' relates to erosion, sedimentation and alien vegetation. The bulk of WQ (water quality) issues are related to turbidity from erosion and sedimentation.

SQ number	River	River PES (EC)	Key PES driver
T31J-05551	Mzimvubu	**C**	Non-flow.
T31J-05582	Ngwekazana	**C**	Non-flow.
T31J-05588	Mzimvubu	**B/C**	Non-flow.

1: Non-flow refers to Non-Flow related activities. 2: Flow refers to Flow related activities.

Table 7.4 River PES and key drivers resulting in modification of natural (T32)

SQ number	River	River PES (EC)	Key PES driver
T32A-04907	Mzintlanga	C	Flow, non-flow.
T32A-04965	Mzintlava	C	Flow, non-flow.
T32B-05103	Mzintlava	C	Flow, non-flow.
T32B-05116		C	Flow, non-flow.
T32B-05184	Mzintlava	C	Non-flow.
T32C-05219	Mill Stream	C	Non-flow.
T32C-05243	aManzamnyama	B/C	Non-flow.
T32C-05273	Mzintlava	C	WQ, non-flow.
T32C-05313	Mzintlava	B	Non-flow.
T32C-05378		B/C	Non-flow.
T32D-05172	Droewig	C	Flow, non-flow.
T32D-05352	Mzintlava	D	Flow, WQ, non-flow.
T32D-05373	Mzintlava	D	WQ, non-flow.
T32E-05446	Mvalweni	C	Non-flow.
T32F-05464	Mzintlava	C/D	Non-flow.
T32G-05536	Mzintlavana	B/C	Non-flow.
T32G-05609	Mbandana	B/C	Non-flow.
T32G-05747	Mzintlavana	B/C	Non-flow.
T32H-05842	Mzintlava	C	Non-flow.

Table 7.5 River PES and key drivers resulting in modification of natural (T33)

SQ number	River	River PES (EC)	Key PES driver
T33A-04887	Mafube	B	Non-flow.
T33A-04892	Kinira	B/C	Non-flow.
T33A-04898	Makomorin	B	
T33A-04903	Kinira	B/C	Non-flow.
T33A-04928		B/C	Non-flow.
T33A-04983	Mafube	C	WQ, non-flow.
T33A-04990	Kinira	C	Non-flow.
T33A-04991		C	WQ, non-flow.
T33A-05011	Kinira	B/C	Non-flow.
T33B-04912	Seeta	B/C	Non-flow.
T33B-04939	Mabele	C	Flow, non-flow.
T33B-04956	Mosenene	C	Non-flow.
T33B-05005	Jordan	B	Non-flow.
T33B-05051	Mabele	B/C	Non-flow.
T33B-05066	Mabele	C	Flow, non-flow.
T33B-05072		B	Non-flow.
T33C-05131	Morulane	C	Non-flow.
T33D-05063	Kinira	C	Flow, non-flow.
T33D-05106	Pabatlong	C	Flow, non-flow.

SQ number	River	River PES (EC)	Key PES driver
T33D-05150	Kinira	C	Flow, non-flow.
T33E-05213	Kinira	C	WQ, non-flow.
T33E-05367	Somabadi	C	WQ, non-flow.
T33F-05285	Rolo	C	WQ, non-flow.
T33F-05326	Kinira	C	Non-flow.
T33F-05398	Kinira	C	Non-flow.
T33F-05439	Ncome	C	Flow, non-flow.
T33G-05395	Kinira	C	Non-flow.
T33G-05587	Cabazi	C	WQ, non-flow.
T33G-05659	Mzimvubu	B	Non-flow.
T33H-05638	Mnceba	C	Non-flow.
T33H-05680	Mzimvubu	C	Non-flow.
T33H-05803	Caba	C	WQ, non-flow.
T33H-05821	Mzimvubu	C	WQ, non-flow.
T33J-05834	Mzimvubu	C	WQ, non-flow.
T33K-06051	Mzimvubu	B	WQ.

Table 7.6 River PES and key drivers resulting in modification of natural (T34)

SQ number	River	River PES (EC)	Key PES driver
T34A-05354	Zindawa	B	Non-flow.
T34A-05362	Vuvu	B	
T34A-05394	Vuvu	B	Non-flow.
T34A-05404	Thina	B	Non-flow.
T34A-05408	Khohlong	B/C	Flow, non-flow.
T34A-05415	Thina	B	Non-flow.
T34B-05269	Nxotshana	B	Non-flow.
T34B-05275	Phiri-e-ntso	B	Non-flow.
T34B-05351	Thina	B/C	Non-flow..
T34B-05356	Thina	B/C	Non-flow.
T34B-05385	Thina	B/C	Non-flow.
T34C-05168	Tinana	B	Non-flow.
T34C-05238	Phinari	B	Non-flow.
T34C-05292	Tinana	B/C	Non-flow.
T34D-05412	Thina	C	Flow, WQ, non-flow.
T34D-05433	Tokwana	C	Flow, non-flow.
T34D-05460	Thina	B/C	Flow, non-flow.
T34D-05462	Khalatsu	C	Flow, non-flow.
T34D-05463	Tokwana	D	Flow, WQ, non-flow.
T34E-05495	Bradgate se Loop	A/B	Non-flow.
T34E-05503	Luzi	B	Non-flow.
T34E-05507	Luzi	B	Non-flow.
T34F-05512	Luzi	B/C	Non-flow.
T34F-05585		B/C	Non-flow.
T34G-05504	Qwidlana	B/C	Non-flow.
T34G-05543	Thina	B/C	Non-flow.
T34G-05634	Nxaxa	B	Non-flow.
T34G-05667	Thina	B	Non-flow.
T34H-05598	Thina	B/C	Non-flow.
T34H-05699	Mvuzi	C	WQ, non-flow.

SQ number	River	River PES (EC)	Key PES driver
T34H-05714	Qhanqu	C	Flow, non-flow.
T34H-05738	Ngcibira	C	Flow, non-flow.
T34H-05769	Tsilithwa	B	Flow.
T34H-05772	Thina	B	Non-flow.
T34H-05791	Tsilithwa	B/C	Flow, non-flow.
T34H-05809	Mvumvu	B/C	Flow, non-flow.
T34H-05826	Ngcothi	B	Non-flow.
T34H-05838	Thina	B/C	Non-flow.
T34K-05835	Thina	B	Flow, WQ, non-flow.

Table 7.7 River PES and key drivers resulting in modification of natural (T35)

SQ number	River	River PES (EC)	Key PES driver
T35A-05596	Tsitsana	B/C	Flow, non-flow.
T35A-05648	Tsitsa	B	Non-flow.
T35A-05657	Hlankomo	B/C	Non-flow.
T35A-05750	Tsitsa	B	Non-flow.
T35B-05709	Pot	B	Non-flow.
T35B-05798	Pot	B	Non-flow.
T35B-05815	Little Pot	B	Non-flow.
T35C-05858	Mooi	A/B	Non-flow.
T35C-05874	Mooi	C	Flow, WQ, non-flow.
T35C-05930	Klein-Mooi	B	Non-flow.
T35D-05721	Tsitsa	B/C	Non-flow.
T35D-05844	Mooi	B	
T35E-05780	Gqukunqa	B	
T35E-05908	Tsitsa	B/C	WQ, non-flow.
T35E-05977	Tsitsa	B	Non-flow.
T35F-05973	Kuntombizininzi	B	Flow.
T35F-05999	Inxu	B	Non-flow.
T35F-06000	Fontana	B	Non-flow.
T35F-06020	Inxu	C/D	WQ, non-flow.
T35F-06080	Inxu	B	Non-flow.
T35F-06112	Rondadura	B	Non-flow.
T35G-06002	Inxu	B/C	Non-flow.
T35G-06021	Inxu	B	Non-flow.
T35G-06069	Gatberg	B	Flow, non-flow.
T35G-06074	Gatberg	B	Non-flow.
T35G-06099	Gatberg	B	Non-flow.
T35G-06100		B/C	Non-flow.
T35G-06108	Inxu	B	Non-flow.
T35G-06118	Gatberg	B/C	Flow, non-flow.
T35G-06133		B/C	Non-flow.
T35G-06135	Gqaqala	B	Non-flow.
T35G-06148			Unchannelled 100m drainage line – not a river.
T35G-06169	Gqaqala	B/C	Flow, non-flow.
T35G-06179		B	Flow, non-flow.
T35H-06024	Inxu	C	WQ, non-flow.
T35H-06053	Inxu	C	WQ, non-flow.
T35H-06158	Qwakele	C	WQ, non-flow.

SQ number	River	River PES (EC)	Key PES driver
T35H-06186	Umnga	C	WQ, non-flow.
T35H-06240	KuNgindi	B/C	Flow, non-flow.
T35H-06282	Umnga	B	Non-flow.
T35J-06088	Inxu	B/C	Non-flow.
T35J-06106	Ncolosi	C/D	WQ, non-flow.
T35K-05897	Culunca	C	WQ, non-flow.
T35K-05904	Tyira	C/D	Flow, WQ, non-flow.
T35K-06037	Tsitsa	C	Flow, non-flow.
T35K-06098	Tsitsa	B/C	Non-flow.
T35K-06167	Xokonxa	C	Flow, WQ, non-flow.
T35L-05976	Tsitsa	B	Non-flow.
T35L-06190	Tsitsa	B	Non-flow.
T35L-06226	Ngcolora	C	Flow, non-flow.
T35M-06187	Tsitsa	B	Non-flow.
T35M-06205	Thina	B	Non-flow.
T35M-06275	Ruze	B	Non-flow.

Table 7.8 River PES and key drivers resulting in modification of natural (T36)

SQ number	River	River PES (EC)	Key PES driver
T36A-06216	Mzintshana	B	Non-flow.
T36A-06220	Mkata	B	Non-flow.
T36A-06250	Mzimvubu	C	Flow, WQ, non-flow.
T36A-06354	Mzimvubu	C	Flow, WQ, non-flow.
T36B-06391	Mzimvubu	C	Flow, WQ, non-flow.

A broad description is provided grouped into zones (**Figure 7.3**) for purposes of providing an ecological status quo description according to the PES. Note that these zones will not be referred or used again but provided as input in the decision-making regarding the delineation of IUAs.

7.3.1 T31 (Mzimvubu)

T31_E1: This zone consists of the upper mountainous reaches of quaternary catchment T31 (T31A, T31B, T31C, T31E), mostly originating along the border between South Africa and Lesotho. These reaches are mostly inaccessible due to the steep slopes of the mountainous area, resulting in limited use and hence impacts on these river reaches. Primary land use and impacts are associated with limited farming (agriculture), grazing, erosion and alien vegetation encroachment. The predominant ecological state of this zone is slightly to moderately modified from natural conditions (B/C).

T31_E2: This zone consists of the middle and lower reaches of catchment T31 (T31D, T31F, T31G and T31J). The predominant land use within this zone consists of formal farming activities (agriculture including dryland and irrigated fields as well as livestock farming practices). The predominant ecological state of this zone is moderately modified from natural conditions (C).

T31_E3: This zone consists of the upper mountainous reaches of quaternary catchments T31H and T31J, mostly originating to the south-east of the town of Matatiele. The steep slopes and mountainous characteristics of some reaches result in limited use and hence low impacts on the

uppermost river reaches in this zone. Primary land use and impacts are associated with the upper reaches of this zone is limited grazing, resulting in some erosion and secondary impacts such as alien vegetation encroachment. Lower reaches of this zone falls within more occupied rural areas where increased dryland agriculture and grazing result in notable erosion. The predominant ecological state of the upper reaches of this zone is slightly modified from natural conditions (B) while the lower reaches are moderately to largely modified (C/D).

7.3.2 T32 (Mzintlava)

T32_E1: This zone consists primarily of the reaches of quaternary catchments T32A, T32B and T32C to the north of and including the town of Kokstad. Although some sections are relatively mountainous with steep slopes, this area is largely utilised for farming. Dryland and irrigated (centre pivots) agriculture and livestock farming make out the predominant land use within this zone while the lower reaches also reflects the impact from the large formal settlements of Kokstad (including water quality deterioration). The predominant ecological state of this zone is moderately modified from natural conditions (C) although the lower reaches in the vicinity of Kokstad are largely modified (category D).

T32_E2: This zone consists of the middle and lower reaches of catchment T32 (T32D, T32E, T32F, T32G and T32H), downstream of zone T3D. The predominant land use within this zone is rural villages with dryland farming practices (mostly subsistence) and livestock farming. Extensive erosion is evident in this zone due to the above-mentioned activities, resulting in moderately to largely modified conditions (predominantly category C and D).

7.3.3 T33 (Kinira)

T33_E1: This zone consists of the upper reaches of the Kinira River which is mostly in a C to B EC. The area is mountainous with dryland cultivation in lower areas and extensive oxbows. The key impacts are associated with sedimentation and erosion

T33_E2: C. This zone consists of the upstream mountainous areas of tributaries of the Kinira. The land use is predominantly dryland cultivation on sloping hillsides. This zone is similar to T33_E1.

T33_E3: Same as above excluding mountain areas.

T33_4: The zone is in a C EC and consists of areas with mixed gorge areas and dryland cultivation.

T33_E5: This zone consists of the main river which is in a C EC with limited land use due to the gorge characteristics of the river.

7.3.4 T34 (Thina)

T34_1: This zone is mountainous with confined streams mostly in B and B/C categories and includes the upper Thina River and its tributaries. The upper portions of most mountainous streams are near natural. Generally, PES drivers are predominantly non-flow related and include dryland cultivation in flatter areas, wattle patches associated with steeper valleys and along confined streams, and scattered alien willows (notably *Salix babylonica* and *S. fragilis*) along alluvial portions of streams. Some gully erosion occurs but is isolated and not predominant.

T34_2: This zone includes Mount Fletcher along the Tokwana River, which is a predominant PES driver affecting water quality and has resulted in PES categories as low as a D. Other impacts include some weirs, dryland cultivation in some areas usually associated with moderate to severe erosion, and the presence of alien vegetation in the riparian zone. PES categories range from B/C to D.

T34_3: This zone comprises mainly the Luzi and Thina rivers and tributaries and includes mountain streams, kloofs and lower lying areas. Some gorge areas exist and are frequently in a better condition that more accessible areas. PES categories range from B to C but are predominantly B/Cs. The area is predominantly impacted by dryland cultivation, livestock grazing and alien vegetation. Isolated patches of forestry occur along the Qhanqu River. Due to intense cultivation and grazing in places, erosion is moderate to severe and gully erosion is common.

T34_4: A small zone including the Ngcibira River and upstream tributaries. The area is near the N2 freeway and is characterised by high human density near Mt Frere. PES categories are all Cs and predominant impacts are overgrazing and resultant erosion, which is severe in places.

T34_5: Comprised of a single but long SQ, the Thina River which meanders through extensive gorge areas. Overall PES is a B, but some areas would be a D if viewed in isolation. The gorge is in good condition but upstream areas have extensive erosion, mainly due to overgrazing. The SQ contains a large weir and photographs show high turbidity.

7.3.5 T35 (Tsitsa)

T35_1: A large zone which includes the Tsitsa, Mooi and Pot rivers and tributaries, and includes mountainous streams, gorge and kloof areas and some flatter areas. PES categories are mostly Bs and B/Cs, but the upper Mooi River is an A/B and the lower Mooi River, which includes Maclear, is a C. In higher mountainous areas, forestry is extensive, mainly *Pinus* species but also some *Eucalyptus* species. The predominant PES driver in these areas is alien vegetation, but some cultivation and grazing also occurs. Lower down along the Tsitsa River dryland cultivation and erosion are extensive and are predominant impacts.

T35_2: Mainly the Inxu River and its tributaries in the vicinity of Ugie. The PES categories in this zone range from B to C and predominant impacts include forestry, with plantation species invading wetlands and the riparian zone, and alien vegetation (mainly along the channel characterised by alien willow species). Water quality is affected in the vicinity of Ugie, where weirs also exist.

T35_3: This zone mainly includes the Umnga and Lower Inxu rivers. PES categories in the zone range from B to C/D but are mostly Cs. Main impacts include dryland cultivation and overgrazing, both with resultant severe erosion. Gully erosion is common and severe. The zone includes the Nqadu Dam on the upper reaches of the Xokonxa River.

T35_4: This zone includes the Tsitsa River and tributaries, mainly a gorge area, and incorporates the Tsitsa Falls. PES categories are mainly Bs due to inaccessibility of the area. The Ngcolora River is in a C category, mainly due to erosion in upstream areas that occur outside the gorge.

7.3.6 T36 (Mzimvubu)

T36 is evaluated as one zone comprising the main Mzimvubu River upstream of the estuary and two tributaries. The main river is in a C EC and the tributaries in a B EC. The area consists mostly of a steep gorge. Land use where access is possible is associated with grazing.

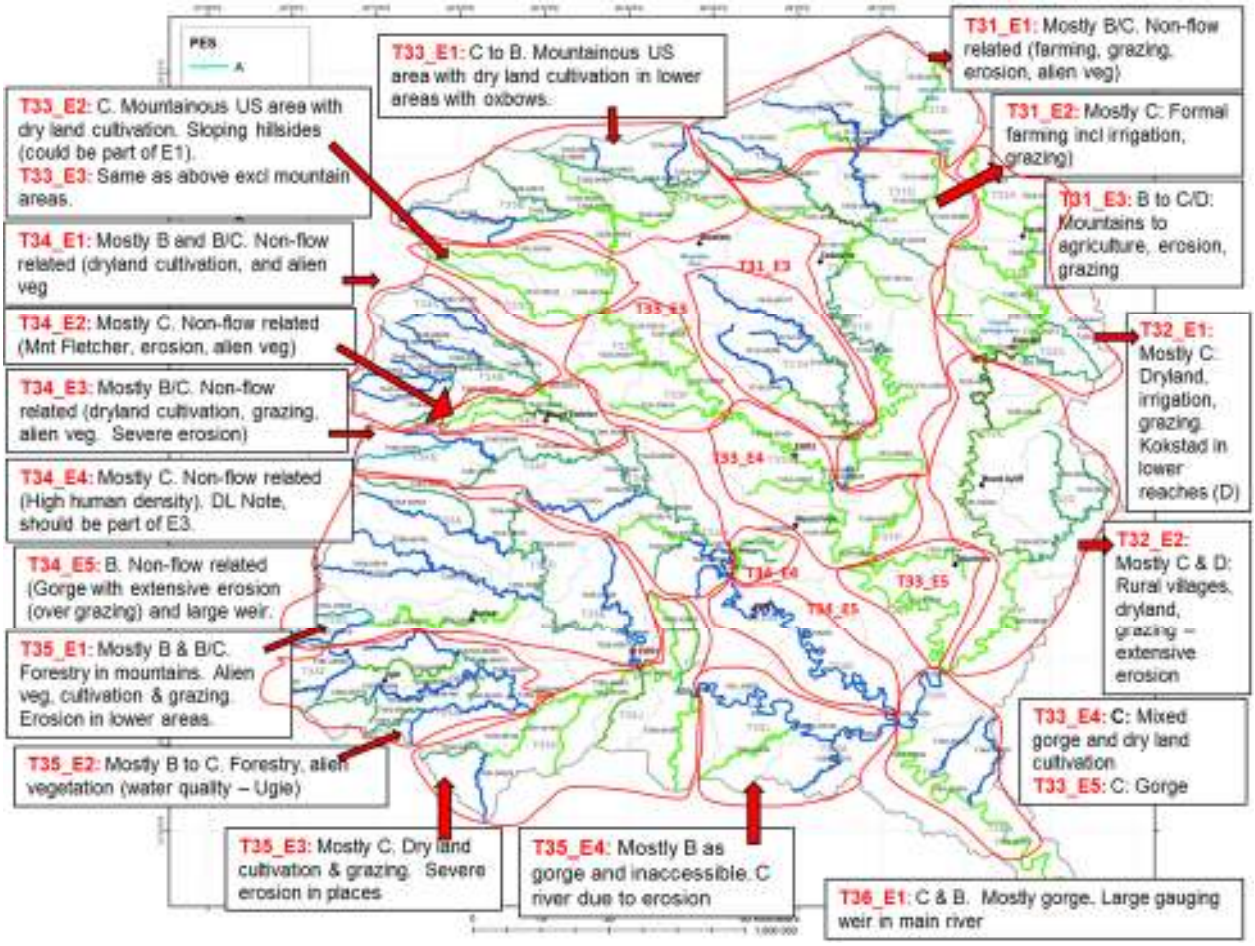


Figure 7.3 Ecological zones demarcated in terms of land use and similar ecological categories

VOLUME B: PRIORITISATION

8 WATER RESOURCE USE IMPORTANCE

The Water Resource Use Importance (WRUI) (DWAF, 2007a) was assessed by assigning a qualitative score to a river reach for four variables that represented the status of the instream flow. The scores of the four variables were combined to determine (qualitatively) an overall score which represented the importance of the river reach in terms of the water resource use. Most often, the maximum value was used to represent the final score. Severity and extent of the variables had to be considered to determine whether the maximum was the appropriate rating for the quaternary catchment.

The variables included in the rating method aimed to represent the status and function of the river reach. The variables and the associated characteristics associated with a score ranging from zero to four are presented in **Table 8.1**.

Table 8.1 Water Resource Use Priority rating variables and scoring characteristics

Variables	Score range and associated characteristic descriptions	
	0	4
Current water balance of catchment contributing flow to the river reach.	Very little water use occurs in the upstream catchment. Low, maintenance and high flow is largely natural.	Significant utilisation of water from the upstream catchment. Low and maintenance flows have been reduced and/or there exists significant regulating storage in the catchment.
Utilisation of the river reach for operational purposes.	Minimum changes in the river flow due to operational purposes.	The river reach is utilised as a conveyance conduit.
Possible future developments and/or water use expected in the catchment.	No known development planned in the catchment that could change the flow in the river reach.	It is expected that future developments that could change the flow in the river could occur.
Water quality related problems, assimilative capacity.	The water quality in the river reach is excellent and large assimilative capacity is present.	The river contains very high loads of pollutants.
Overall score:	There is no reason to determine the EWR in the river reach from a water resource management perspective.	A comprehensive EWR determination is necessary from a water use point of view.

The results are provided for the SQs with VERY HIGH rating in **Table 8.2**. The detailed Excel spreadsheet will be made available electronically with all data provided with the main report.

Table 8.2 WRUI evaluation for SQ with a VERY HIGH rating

SQ	River	Comment
T35E-05908	Tsitsa	Future Development.
T35E-05977	Tsitsa	Future Development.
T35K-06037	Tsitsa	Future Development.
T35K-06098	Tsitsa	Future Development.
T35L-05976	Tsitsa	Future Development.

SQ	River	Comment
T35L-06190	Tsitsa	Future Development.
T35M-06187	Tsitsa	Future Development.
T35M-06205	Thina	Future Development.
T36A-06250	Mzimvubu	Future Development.
T36A-06354	Mzimvubu	Future Development.
T36B-06391	Mzimvubu	Future Development.

9 SOCIO-CULTURAL IMPORTANCE

9.1 OVERVIEW

As indicated in **Chapter 5** a SCI model is developed per Sub-Quaternary and this allows for an overall analysis of socio-cultural importance that can be used to prioritise reaches.

9.2 SOCIO-CULTURAL IMPORTANCE

The SCI was generated by scoring each quaternary catchment based on the following features (Huggins *et al.*, 2010): To generate the SCI model, information was extracted in a master spreadsheet that incorporates all the SCI results. Column descriptions in the SCI sheet in the master spreadsheet are as follows:

- **Column A**: Sub-Quaternary (SQ) number. Individual code provided for each SQ by DWA and based on the codes used in the National Freshwater Ecosystem Priority Area (NFEPA) assessment.
- **Column B**: River. River name where available.
- **Column C**: Summarised comment on the SQ and river reach.
- **Column D**: Ritual Use. This was scored between 0 – 5. The question that was asked was "How much ritual use of the river takes place?" Typically, this would be for ceremonial purposes or for spiritual/religious activities. An example would be pools used for traditional initiation purposes. Both intensity and significance of use are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to make use of the river for ritual use and significance relates to the degree to which the river is of critical importance to people.
- **Column E**: Weighted score for Ritual Use. Ritual Use is given a weighted score of 50 points. So a score of 3 out of 5 in Column D would result in a weighted score of 120.
- **Column F**: Aesthetic Value. This was scored between 0 – 5. The question that was asked was "How important is the aesthetic value to people? Does the river stretch add value to people's life as an object of natural beauty? Would changing flows detract from this value?"
- **Column G**: Weighted score for Aesthetic Value. Aesthetic Value is given a weighted score of 50 points.
- **Column H**: Resource Dependence. This was scored between 0 – 5. This refers to the goods and services delivered by the river system and peoples' dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. It should be noted that commercial or "for financial gain" usage of resources is excluded from consideration in this instance. Both intensity and significance of use are valued and the higher of the two scores is adopted.
- **Column I**: Weighted score for Resource Dependence. Resource Dependence is given a weighted score of 225 points.
- **Column J**: Recreational Use. This was scored between 0 – 5. The question that was asked was "Does the river stretch provide recreational facilities to people and would this be affected by changing flows?"
- **Column K**: Weighted score for Recreational Use. Recreational Use is given a weighted score of 125 points.
- **Column L**: Historical/Cultural Value. This was scored between 0 – 5. The question that was asked was "Does the river have a strong cultural or historical value?"

- **Column M**: Weighted score for Historical/Cultural Value. Historical/Cultural Value is given a weighted score of 50 points.
- **Column N**: This is the overall SCI score derived by adding the weighted scores and dividing by the number of criteria and as a proportion of the overall maximum score.

Table 9.1 SCI rating

SCI score	Category	Comment
0 – 0.99	**VERY LOW**	Of little or no socio-cultural importance.
1 – 1.99	**LOW**	Of some importance. PES not critical, but caution should be displayed with regard to negative impact on dependent communities.
2 – 2.99	**MODERATE**	Of moderate importance. PES should not be allowed to be negative affected without strong motivation.
3 – 3.99	**HIGH**	Of high importance. A score in this range motivates for maintain or potentially positive change to PES.
4 – 5	**VERY HIGH**	Of extreme importance. A score in this range motivates for positive change to PES.

The following SQs, as set out in 9–2 below, scored “High”. There were no scores in the “Very High” range. The bulk of those scoring HIGH did so either because of the recreation and aesthetic value or the high dependence on resources associated with poor and vulnerable communities located within the SQ.

Table 9.2 Weighted SCI scores per SQ for all reaches scoring “High”

SQ number	River	Causes/sources comment	Weighted score
T36B-06391	Mzimvubu	Lower section of river including estuary and Port St Johns 10km.	3.75
T31C-04796	Mngeni	Subsistence farming, higher rural pop density (closer settlement), 35 km river	3.65
T31E-04836	Tswereka	Subsistence farming, higher rural pop density (closer settlement), 25 km river	3.60
T31G-05071	Mzimvubu	60 km river, extensive commercial farming, also subsistence closer settlement in bottom half	3.60
T33C-05131	Morulane	Patches of very dense settlement, subsistence, 56km	3.48
T32F-05464	Mzintlava	Subsistence farming, higher rural pop density, 76 km river, Mount Ayliff	3.38
T33A-04903	Kinira	Patches of very dense settlement, subsistence, 21km	3.38
T33A-04990	Kinira	Small scale and dense agriculture, patches of density, 30km	3.38
T33B-04956	Mosenene	Patches of very dense settlement, subsistence, 23km	3.38
T33E-05213	Kinira	Patches of very dense settlement, subsistence 33km	3.38
T33F-05439	Ncome	Closer settlement in lower portion 30km	3.38
T33G-05395	Kinira	Isolated but with closer settlement in lower portion 55km	3.38

SQ number	River	Causes/sources comment	Weighted score
T34D-05463	Tokwana	Patches of very dense settlement, subsistence, 17km, Mount Fletcher	3.38
T34H-05598	Thina	Dense agricultural development and dense closer settlement, subsistence, 27km	3.38
T31C-04879	Nyongo	Subsistence farming, higher rural pop density (closer settlement), 23 km river	3.35
T31E-04910	Malithasana	Subsistence farming, higher rural pop density, 24 km river	3.35
T33D-05106	Pabatlong	Patches of very dense settlement, subsistence, 48km	3.35
T31E-04931	Tswereka	Commercial lower and subsistence upper farming, 22 km river, rural pop higher density in upper	3.30
T34A-05362	Vuvu	Isolated but with closer settlement in lower portion 44km	3.28
T34B-05275	Phiri-e-ntso	Isolated but with closer settlement in lower portion 21km	3.28
T34C-05292	Tinana	Patches of very dense settlement, subsistence, 26km	3.28
T34D-05412	Thina	Patches of very dense settlement, subsistence, 19km	3.28
T32G-05536	Mzintlavana	Subsistence farming, lower rural pop density, 37 km river, but some dense settlement	3.20
T33A-04991		Some very dense settlement, town of Maluti, some subsistence agriculture 17km	3.20
T33H-05680	Mzimvubu	Some very dense settlement, town of Mount Frere, some subsistence agriculture 42km	3.20
T33H-05803	Caba	Some very dense settlement, town of Tabankulu, some subsistence agriculture 31km	3.20
T31H-05177	Mvenyane	Mostly commercial farming and plantation, closer settlement at bottom, 43km	3.15
T34G-05634	Nxaxa	Isolated but with closer settlement in portions 37km	3.15
T34H-05699	Mvuzi	Dense agricultural development and closer settlement, subsistence, 13km	3.15
T34H-05714	Qhanqu	Dense agricultural development and closer settlement, subsistence, 22km	3.15
T35L-05976	Tsitsa	Tsitsa Falls, closer and planned settlement, subsistence agriculture 55km	3.05
T32G-05747	Mzintlavana	Subsistence farming, higher rural pop density, 29 km river	3.03
T33B-05072		Subsistence farming, higher rural pop density, 9 km river	3.03
T33D-05063	Kinira	Patches of very dense settlement, subsistence, 22km	3.03
T33E-05367	Somabadi	Patches of very dense settlement, subsistence,17km	3.03
T33F-05285	Rolo	Subsistence farming, higher rural pop density, 18 km river	3.03
T33G-05587	Cabazi	Patches of very dense settlement, subsistence, 23km	3.03

SQ number	River	Causes/sources comment	Weighted score
T34A-05408	Khohlong	Isolated but with closer settlement in lower portion 19km	3.03
T34A-05415	Thina	Isolated but with closer settlement in lower portion 21km	3.03
T34B-05351	Thina	Patches of very dense settlement, subsistence, 17km	3.03
T34F-05512	Luzi	Patches of very dense settlement, subsistence, 33km	3.03

10 RIVER ECOLOGICAL IMPORTANCE

10.1 ECOLOGICAL IMPORTANCE AND SENSITIVITY

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Resh *et al.*, 1988; Milner, 1994). Both abiotic and biotic components of the system were taken into consideration in the assessment.

The importance evaluation for rivers used for this study were those generated as part of the PESEIS study (DWS, 2014b) from the front end models as provided by Dr Kleynhans, D:RQIS, DWS. The Ecological Importance (EI) and Ecological Sensitivity (ES) of SQs were assessed to obtain an indication of its vulnerability to environmental modification within the context of the PES. This would relate to the ability of the SQ to endure, resist and be able to recover from various forms of human use (DWS, 2014b). Further explanations of the functions of the model must be referred to D:RQIS.

10.2 FRESHWATER ECOSYSTEM PRIORITY AREAS (FEPAS)

Freshwater Ecosystem Priority Areas (FEPAs) for SQ river reaches were indicated in the master spreadsheet. Table 10.1 provides those SQ with a high NFEPA in the last column (**Table 10.1**). No review or adjustments have been made to these DWS, 2014b results during this study and they have been taken as is (column 3 and 4 in Table 10.1).

Table 10.1 SQs with EIS as High or Very High

SQ number	River	River EI (rating)	River ES (rating)	NFEPA (rating)
T31A-04712	Mzimvubu	MODERATE	HIGH	HIGH
T31B-04873		MODERATE	HIGH	HIGH
T31C-04796	Mngeni	MODERATE	HIGH	HIGH
T31C-04866	Mzimvubu	MODERATE	MODERATE	HIGH
T31D-05060		MODERATE	HIGH	HIGH
T31E-04836	Tswereka	MODERATE	HIGH	HIGH
T31E-04910	Malithasana	MODERATE	HIGH	HIGH
T31F-05111	Mzimvubu	MODERATE	MODERATE	HIGH
T31G-05071	Mzimvubu	MODERATE	MODERATE	HIGH
T31G-05382		MODERATE	HIGH	HIGH
T31H-05177	Mvenyane	HIGH	HIGH	HIGH
T31H-05296	Mkemane	HIGH	MODERATE	HIGH
T31H-05304		MODERATE	HIGH	HIGH
T31H-05437	Mkemane	MODERATE	HIGH	HIGH
T31H-05445		MODERATE	HIGH	HIGH
T31J-05582	Ngwekazana	MODERATE	HIGH	HIGH
T31J-05588	Mzimvubu	MODERATE	MODERATE	HIGH
T32A-04965	Mzintlava	MODERATE	HIGH	HIGH
T32B-05116		MODERATE	HIGH	HIGH
T32C-05219	Mill Stream	MODERATE	HIGH	HIGH
T32C-05243	aManzamnyama	MODERATE	HIGH	HIGH
T32C-05378		MODERATE	HIGH	HIGH

SQ number	River	River EI (rating)	River ES (rating)	NFEPA (rating)
T32F-05464	Mzintlava	HIGH	HIGH	HIGH
T32G-05536	Mzintlavana	HIGH	HIGH	HIGH
T32G-05609	Mbandana	HIGH	HIGH	HIGH
T32G-05747	Mzintlavana	HIGH	HIGH	HIGH
T32H-05842	Mzintlava	HIGH	HIGH	HIGH
T33A-04887	Mafube	MODERATE	HIGH	HIGH
T33A-04898	Makomorin	MODERATE	HIGH	HIGH
T33B-04912	Seeta	MODERATE	HIGH	HIGH
T33B-05005	Jordan	MODERATE	HIGH	HIGH
T33B-05072		MODERATE	HIGH	HIGH
T33F-05285	Rolo	MODERATE	HIGH	HIGH
T33F-05326	Kinira	MODERATE	HIGH	HIGH
T33H-05803	Caba	HIGH	HIGH	HIGH
T33H-05821	Mzimvubu	MODERATE	HIGH	HIGH
T33J-05834	Mzimvubu	HIGH	HIGH	HIGH
T33K-06051	Mzimvubu	HIGH	HIGH	HIGH
T34A-05354	Zindawa	HIGH	HIGH	HIGH
T34A-05362	Vuvu	HIGH	HIGH	HIGH
T34A-05394	Vuvu	HIGH	HIGH	HIGH
T34A-05404	Thina	HIGH	HIGH	HIGH
T34A-05408	Khohlong	HIGH	HIGH	HIGH
T34A-05415	Thina	MODERATE	HIGH	HIGH
T34B-05275	Phiri-e-ntso	MODERATE	HIGH	HIGH
T34C-05168	Tinana	MODERATE	HIGH	HIGH
T34C-05238	Phinari	MODERATE	HIGH	HIGH
T34D-05412	Thina	MODERATE	HIGH	HIGH
T34D-05462	Khalatsu	MODERATE	HIGH	HIGH
T34E-05495	Bradgate se Loop	HIGH	HIGH	HIGH
T34E-05503	Luzi	MODERATE	HIGH	HIGH
T34E-05507	Luzi	MODERATE	HIGH	HIGH
T34H-05809	Mvumvu	MODERATE	HIGH	HIGH
T34K-05835	Thina	HIGH	MODERATE	HIGH
T35C-05858	Mooi	HIGH	HIGH	HIGH
T35D-05721	Tsitsa	MODERATE	HIGH	HIGH
T35D-05844	Mooi	MODERATE	HIGH	HIGH
T35F-05973	Kuntombizininzi	HIGH	HIGH	HIGH
T35F-05999	Inxu	MODERATE	HIGH	HIGH
T35F-06000	Fontana	MODERATE	HIGH	HIGH
T35F-06020	Inxu	MODERATE	HIGH	HIGH
T35F-06112	Rondadura	MODERATE	HIGH	HIGH
T35G-06002	Inxu	MODERATE	HIGH	HIGH
T35G-06021	Inxu	MODERATE	HIGH	HIGH
T35G-06069	Gatberg	HIGH	HIGH	HIGH
T35G-06074	Gatberg	MODERATE	HIGH	HIGH
T35G-06099	Gatberg	MODERATE	HIGH	HIGH
T35G-06100		MODERATE	HIGH	HIGH
T35G-06108	Inxu	MODERATE	HIGH	HIGH
T35G-06118	Gatberg	MODERATE	HIGH	HIGH
T35G-06133		MODERATE	HIGH	HIGH

SQ number	River	River EI (rating)	River ES (rating)	NFEPA (rating)
T35G-06135	Gqaqala	MODERATE	HIGH	HIGH
T35G-06179		MODERATE	HIGH	HIGH
T35H-06024	Inxu	MODERATE	HIGH	HIGH
T35H-06053	Inxu	MODERATE	HIGH	HIGH
T35H-06158	Qwakele	MODERATE	HIGH	HIGH
T35J-06088	Inxu	MODERATE	HIGH	HIGH
T35J-06106	Ncolosi	MODERATE	HIGH	HIGH
T35K-05897	Culunca	MODERATE	HIGH	HIGH
T35M-06275	Ruze	HIGH	MODERATE	HIGH
T36A-06216	Mzintshana	MODERATE	MODERATE	HIGH
T36A-06220	Mkata	HIGH	HIGH	HIGH
T36A-06250	Mzimvubu	MODERATE	HIGH	HIGH
T36A-06354	Mzimvubu	MODERATE	HIGH	HIGH

The reasoning behind the selection of a specific SQ as a NFEPA was not clear within the data (meta data or atlas) provided as part of the NFEPA documentation. The raw data (such as the fish distribution and conservation status description) used for inclusion in the FEPA was also not readily available. It was however evident that the primary FEPA selection criteria was that a reach had to fall within a good PES and that a fish of conservation importance must be present. Nel *et al.*, 2011 indicated that the base criterium of the river FEPA is the following: "Rivers had to be in a good condition (A or B PES) to be chosen as FEPAs".

The results of the PESEIS study (DWS, 2014b) provided a higher confidence PES assessment as that on which the NFEPA study was based [which was largely Kleynhans's 2000 PESEIS database as well as some localised and expert data]. The PESEIS study (DWS, 2014b) included a Google Earth™ assessment by various specialists with different backgrounds and extensive local knowledge and it must supersede (Kleynhans, *pers. comm.*) the NFEPA baseline. The DWS 2014b PESEIS information was further refined during this study (2016) based on the latest available information (especially Google Earth aerial imagery) and hence a more recent PES was calculated for each SQ.

The results of the PESEIS study (DWS, 2014b) also provided distribution information for fish species in every SQ based on survey results and expert knowledge. These results also superseded the fish information used for the NFEPA assessment and hence the potential presence of important fish species in an SQ were verified by the use of the PESEIS (DWS, 2014b) database.

Based on the above, the verification of the NFEPAs was essential prior to the NFEPA status being used to influence decision-making within the NWRCS. The following filtering process was followed to verify the current NFEPA status:

- All FEPAs were identified from the shapefiles (Nel *et al.*, 2011) as well as correlating it with the data provided in the front end PESEIS models (DWS, 2014b).
- If the PES results from the PESEIS project (DWS 2014b and 2016 update) indicated that the SQ was not in a B or higher PES, it was not further considered as a FEPA (Category B/C was considered to be marginal and hence included within the acceptable limit).
- The presence of the important fish species (that the NFEPA was based on) in the SQ were verified using the information from the PESEIS study (DWS, 2014b).

There are also Phase 2 FEPAs which were in a "present condition of a C (moderately modified) Ecological Category." According to Nel *et al.* (2011) the condition of these Phase 2 FEPAs should not be degraded further, as they may in future be considered for rehabilitation. This implied that all Phase 2 FEPAs should be in a C PES and maintained in the short term as a C PES. These Phase 2 FEPAs were therefore not further considered as the EcoClassification approach will never set the Recommended Ecological Category (REC) to be lower than the PES.

Adjustments of EIS based on FEPA: When the latest information confirmed that a SQ qualifies to be considered as a NFEPA, the ecological importance and sensitivity (EIS) was increased to fall in a minimum of a "high" category.

10.3 ADJUSTED RIVER ECOLOGICAL IMPORTANCE AND SENSITIVITY RESULTS

The SQs with associated NFEPAs (see **Table 10.1**) are listed and verified in **Table 10.2**. The EIS results for all the SQs are provided in **Table 11.2**, column 3.

All NFEPAs within the T3 catchment listed *Barbus anoplus* as the fish species of concern used during the NFEPA selection process. The current IUCN rating (2016-1) of this species remains *Least Concern*, although it is indicated that this species complex is currently under revision (ideally IUCN should indicate this species as Data Deficient: Taxonomy). Communication with Dr A. Bok (and Dr L. da Costa) indicate that the *Barbus anoplus/amatolicus* (recent genus change recommended for African *Barbus* to *Enteromius*) may well be of conservation concern, validating the use of this species in the FEPA delineation of this region. Further studies (including genetic verification) is still required before the taxonomy of these "new" species can be finalised. Currently the species are referred to as **Enteromius sp.* "*amatolicus Transkei*" (*Mzimvubu catchment*) and **Enteromius sp.* "*amatolicus Mzintlava*" (*Mzintlava catchment*). The NFEPA's (Driver *et al.,* 2011) of catchment T3 may require further revision once more information becomes available on the actual species composition, distribution, and conservation status of the "new" *Barbus/Enteromius* complex of species.

Table 10.2 FEPA verification based on PES data and fish information

SQ no	River	River EIS (value)	River EIS (rating)	Revised PES	River FEPA	FEPA comment	FEPA verification	Adjusted EIS (NFEPA considered)	Adjusted EIS
T31A-04712	Mzimvubu	2.9	Moderate	**B/C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Marginally qualifies** for FEPA based on B/C PES.	√?	3.0	High
T31C-04866	Mzimvubu	2.7	Moderate	**B**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Qualifies** for FEPA based on B PES.	√?	3.0	High
T31F-05111	Mzimvubu	2.6	Moderate	**B**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Qualifies** for FEPA based on B PES.	√?	3.0	High
T31F-05112	Mzimvubu	2.6	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Does not qualify** for FEPA based on C PES (outside A-B range).	X	2.6	Moderate
T31G-05071	Mzimvubu	2.6	Moderate	**B/C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Marginally qualifies** for FEPA based on B/C PES.	√?	3.0	High
T31G-05382		3.1	High	**B/C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Marginally qualifies** for FEPA based on B/C PES.	√?	3.1	High
T31J-05257	Mzimvubu	2.8	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Does not qualify** for FEPA based on C PES (outside A-B range).	X	2.8	Moderate
T31J-05551	Mzimvubu	2.6	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Does not qualify** for FEPA based on C PES (outside A-B range).	X	2.6	Moderate

SQ no	River	River EIS (value)	River EIS (rating)	Revised PES	River FEPA	FEPA comment	FEPA verification	Adjusted EIS (NFEPA considered)	Adjusted EIS
T31J-05588	Mzimvubu	2.5	Moderate	**B/C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus likely* present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Marginally qualifies** for FEPA based on B/C PES (based on A or B criteria).	√?	3.0	High
T32A-04965	Mzintlava	2.9	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Does not qualify** for FEPA based on C PES (outside A-B range).	X	2.9	Moderate
T32B-05103	Mzintlava	2.8	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). Do not qualify for FEPA based on C PES (outside A-B range).	X	2.8	Moderate
T32B-05184	Mzintlava	2.7	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Does not qualify** for FEPA based on C PES (outside A-B range).	X	2.7	Moderate
T32C-05219	Mill Stream	2.9	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Does not qualify** for FEPA based on C PES (outside A-B range).	X	2.9	Moderate
T32C-05273	Mzintlava	2.5	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Does not qualify** for FEPA based on C PES (outside A-B range).	X	2.5	Moderate
T34H-05738	Ngcibira	2.8	Moderate	**C**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Does not qualify** for FEPA based on C PES (outside A-B range).	X	2.8	Moderate
T36A-06216	Mzintshana	2.8	Moderate	**B**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Qualifies** for FEPA based on B PES.	√?	3.0	High
T36A-06220	Mkata	3.0	High	**B**	FEPA (*Barbus anoplus*#)	*Barbus anoplus* likely present in this SQ (based on PESEIS, 2013). Selection criteria based on *B. anoplus* uncertain (see detail). **Qualifies** for FEPA based on B PES.	√?	3.0	High

11 DETERMINATION OF PRIORITY RIVER SQs

A biodiversity/ecological hotspot is a biogeographic region which is a significant reservoir of biodiversity which is threatened with destruction (http://en.wikipedia. org/wiki/Biodiversity_hotspot). In the context used here, the hotspot represents a river reach with a high Integrated Environmental Importance (IEI) which could be under threat due to its importance for water resource use. The hotspots are therefore an indication of areas where detailed investigations would be required if, for example, development was being considered or the area was under water resource use stress. These hotspots usually represent areas which are already stressed or will be stressed in future (Louw and Huggins, 2007; Louw *et al.,* 2010).

In order to link with the RQO terminology, the hotspots will from hereon be referred to as High Priority Resource Units.

Classification is usually undertaken for a large area with many IUAs. IUAs are a combination of the socio-economic region defined in watershed boundaries, within which ecological information is provided at a finer scale. This requires that biophysical nodes be nested within the IUAs (DWA, 2007). Ideally, each SQ (or combined SQs into RUs) requires some level of EWR assessment. The hotspot identification will therefore provide an indication of the level of EWR assessment required at the biophysical nodes. In essence, this would be similar to a filtering process where the most detailed assessment is undertaken at hotspots, and less detailed assessments at the other areas. Nodes that are EWR sites represent the areas where most detailed EWR methods will be required.

The purpose of the identification of High Priority Resource Units for this study was the following:

- To determine whether hotspots were addressed by existing EWR sites.
- To provide guidance to levels of Reserve that might be required for licensing purposes within the framework provided by the National Water Resource Classification System (NWRCS).
- To provide an indication where scenario development and testing would be important.
- To provide guidance to areas with a very low hotspot evaluation as flow requirements for these might be not be necessary.
- To link to the RQO process that provides different levels of RQOs linked to the RU priority level.

The process used is described in **Figure 11.1** and relied on the results (with modifications during this study) of the PESEIS study.

As part of this assessment, the Water Resource Use Importance (WRUI) was undertaken as well as the Socio-Cultural Importance (SCI). These were undertaken on a Sub-Quaternary scale but grouped where similar.

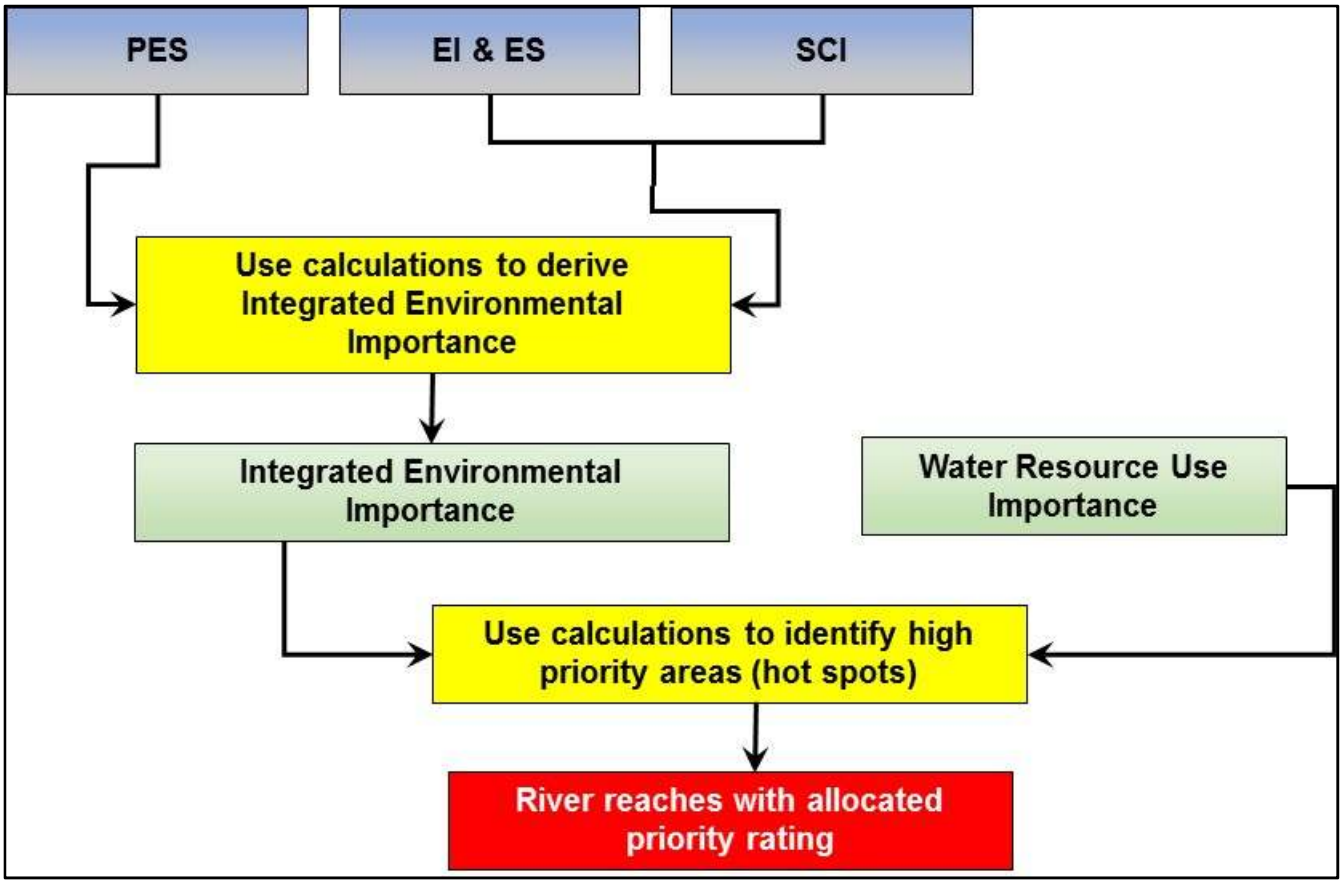


Figure 11.1 Summary of the process to identify biophysical nodes for EWR assessment

The steps used to identify the priority areas (hotspots) were:

- Desktop EcoClassification which included the determination of the Ecological Importance and Sensitivity (EIS); Socio-Cultural Importance (SCI) and Present Ecological State (PES).
- Determination of the IEI by integrating the EIS, SCI and the PES.
- Determining the WRUI.
- Identification of the areas which were priority hotspots because of high IEI and/or WRUI and required more detailed studies.
- Provide recommendations for the locality of detailed EWR sites.

11.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

11.1.1 Integrated Environmental Importance approach

As described above, the Ecological and Socio-Cultural Importance were assessed separately and were then integrated with the PES to determine the Integrated Environmental Importance. The PES forms part of the Integrated Environmental Importance as rivers (or wetlands) in good condition are scarce, and therefore important in their own right. A river that is in very good condition, but of low EIS, and/or SCI; might still be important from an ecological perspective, as it could be one of a limited number of that type of river that is in good condition. The Integrated Environmental Importance also provides an indication of the restoration potential. The restoration potential refers to the probability of achieving the rehabilitation of the river to an improved state. For example, if a river has very high Ecological and Socio-Cultural Importance, but is in bad condition, the restoration potential is often low and that will result in a low Integrated Environmental Importance.

The EIS and SCI ratings were not averaged, but the highest score of the two (referred to in tables as an Importance Score (IS) are used to integrate it with the PES. This is then called the Integrated Environmental Importance. A matrix (**Table 11.1**) to aid in consistently providing an integrated rating comparing EIS, SCI, and PES was designed during 2006 (Louw and Huggins, 2007) and modified during this study to automate the process and thereby produce more consistent answers.

Table 11.1 Matrix used to determine a combined EIS/SCI and PES value which provides an Integrated Environmental Importance value

EIS &SCI (max)									
	Very high	4-5	3	3	3	4	5	5	5	5
	High	3-3.9	3	3	3	3	4	5	5	5
	Moderate	2-2.9	2	2	2	3	3	4	5	5
	Low	1-1.9	1	1	2	2	3	4	4	4
	Very low	0-0.9	1	1	1	2	2	3	4	4
			D/E to F	D	C/D	C	B/C	B	A/B	A
			>3.2	2.7-3.2	2.3-2.6	1.7-2.2	1.3-1.6	0.7-1.2	0.3-0.6	<0.3
			PES							

11.1.2 Integrated Environmental Importance results

The results are provided in **Table 11.2**.

Table 11.2 IS and IEI results

SQ number	River	River EIS	SCI	IS	PES		IEI
T31A-04712	Mzimvubu	Moderate	Moderate	High	B/C		4
T31B-04745	Krom	Moderate	Low	Moderate	C		3
T31B-04868	Krom	Moderate	Low	Moderate	B		4
T31B-04873		High	Low	High	C		3
T31C-04796	Mngeni	High	High	High	B		5
T31C-04866	Mzimvubu	Moderate	Moderate	High	B		5
T31C-04879	Nyongo	Moderate	High	High	C		3
T31C-04929	Mzimvubu	Moderate	Low	Moderate	C		3
T31D-04926	Mzimvubu	Moderate	Low	Moderate	B		4
T31D-04936	Riet	Moderate	Low	Moderate	C		3
T31D-05030	Riet	Moderate	Low	Moderate	C		3
T31D-05060		High	Moderate	High	B/C		4
T31D-05076	Mzimvubu	Moderate	Low	Moderate	C		3
T31E-04836	Tswereka	Moderate	High	High	B		5
T31E-04910	Malithasana	Moderate	High	High	B/C		4
T31E-04931	Tswereka	Moderate	High	High	B/C		4
T31E-05013	Tswereka	Moderate	Moderate	Moderate	D		2
T31E-05055		Moderate	Moderate	Moderate	C		3
T31F-05108		Moderate	Low	Moderate	B/C		3
T31F-05111	Mzimvubu	Moderate	Low	High	B		5
T31F-05112	Mzimvubu	Moderate	Moderate	Moderate	C		3
T31F-05134		Moderate	Low	Moderate	C		3
T31G-05071	Mzimvubu	Moderate	High	High	B/C		4

SQ number	River	River EIS	SCI	IS	PES		IEI
T31G-05382		High	Low	High	B/C		4
T31H-05177	Mvenyane	High	High	High	B		5
T31H-05296	Mkemane	High	Moderate	High	B		5
T31H-05304		Moderate	Moderate	High	B		5
T31H-05324	Mvenyane	Moderate	Moderate	Moderate	B/C		3
T31H-05437	Mkemane	Moderate	Moderate	High	C/D		3
T31H-05445		High	Moderate	High	C		3
T31H-05516	Mvenyane	Moderate	Moderate	Moderate	C/D		2
T31J-05257	Mzimvubu	Moderate	Moderate	Moderate	C		3
T31J-05551	Mzimvubu	Moderate	Moderate	Moderate	C		3
T31J-05582	Ngwekazana	Moderate	Moderate	High	C		3
T31J-05588	Mzimvubu	Moderate	Moderate	High	B/C		4
T32A-04907	Mzintlanga	Moderate	Low	Moderate	C		3
T32A-04965	Mzintlava	Moderate	Moderate	High	C		3
T32B-05103	Mzintlava	Moderate	Moderate	Moderate	C		3
T32B-05116		Moderate	Moderate	High	C		3
T32B-05184	Mzintlava	Moderate	Moderate	Moderate	C		3
T32C-05219	Mill Stream	Moderate	Low	High	C		3
T32C-05243	aManzamnyama	Moderate	Moderate	High	B/C		4
T32C-05273	Mzintlava	Moderate	Low	Moderate	C		2
T32C-05313	Mzintlava	Moderate	Moderate	Moderate	B		4
T32C-05378		Moderate	Moderate	High	B/C		4
T32D-05172	Droewig	Moderate	Low	Moderate	C		3
T32D-05352	Mzintlava	Moderate	Low	Moderate	D		2
T32D-05373	Mzintlava	Moderate	Low	Moderate	D		2
T32E-05446	Mvalweni	Moderate	Moderate	Moderate	C		2
T32F-05464	Mzintlava	High	High	High	C/D		3
T32G-05536	Mzintlavana	High	High	High	B/C		4
T32G-05609	Mbandana	High	Moderate	High	B/C		4
T32G-05747	Mzintlavana	High	High	High	B/C		4
T32H-05842	Mzintlava	High	Moderate	High	C		3
T33A-04887	Mafube	Moderate	Moderate	High	B		5
T33A-04892	Kinira	Moderate	Moderate	Moderate	B/C		3
T33A-04898	Makomorin	High	Moderate	High	B		5
T33A-04903	Kinira	Moderate	High	High	B/C		4
T33A-04928		Moderate	Moderate	Moderate	B/C		3
T33A-04983	Mafube	Moderate	Moderate	Moderate	C		3
T33A-04990	Kinira	Moderate	High	High	C		3
T33A-04991		Moderate	High	High	C		3
T33A-05011	Kinira	Moderate	Moderate	Moderate	B/C		3
T33B-04912	Seeta	Moderate	Moderate	High	B/C		4
T33B-04939	Mabele	Moderate	Low	Moderate	C		3
T33B-04956	Mosenene	Moderate	High	High	C		3
T33B-05005	Jordan	Moderate	Moderate	High	B		5
T33B-05051	Mabele	Moderate	Moderate	Moderate	B/C		3
T33B-05066	Mabele	Moderate	Low	Moderate	C		3
T33B-05072		High	High	High	B		5

SQ number	River	River EIS	SCI	IS	PES		IEI
T33C-05131	Morulane	Moderate	High	High	C		3
T33D-05063	Kinira	Moderate	High	High	C		3
T33D-05106	Pabatlong	Moderate	High	High	C		3
T33D-05150	Kinira	Moderate	Moderate	Moderate	C		3
T33E-05213	Kinira	Moderate	High	High	C		3
T33E-05367	Somabadi	Moderate	High	High	C		3
T33F-05285	Rolo	High	High	High	C		3
T33F-05326	Kinira	High	Moderate	High	C		3
T33F-05398	Kinira	Moderate	Moderate	Moderate	C		3
T33F-05439	Ncome	Moderate	High	High	C		3
T33G-05395	Kinira	Moderate	High	High	C		3
T33G-05587	Cabazi	Moderate	High	High	C		3
T33G-05659	Mzimvubu	Moderate	Low	Moderate	B		4
T33H-05638	Mnceba	Moderate	Moderate	Moderate	C		3
T33H-05680	Mzimvubu	Moderate	High	High	C		3
T33H-05803	Caba	High	High	High	C		3
T33H-05821	Mzimvubu	High	Low	High	C		3
T33J-05834	Mzimvubu	High	Moderate	High	C		3
T33K-06051	Mzimvubu	High	Moderate	High	B		5
T34A-05354	Zindawa	High	Moderate	High	B		5
T34A-05362	Vuvu	High	High	High	B		5
T34A-05394	Vuvu	High	Low	High	B		5
T34A-05404	Thina	High	Low	High	B		5
T34A-05408	Khohlong	High	High	High	B/C		4
T34A-05415	Thina	Moderate	High	High	B		5
T34B-05269	Nxotshana	Moderate	Moderate	Moderate	B		4
T34B-05275	Phiri-e-ntso	Moderate	High	High	B		5
T34B-05351	Thina	Moderate	High	High	B/C		4
T34B-05356	Thina	Moderate	Moderate	Moderate	B/C		3
T34B-05385	Thina	Moderate	Low	Moderate	B/C		3
T34C-05168	Tinana	Moderate	Low	High	B		5
T34C-05238	Phinari	Moderate	Low	High	B		5
T34C-05292	Tinana	Moderate	High	High	B/C		4
T34D-05412	Thina	Moderate	High	High	C		3
T34D-05433	Tokwana	Moderate	Low	Moderate	C		3
T34D-05460	Thina	Moderate	Moderate	Moderate	B/C		3
T34D-05462	Khalatsu	Moderate	Moderate	High	C		3
T34D-05463	Tokwana	Moderate	High	High	D		3
T34E-05495	Bradgate se Loop	Moderate	Moderate	High	A/B		5
T34E-05503	Luzi	High	Low	High	B		5
T34E-05507	Luzi	Moderate	Moderate	High	B		5
T34F-05512	Luzi	Moderate	High	High	B/C		4
T34F-05585		Moderate	Moderate	Moderate	B/C		3
T34G-05504	Qwidlana	Moderate	Moderate	Moderate	B/C		3
T34G-05543	Thina	Moderate	Moderate	Moderate	B/C		3
T34G-05634	Nxaxa	Moderate	High	High	B		5

SQ number	River	River EIS	SCI	IS	PES		IEI
T34G-05667	Thina	Moderate	Low	Moderate	B		4
T34H-05598	Thina	Moderate	High	High	B/C		4
T34H-05699	Mvuzi	Moderate	High	High	C		3
T34H-05714	Qhanqu	Moderate	High	High	C		3
T34H-05738	Ngcibira	Moderate	Moderate	Moderate	C		3
T34H-05769	Tsilithwa	Moderate	Moderate	Moderate	B		4
T34H-05772	Thina	Moderate	Moderate	Moderate	B		4
T34H-05791	Tsilithwa	Moderate	Moderate	Moderate	B/C		3
T34H-05809	Mvumvu	High	Low	High	B/C		4
T34H-05826	Ngcothi	Moderate	Moderate	Moderate	B		4
T34H-05838	Thina	Moderate	Low	Moderate	B/C		3
T34K-05835	Thina	High	High	High	B		4
T35A-05596	Tsitsana	Moderate	Moderate	Moderate	B/C		3
T35A-05648	Tsitsa	Moderate	Low	Moderate	B		4
T35A-05657	Hlankomo	Moderate	Moderate	Moderate	B/C		3
T35A-05750	Tsitsa	Moderate	Moderate	Moderate	B		4
T35B-05709	Pot	Moderate	Moderate	Moderate	B		4
T35B-05798	Pot	Moderate	Moderate	Moderate	B		4
T35B-05815	Little Pot	Moderate	Moderate	Moderate	B		4
T35C-05858	Mooi	High	Moderate	High	A/B		5
T35C-05874	Mooi	Moderate	Moderate	Moderate	C		3
T35C-05930	Klein-Mooi	Moderate	Moderate	Moderate	B		4
T35D-05721	Tsitsa	Moderate	High	High	B/C		4
T35D-05844	Mooi	Moderate	Low	High	B		5
T35E-05780	Gqukunqa	Moderate	Moderate	Moderate	B		4
T35E-05908	Tsitsa	Moderate	Moderate	Moderate	B/C		3
T35E-05977	Tsitsa	Moderate	Moderate	Moderate	B		4
T35F-05973	Kuntombizininzi	High	Moderate	High	B		5
T35F-05999	Inxu	High	Moderate	High	B		5
T35F-06000	Fontana	High	Moderate	High	B		5
T35F-06020	Inxu	High	Moderate	High	C/D		3
T35F-06080	Inxu	Moderate	Moderate	Moderate	B		4
T35F-06112	Rondadura	High	Low	High	B		5
T35G-06002	Inxu	High	Low	High	B/C		4
T35G-06021	Inxu	High	Moderate	High	B		5
T35G-06069	Gatberg	High	Moderate	High	B		5
T35G-06074	Gatberg	High	Moderate	High	B		5
T35G-06099	Gatberg	High	Moderate	High	B		5
T35G-06100		High	Moderate	High	B/C		4
T35G-06108	Inxu	High	Moderate	High	B		5
T35G-06118	Gatberg	High	Moderate	High	B/C		4
T35G-06133		High	Moderate	High	B/C		4
T35G-06135	Gqaqala	Moderate	Moderate	High	B		5
T35G-06148	Not assessed – drainage line						
T35G-06169	Gqaqala	Moderate	Moderate	Moderate	B/C		3
T35G-06179		High	Moderate	High	B		5
T35H-06024	Inxu	High	Moderate	High	C		3

SQ number	River	River EIS	SCI	IS	PES		IEI
T35H-06053	Inxu	High	Moderate	High	C		3
T35H-06158	Qwakele	High	Moderate	High	C		3
T35H-06186	Umnga	Moderate	Moderate	Moderate	C		3
T35H-06240	KuNgindi	Moderate	Moderate	Moderate	B/C		3
T35H-06282	Umnga	Moderate	Moderate	Moderate	B		4
T35J-06088	Inxu	Moderate	Low	High	B/C		4
T35J-06106	Ncolosi	High	Moderate	High	C/D		3
T35K-05897	Culunca	High	Moderate	High	C		3
T35K-05904	Tyira	Moderate	Moderate	Moderate	C/D		2
T35K-06037	Tsitsa	Moderate	Moderate	Moderate	C		3
T35K-06098	Tsitsa	Moderate	Moderate	Moderate	B/C		3
T35K-06167	Xokonxa	Moderate	Moderate	Moderate	C		3
T35L-05976	Tsitsa	Moderate	High	High	B		5
T35L-06190	Tsitsa	Moderate	Moderate	Moderate	B		4
T35L-06226	Ngcolora	Moderate	Moderate	Moderate	C		3
T35M-06187	Tsitsa	Moderate	Moderate	Moderate	B		4
T35M-06205	Thina	Moderate	Moderate	Moderate	B		4
T35M-06275	Ruze	High	Moderate	High	B		5
T36A-06216	Mzintshana	Moderate	Moderate	High	B		5
T36A-06220	Mkata	High	Moderate	High	B		5
T36A-06250	Mzimvubu	Moderate	Moderate	High	C		3
T36A-06354	Mzimvubu	Moderate	Moderate	High	C		3
T36B-06391	Mzimvubu	Moderate	High	High	C		3

11.2 PRIORITISATION OF SUB-QUATERNARY CATCHMENTS

11.2.1 Approach to prioritise SQs

High Priority SQs (hotspots) are identified by comparing (or overlaying) Integrated Environmental Importance with Water Resource Use Importance. A biodiversity/ecological hotspot is a biogeographic region which is a significant reservoir of biodiversity which is threatened with destruction (http://en.wikipedia. org/wiki/Biodiversity_hotspot). In the context used here, the hotspot represents a river reach with a high Integrated Environmental Importance which could be under threat due to its importance for water resource use.

The hotspots are an indication of areas where detailed investigations would be required if development was being considered. These hotspots usually represent areas which are already stressed or will be stressed in future. This assessment can therefore guide decision-making with regard to which areas are in need of detailed EWR and other studies (modified from Louw and Huggins, 2007).

A matrix was designed (Louw and Huggins, 2007) and modified during this study to guide the consistent identification of hotspots (**Table 11.3**). The Y-axis is based on the Integrated Environmental Importance value derived from the first matrix (**Table 11.1**). The X-axis depicts an estimate of water resource use, with 0 being of no importance and 4 being of very high importance. The information derived from the matrix provides an indication of the level of studies required.

Although the terminology used is the same as that used for the different levels of EWR studies in South Africa, it is a descriptive term which is relevant for any environmental assessment required.

As an example – an Integrated Environmental Importance of 2.5 and Water Resource Use importance value of 3.5 would require a comprehensive EWR assessment and this specific SQ would represent a hotspot.

Table 11.3 Matrix used in assessing hotspots

IEI	Very high	4-5	2	2	2	2	3	3	4	4	4
	High	3-3.99	1	2	2	2	2	3	3	4	4
	Moderate	2-2.99	1	1	1	2	2	2	3	3	3
	Low	1-1.99	1	1	1	1	1	2	2	2	3
	Very low	0-0.99	1	1	1	1	1	1	1	2	2
			0	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**
			Very low	**Low**		**Moderate**		**High**		**Very high**	
			Water Resource Importance								

11.2.2 Priority SQ results

The SQs and their identified priority ratings are illustrated in **Table 11.4** and the map in **Figure 11.2**. Only SQs with a score of 3 and 4 have been provided.

Table 11.4 Priority SQ results

SQ number	River	IEI	WRUI	Priority
T31A-04712	Mzimvubu	4	1	2
T31B-04745	Krom	3	2	2
T31B-04868	Krom	4	1	2
T31B-04873		3	2	2
T31C-04796	Mngeni	5	2	3
T31C-04866	Mzimvubu	5	1	2
T31C-04879	Nyongo	3	2	2
T31C-04929	Mzimvubu	3	1	2
T31D-04926	Mzimvubu	4	1	2
T31D-04936	Riet	3	2	2
T31D-05030	Riet	3	2	2
T31D-05060		4	1	2
T31D-05076	Mzimvubu	3	2	2
T31E-04836	Tswereka	5	1	2
T31E-04910	Malithasana	4	1	2
T31E-04931	Tswereka	4	2	3
T31E-05013	Tswereka	2	3	3
T31E-05055		3	2	2
T31F-05108		3	2	2
T31F-05111	Mzimvubu	5	2	3
T31F-05112	Mzimvubu	3	2	2
T31F-05134		3	2	2
T31G-05071	Mzimvubu	4	2	3
T31G-05382		4	2	3
T31H-05177	Mvenyane	5	1	2

SQ number	River	IEI	WRUI	Priority
T31H-05296	Mkemane	5	1	2
T31H-05304		5	1	2
T31H-05324	Mvenyane	3	1	2
T31H-05437	Mkemane	3	1	2
T31H-05445		3	1	2
T31H-05516	Mvenyane	2	1	1
T31J-05257	Mzimvubu	3	2	2
T31J-05551	Mzimvubu	3	2	2
T31J-05582	Ngwekazana	3	1	2
T31J-05588	Mzimvubu	4	2	3
T32A-04907	Mzintlanga	3	2	2
T32A-04965	Mzintlava	3	2	2
T32B-05103	Mzintlava	3	2	2
T32B-05116		3	3	3
T32B-05184	Mzintlava	3	2	2
T32C-05219	Mill Stream	3	2	2
T32C-05243	aManzamnyama	4	2	3
T32C-05273	Mzintlava	2	3	3
T32C-05313	Mzintlava	4	3	4
T32C-05378		4	2	3
T32D-05172	Droewig	3	2	2
T32D-05352	Mzintlava	2	3	3
T32D-05373	Mzintlava	2	3	3
T32E-05446	Mvalweni	2	2	2
T32F-05464	Mzintlava	3	3	3
T32G-05536	Mzintlavana	4	2	3
T32G-05609	Mbandana	4	1	2
T32G-05747	Mzintlavana	4	1	2
T32H-05842	Mzintlava	3	3	3
T33A-04887	Mafube	5	1	2
T33A-04892	Kinira	3	1	2
T33A-04898	Makomorin	5	1	2
T33A-04903	Kinira	4	2	3
T33A-04928		3	2	2
T33A-04983	Mafube	3	2	2
T33A-04990	Kinira	3	3	3
T33A-04991		3	3	3
T33A-05011	Kinira	3	2	2
T33B-04912	Seeta	4	2	3
T33B-04939	Mabele	3	1	2
T33B-04956	Mosenene	3	2	2
T33B-05005	Jordan	5	1	2
T33B-05051	Mabele	3	1	2
T33B-05066	Mabele	3	1	2
T33B-05072		5	1	2
T33C-05131	Morulane	3	2	2
T33D-05063	Kinira	3	2	2
T33D-05106	Pabatlong	3	2	2
T33D-05150	Kinira	3	2	2

SQ number	River	IEI	WRUI	Priority
T33E-05213	Kinira	3	2	2
T33E-05367	Somabadi	3	1	2
T33F-05285	Rolo	3	2	2
T33F-05326	Kinira	3	2	2
T33F-05398	Kinira	3	2	2
T33F-05439	Ncome	3	2	2
T33G-05395	Kinira	3	2	2
T33G-05587	Cabazi	3	1	2
T33G-05659	Mzimvubu	4	2	3
T33H-05638	Mnceba	3	1	2
T33H-05680	Mzimvubu	3	1	2
T33H-05803	Caba	3	1	2
T33H-05821	Mzimvubu	3	1	2
T33J-05834	Mzimvubu	3	1	2
T33K-06051	Mzimvubu	5	1	2
T34A-05354	Zindawa	5	1	2
T34A-05362	Vuvu	5	1	2
T34A-05394	Vuvu	5	1	2
T34A-05404	Thina	5	1	2
T34A-05408	Khohlong	4	1	2
T34A-05415	Thina	5	1	2
T34B-05269	Nxotshana	4	1	2
T34B-05275	Phiri-e-ntso	5	1	2
T34B-05351	Thina	4	1	2
T34B-05356	Thina	3	1	2
T34B-05385	Thina	3	1	2
T34C-05168	Tinana	5	1	2
T34C-05238	Phinari	5	1	2
T34C-05292	Tinana	4	1	2
T34D-05412	Thina	3	1	2
T34D-05433	Tokwana	3	0	1
T34D-05460	Thina	3	2	2
T34D-05462	Khalatsu	3	1	2
T34D-05463	Tokwana	3	3	3
T34E-05495	Bradgate se Loop	5	0	2
T34E-05503	Luzi	5	0	2
T34E-05507	Luzi	5	1	2
T34F-05512	Luzi	4	1	2
T34F-05585		3	1	2
T34G-05504	Qwidlana	3	2	2
T34G-05543	Thina	3	2	2
T34G-05634	Nxaxa	5	1	2
T34G-05667	Thina	4	2	3
T34H-05598	Thina	4	2	3
T34H-05699	Mvuzi	3	2	2
T34H-05714	Qhanqu	3	2	2
T34H-05738	Ngcibira	3	1	2
T34H-05769	Tsilithwa	4	1	2
T34H-05772	Thina	4	2	3

SQ number	River	IEI	WRUI	Priority
T34H-05791	Tsilithwa	3	1	2
T34H-05809	Mvumvu	4	1	2
T34H-05826	Ngcothi	4	2	3
T34H-05838	Thina	3	2	2
T34K-05835	Thina	4	2	3
T35A-05596	Tsitsana	3	1	2
T35A-05648	Tsitsa	4	1	2
T35A-05657	Hlankomo	3	2	2
T35A-05750	Tsitsa	4	2	3
T35B-05709	Pot	4	1	2
T35B-05798	Pot	4	2	3
T35B-05815	Little Pot	4	1	2
T35C-05858	Mooi	5	1	2
T35C-05874	Mooi	3	3	3
T35C-05930	Klein-Mooi	4	1	2
T35D-05721	Tsitsa	4	2	3
T35D-05844	Mooi	5	2	3
T35E-05780	Gqukunqa	4	1	2
T35E-05908	Tsitsa	3	4	4
T35E-05977	Tsitsa	4	4	4
T35F-05973	Kuntombizininzi	5	3	4
T35F-05999	Inxu	5	2	3
T35F-06000	Fontana	5	3	4
T35F-06020	Inxu	3	3	3
T35F-06080	Inxu	4	1	2
T35F-06112	Rondadura	5	1	2
T35G-06002	Inxu	4	3	4
T35G-06021	Inxu	5	3	4
T35G-06069	Gatberg	5	3	4
T35G-06074	Gatberg	5	3	4
T35G-06099	Gatberg	5	2	3
T35G-06100		4	2	3
T35G-06108	Inxu	5	3	4
T35G-06118	Gatberg	4	3	4
T35G-06133		4	3	4
T35G-06135	Gqaqala	5	3	4
T35G-06148	Not assessed – drainage line			
T35G-06169	Gqaqala	3	1	2
T35G-06179		5	1	2
T35H-06024	Inxu	3	2	2
T35H-06053	Inxu	3	2	2
T35H-06158	Qwakele	3	2	2
T35H-06186	Umnga	3	2	2
T35H-06240	KuNgindi	3	2	2
T35H-06282	Umnga	4	1	2
T35J-06088	Inxu	4	2	3
T35J-06106	Ncolosi	3	2	2
T35K-05897	Culunca	3	2	2
T35K-05904	Tyira	2	2	2

SQ number	River	IEI	WRUI	Priority
T35K-06037	Tsitsa	3	4	4
T35K-06098	Tsitsa	3	4	4
T35K-06167	Xokonxa	3	3	3
T35L-05976	Tsitsa	5	4	4
T35L-06190	Tsitsa	4	4	4
T35L-06226	Ngcolora	3	2	2
T35M-06187	Tsitsa	4	4	4
T35M-06205	Thina	4	4	4
T35M-06275	Ruze	5	1	2
T36A-06216	Mzintshana	5	1	2
T36A-06220	Mkata	5	2	3
T36A-06250	Mzimvubu	3	4	4
T36A-06354	Mzimvubu	3	4	4
T36B-06391	Mzimvubu	3	4	4

The rivers where High Priority SQs dominate are the Mzimvubu, Tsitsa, Thina, Inxu, Gatberg and the Mzintlava.

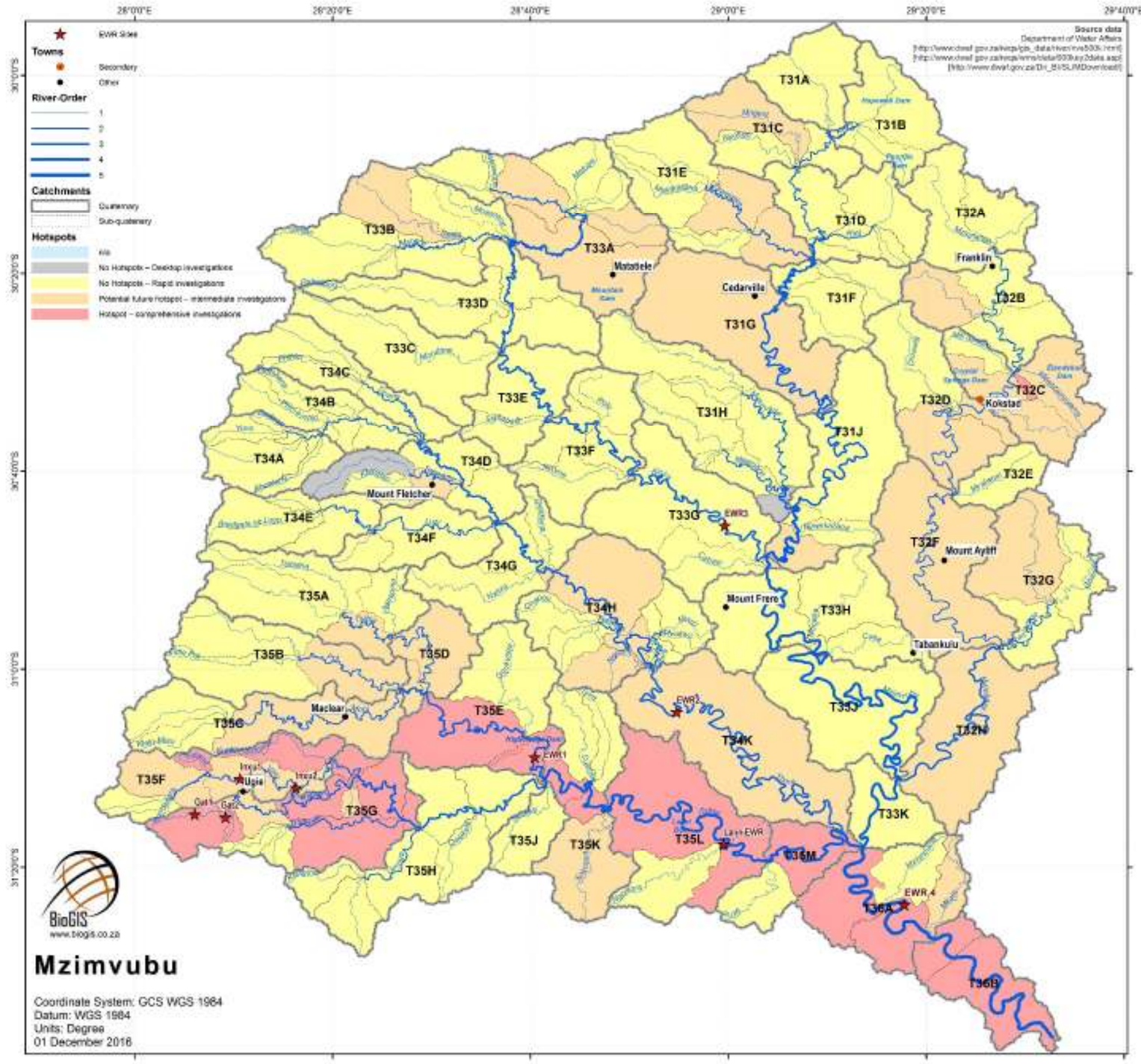


Figure 11.2 SQs and their identified priority ratings

12 WETLAND ECOLOGICAL IMPORTANCE AND PRIORITISATION

12.1 INTRODUCTION

The purpose of the prioritisation process was to identify priority wetlands or wetland systems within the T3 catchment. This was done at the SQ scale to facilitate comparability with other disciplines and to aid in the identification of hotspots (high priority river, wetland and/or groundwater areas). Prioritisation included an assessment of Present Ecological State (PES), Integrated Ecological Importance (IEI) and Social and Cultural Importance (SCI; as outlined in **Chapter 9**).

12.2 APPROACH TO PRIORITISE WETLANDS

The objective of this step was to identify high priority wetlands or wetland groups. These high priority areas were selected based on ecological, socio-cultural and water resource use importance and are often areas of high ecological importance where water resources are stressed or may be stressed in future. The assessment of PES relied on existing metrics within the PESEIS database (DWS, 2014b), while the assessment of ecological importance and sensitivity relied on the following actions:

- Identify and rate biodiversity value and ecological importance. Rate specific criteria that define biodiversity value based on desktop information [e.g. RAMSAR status, condition, habitats for rare and endangered species (birds, frogs etc.), critical biodiversity areas (Berliner & Desmet, 2007)].
- Identify and rate functional value. Rate specific criteria that evaluate the functional value including socio-economic value; hydrological functioning (flow regulation, maintenance of base flows) and water quality amelioration.
- Identify and rate sensitivity of each wetland unit using criteria such as size, type known sensitive species or habitats, degree of impact.
- Risk of degradation: Rate risk to wetland unit based on land use and water demand.

Summary results of the assessment are shown in **Table 12.1.** Columns in **Table 12.1** are as follows:

- **Column 1**: SQ number from the PESEIS study (DWS, 2014b).
- **Column 2**: River name.
- **Column 3**: Wetland Ecological Importance (EI) obtained from an integration of RAMSAR status, wetland FEPA status, provision of habitats for rare and endangered species (birds, frogs, plants), critical biodiversity areas (Berliner & Desmet, 2007), and wetland extent (area).
- **Column 4**: Wetland Ecological Sensitivity (ES) based on natural land cover data within wetlands and within a 100m buffer around wetlands (data from NFEPA; Nel *et al*., 2011), as well as the extent of wetlands. The assessment was based on the assumption that smaller wetlands with less natural cover within and surrounding them will likely be more sensitive to further degradation, given current pressures.
- **Column 5**: Socio-Cultural Importance (SCI) based on the PESEIS study (DWS, 2014b).
- **Column 6**: Integrated (or final) Importance and Sensitivity (IIS), which represents the maximum of the Ecological Importance (EI), Ecological Sensitivity (ES) and SCI.
- **Column 7**: PES obtained from both of the riparian/wetland metrics rated in the PESEIS database (DWS, 2014), some of which were updated.

- **Column 8**: Integrated Environmental Importance (based on a rating from 1 – 5 where 1 is Very Low and 5 is Very High): The Integrated Environmental Importance (IEI) considers both the integrated importance and sensitivity and the PES.
- **Column 9**: Water Resource Use Importance (WRUI) (based on a rating from 0 – 4 where 0 is Very Low and 4 is Very High) based on the PESEIS study (DWS, 2014b).
- **Column 10**: Wetland Priority (based on a rating from 0 – 4 where 0 is Very Low and 4 is Very High) and considers the IEI and the WRUI.

12.3 PRESENT ECOLOGICAL STATE

The assessment of wetland PES relied on both of the riparian/wetland metrics rated in the PESEIS database (DWS, 2014): Riparian/wetland zone and zone continuity modification. Riparian/wetland zone modification relates to “modifications that indicate the potential that wetland zones may have been changed from reference [condition] in terms of structure and composition that may influence these zones regarding functioning and processes occurring within these zones”, and also refers to these zones as habitat for biota. Riparian/wetland zone continuity modification relates to “modifications that indicate the potential that riparian/wetland connectivity may have changed from the reference [condition]”. Physical fragmentation (both longitudinal and lateral) is the indicator used for wetland continuity and includes for example inundation by weirs and dams, physical removal for farming, mining, overgrazing etc. and the presence of roads or other human structure, e.g. urban areas. The underlying assumption is that these two metrics incorporate wetlands within each SQ, and as such should provide a useful measure of a more detailed investigation (visual assessment by specialist using satellite imagery) of overall ecological state. Furthermore, it is assumed that although these metrics include the riparian area, they remain a more realistic assessment of PES than the “wetcon” condition values within NFEPA data. Results of the assessment are shown in **Figure 12.1** and **Table 12.1**.

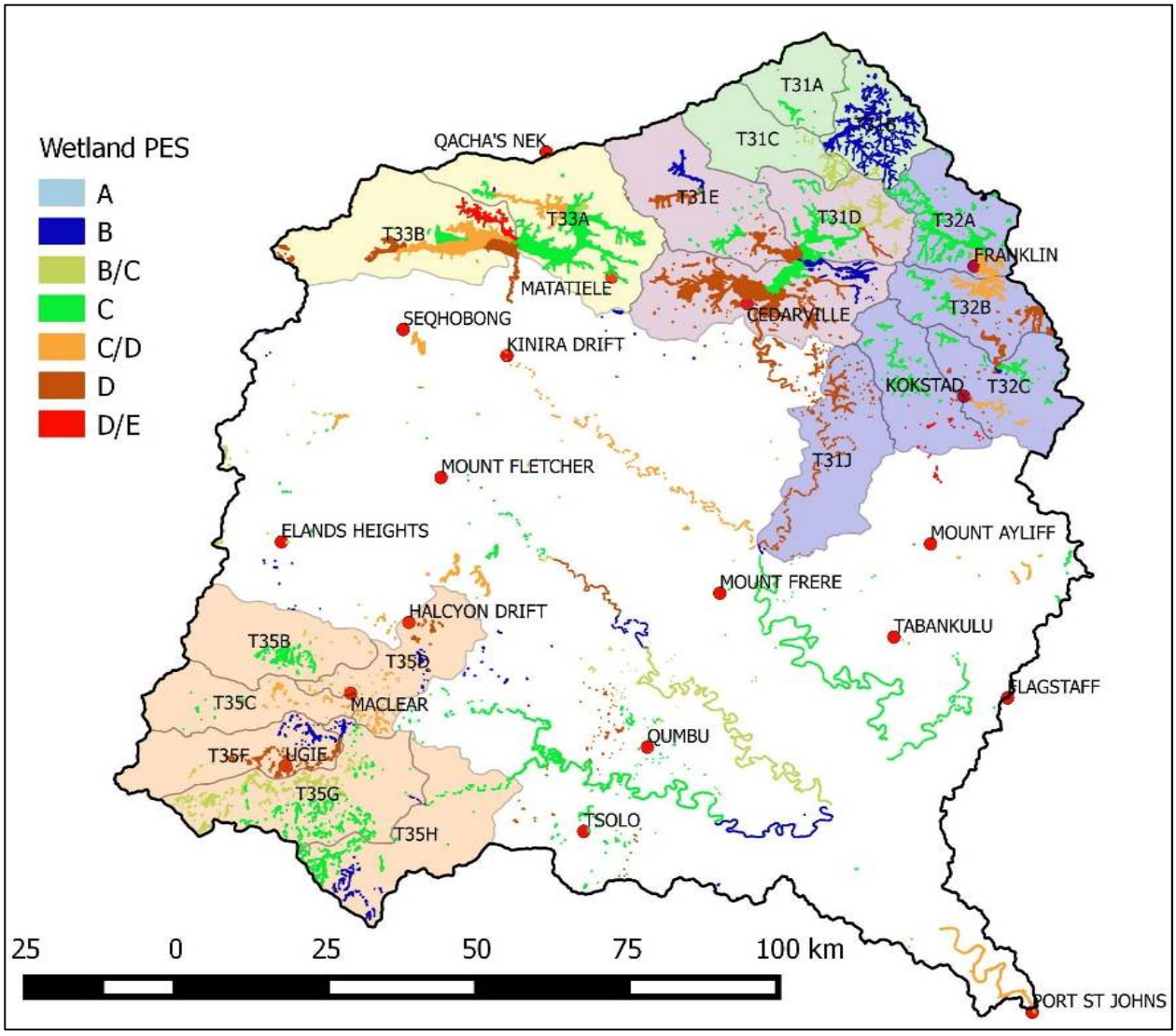


Figure 12.1 PES values assigned to wetlands within each SQ (where wetlands occurred according to the NFEPA coverage)

12.4 INTEGRATED ENVIRONMENTAL IMPORTANCE

The determination of Ecological Importance (EI) considered the following criteria:

- RAMSAR status – any wetland designated as a RAMSAR site would automatically be assigned a VERY HIGH EI, although none of these existed within the T3 catchment.
- Wetland FEPA status – any wetland denoted as a FEPA wetland was assigned a HIGH EI.
- Habitats for rare and endangered species (birds, frogs etc.), e.g. cranes in NFEPA data – any wetland highlighted as important for endangered wetland-specific species was assigned a HIGH EI.
- Eastern Cape critical biodiversity areas (CBAs; Berliner & Desmet, 2007) – wetlands within CBA 1 areas were assigned a HIGH EI, whereas those within CBA 2 areas were assigned a MODERATE EI (**Figure 12.2**).
- Wetland extent – wetland area was calculated using the NFEPA coverage data where a summation of area of wetland polygons based on unit ID (unit IDs with the same value represent a single SQ) was expressed as a percentage of the area of the largest wetland. SQs where the proportional wetland area was 30% or more were assigned a VERY HIGH EI, those where the proportional wetland area was 10% or more were assigned a HIGH EI,

those where the proportional wetland area was 5% or more were assigned a MODERATE EI, and smaller wetlands where the proportional wetland area was >0% were assigned a LOW EI. Where wetlands were absent the SQ was assigned a VERY LOW EI.

The integrated EI for each SQ was calculated using the maximum value assigned during the above process (**Table 12.1**).

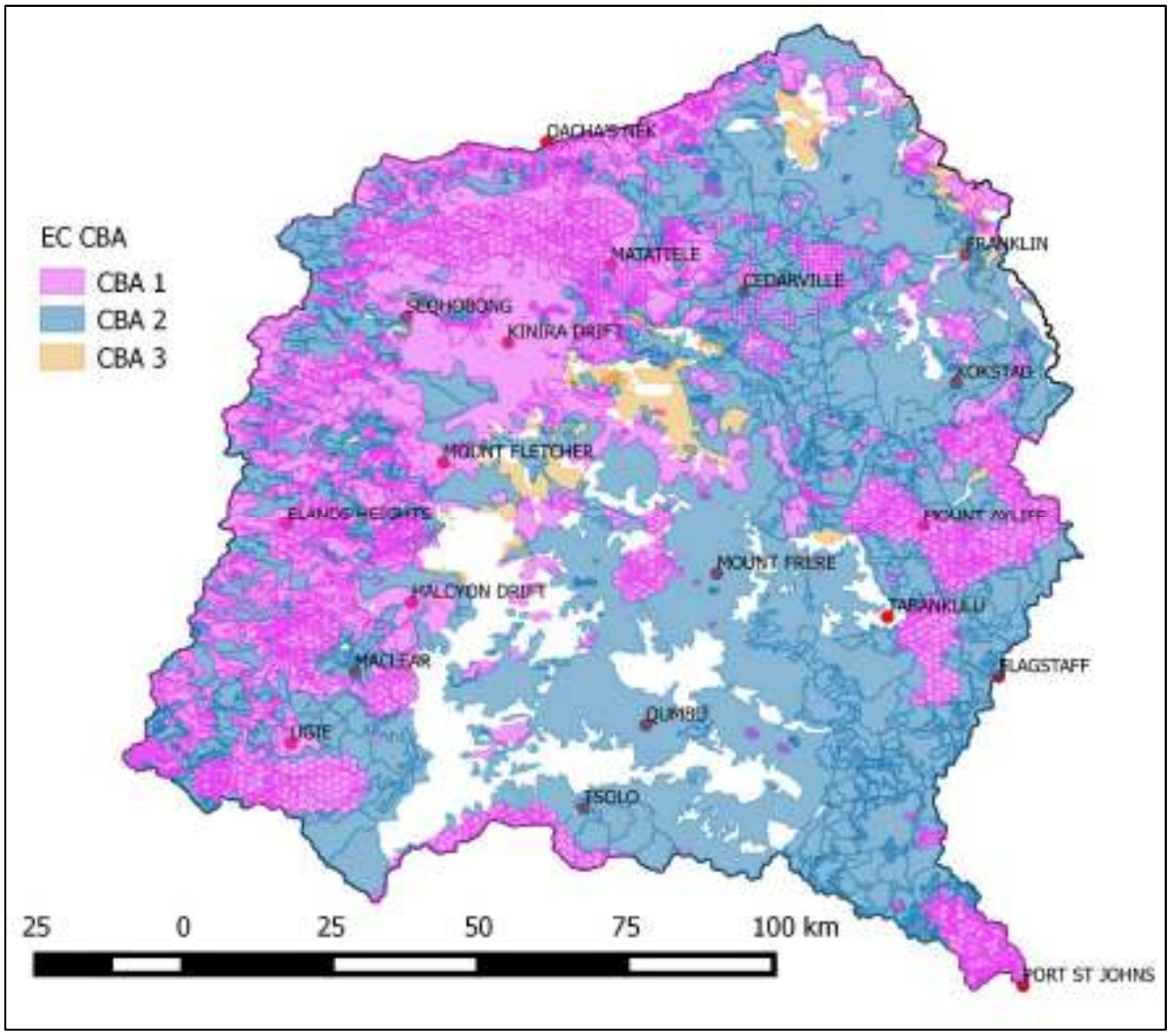


Figure 12.2. Eastern Cape (EC) critical biodiversity areas (CBAs) within T3 (Berliner & Desmet, 2007)

The Ecological Sensitivity (ES) was based on natural land cover data within wetlands and within a 100m buffer around wetlands (Data from NFEPA; Nel *et al.*, 2011), as well as the extent of wetlands. The assessment is based on the assumption that smaller wetlands with less natural cover within and surrounding them will likely be more sensitive to further degradation, given current pressures (**Table 12.1**). The final importance and sensitivity was simply taken to be the maximum rating of the EI, ES and SCI (**Table 12.1**). The Integrated Environmental Importance (IEI) was determined using the matrix shown in **Table 12.1**, which considers both the final importance and sensitivity and the PES. Results are on a scale of 1–5 (where 1 is VERY LOW and 5 is VERY HIGH), and show that most of the VERY HIGH priority wetlands occur within one of the five delineated wetland zones (**Table 12.1** and **Figure 12.3**).

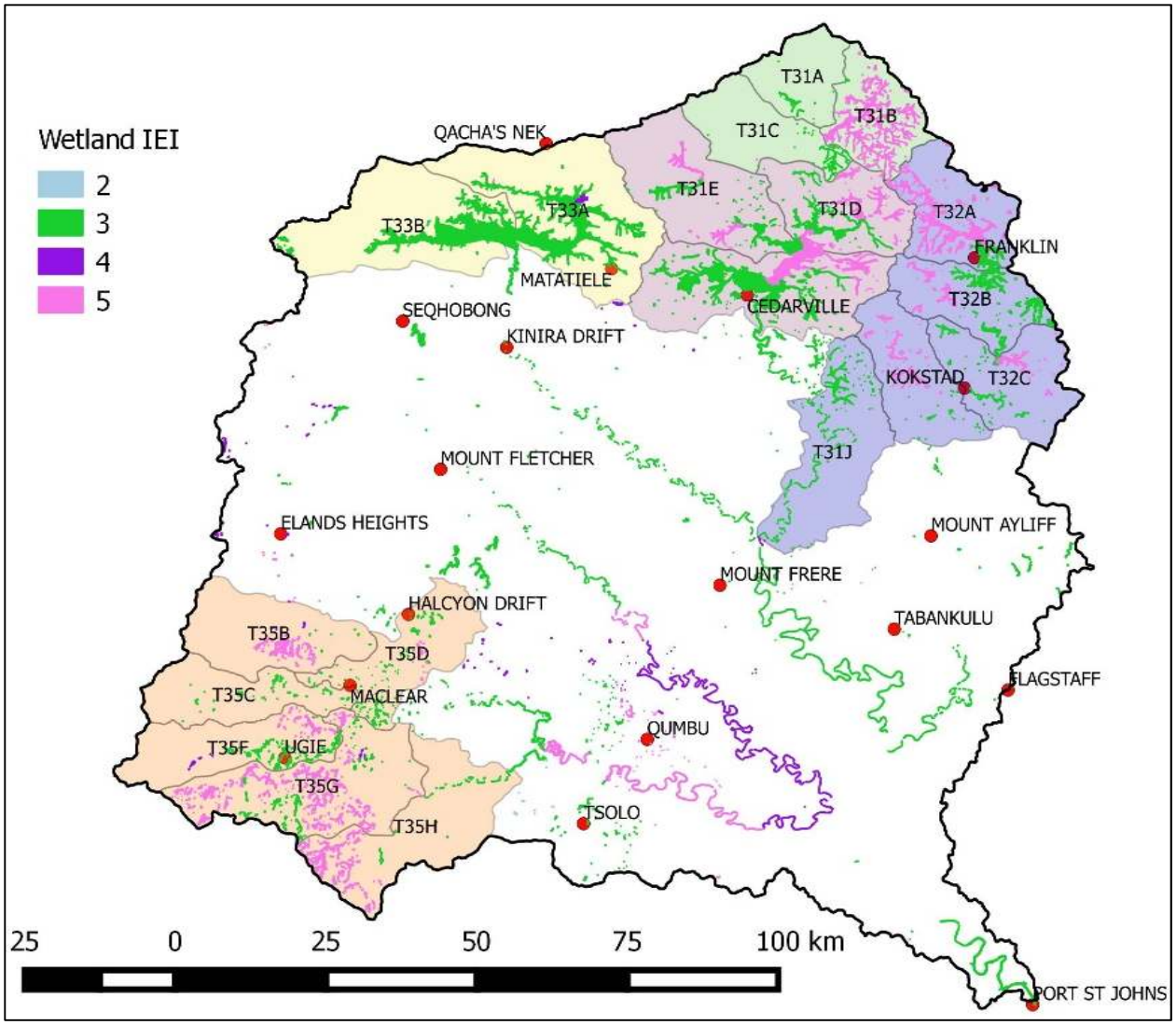


Figure 12.3 Integrated Environmental Importance (IEI) for each SQ in relation to wetland zones

12.5 PRIORITY WETLANDS

The final prioritisation of wetlands per SQ considers both the IEI (**Figure 12.3**) and the Water Resource Unit Importance (WRUI) in the same way hotspots are determined. The WRUI is covered in **Chapter 8**. The IEI and WRUI are integrated using a matrix of scores (Louw and Huggins, 2007; **Table 11.3**) to determine the final rating of priority, which can range from a value of 1 to 4 where 1 is Low and 4 is Very High. Results show that most High and Very High priority wetlands occur within the five wetland zones, except for the estuary and those shown as channelled valley-bottoms along the highly confined regions of the lower Tsitsa, Thina, Mzintlava and Mzimvubu rivers (**Table 12.1** and **Figure 12.4**).

Table 12.1 Wetland priority, also showing wetland EI, ES, IIS, PES and IEI per SQ

SQ PESEIS	Name	Wetland EI	Wetland ES	SCI	IIS	PES	IEI	WRUI	PRIORITY
T31A-04712	Mzimvubu	HIGH	LOW	MODERATE	HIGH	C	3	1	2
T31B-04745	Krom	HIGH	MODERATE	LOW	HIGH	B	5	2	3
T31B-04868	Krom	VERY HIGH	MODERATE	LOW	VERY HIGH	B	5	1	2
T31B-04873		VERY HIGH	MODERATE	LOW	VERY HIGH	B	5	2	3
T31C-04796	Mngeni	HIGH	MODERATE	HIGH	HIGH	C	3	2	2
T31C-04866	Mzimvubu	MODERATE	MODERATE	MODERATE	MODERATE	B/C	3	1	2
T31C-04879	Nyongo	MODERATE	VERY HIGH	HIGH	VERY HIGH	C	5	2	3
T31D-04926	Mzimvubu	HIGH	MODERATE	LOW	HIGH	C	3	1	2
T31D-04936	Riet	VERY HIGH	MODERATE	LOW	VERY HIGH	B/C	5	2	3
T31D-05030	Riet	HIGH	LOW	LOW	HIGH	C	3	2	2
T31D-05060		HIGH	MODERATE	MODERATE	HIGH	D	3	1	2
T31D-05076	Mzimvubu	VERY HIGH	VERY LOW	LOW	VERY HIGH	C	5	2	3
T31E-04836	Tswereka	HIGH	MODERATE	HIGH	HIGH	B	5	1	2
T31E-04910	Malithasana	HIGH	MODERATE	HIGH	HIGH	D	3	1	2
T31E-04931	Tswereka	HIGH	HIGH	HIGH	HIGH	C	3	2	2
T31E-05013	Tswereka	HIGH	MODERATE	MODERATE	HIGH	D	3	3	3
T31E-05055		VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	2	3
T31F-05108		VERY HIGH	LOW	LOW	VERY HIGH	B	5	2	3
T31F-05111	Mzimvubu	HIGH	VERY LOW	LOW	HIGH	B	5	2	3
T31F-05112	Mzimvubu	VERY HIGH	LOW	MODERATE	VERY HIGH	C	5	2	3
T31F-05134		VERY HIGH	MODERATE	LOW	VERY HIGH	D	3	2	2
T31G-05071	Mzimvubu	VERY HIGH	MODERATE	HIGH	VERY HIGH	D	3	2	2
T31H-05177	Mvenyane	HIGH	LOW	HIGH	HIGH	B	4	1	2
T31H-05324	Mvenyane	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	1	2
T31J-05257	Mzimvubu	HIGH	MODERATE	MODERATE	HIGH	D	3	2	2
T31J-05551	Mzimvubu	HIGH	VERY LOW	MODERATE	HIGH	D	3	2	2
T31J-05582	Ngwekazana	HIGH	LOW	MODERATE	HIGH	D	3	1	2
T31J-05588	Mzimvubu	HIGH	MODERATE	MODERATE	HIGH	D	3	2	2
T32A-04907	Mzintlanga	VERY HIGH	MODERATE	LOW	VERY HIGH	C	5	2	3
T32A-04965	Mzintlava	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	2	3
T32B-05103	Mzintlava	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C/D	3	2	2
T32B-05116		VERY HIGH	HIGH	MODERATE	VERY HIGH	C	5	3	4
T32B-05184	Mzintlava	VERY HIGH	MODERATE	MODERATE	VERY HIGH	D	3	2	2
T32C-05219	Mill Stream	HIGH	MODERATE	LOW	HIGH	C	3	2	2
T32C-05243	aManzamnyama	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	2	3
T32C-05273	Mzintlava	HIGH	HIGH	LOW	HIGH	D	3	3	3
T32C-05313	Mzintlava	HIGH	MODERATE	MODERATE	HIGH	B	5	3	4
T32C-05378		HIGH	MODERATE	MODERATE	HIGH	C/D	3	2	2
T32D-05172	Droewig	VERY HIGH	MODERATE	LOW	VERY HIGH	C	5	2	3
T32D-05352	Mzintlava	HIGH	MODERATE	LOW	HIGH	D	3	3	3
T32D-05373	Mzintlava	HIGH	MODERATE	LOW	HIGH	D/E	3	3	3
T32F-05464	Mzintlava	HIGH	LOW	HIGH	HIGH	D	3	3	3
T32G-05536	Mzintlavana	HIGH	LOW	HIGH	HIGH	C/D	3	2	2
T32G-05609	Mbandana	HIGH	LOW	MODERATE	HIGH	C	3	1	2
T32H-05842	Mzintlava	HIGH	LOW	MODERATE	HIGH	C	3	3	3
T33A-04887	Mafube	HIGH	HIGH	MODERATE	HIGH	C	3	1	2

SQ PESEIS	Name	Wetland EI	Wetland ES	SCI	IIS	PES	IEI	WRUI	PRIORITY
T33A-04892	Kinira	HIGH	VERY LOW	MODERATE	HIGH	C	3	1	2
T33A-04898	Makomorin	HIGH	LOW	MODERATE	HIGH	B	5	1	2
T33A-04903	Kinira	HIGH	MODERATE	HIGH	HIGH	C/D	3	2	2
T33A-04928		HIGH	MODERATE	MODERATE	HIGH	B/C	4	2	3
T33A-04983	Mafube	HIGH	MODERATE	MODERATE	HIGH	C	3	2	2
T33A-04990	Kinira	HIGH	LOW	HIGH	HIGH	C	3	3	3
T33A-04991		HIGH	VERY LOW	HIGH	HIGH	C	3	3	3
T33A-05011	Kinira	HIGH	LOW	MODERATE	HIGH	C	3	2	2
T33B-04912	Seeta	HIGH	VERY LOW	MODERATE	HIGH	C	3	2	2
T33B-04939	Mabele	HIGH	LOW	LOW	HIGH	C/D	3	1	2
T33B-04956	Mosenene	HIGH	LOW	HIGH	HIGH	D/E	3	2	2
T33B-05005	Jordan	VERY HIGH	VERY LOW	MODERATE	VERY HIGH	D	3	1	2
T33B-05051	Mabele	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	1	2
T33B-05066	Mabele	HIGH	VERY LOW	LOW	HIGH	D	3	1	2
T33B-05072		HIGH	VERY LOW	HIGH	HIGH	C/D	3	1	2
T33C-05131	Morulane	HIGH	LOW	HIGH	HIGH	C/D	3	2	2
T33D-05063	Kinira	VERY HIGH	VERY LOW	HIGH	VERY HIGH	D	3	2	2
T33D-05106	Pabatlong	HIGH	VERY HIGH	HIGH	VERY HIGH	C/D	3	2	2
T33D-05150	Kinira	HIGH	LOW	MODERATE	HIGH	C/D	3	2	2
T33E-05213	Kinira	HIGH	MODERATE	HIGH	HIGH	C/D	3	2	2
T33E-05367	Somabadi	MODERATE	VERY HIGH	HIGH	VERY HIGH	C/D	3	1	2
T33F-05285	Rolo	MODERATE	VERY LOW	HIGH	HIGH	D	3	2	2
T33F-05326	Kinira	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	2	2
T33F-05398	Kinira	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	2	2
T33F-05439	Ncome	MODERATE	VERY LOW	HIGH	HIGH	C/D	3	2	2
T33G-05395	Kinira	HIGH	LOW	HIGH	HIGH	C/D	3	2	2
T33G-05587	Cabazi	MODERATE	HIGH	HIGH	HIGH	C/D	3	1	2
T33G-05659	Mzimvubu	MODERATE	MODERATE	LOW	MODERATE	B	4	2	3
T33H-05638	Mnceba	MODERATE	VERY HIGH	MODERATE	VERY HIGH	C	5	1	2
T33H-05680	Mzimvubu	MODERATE	LOW	HIGH	HIGH	C	3	1	2
T33H-05803	Caba	HIGH	MODERATE	HIGH	HIGH	C/D	3	1	2
T33H-05821	Mzimvubu	MODERATE	MODERATE	LOW	MODERATE	C	3	1	2
T33J-05834	Mzimvubu	MODERATE	LOW	MODERATE	MODERATE	C	3	1	2
T34A-05394	Vuvu	HIGH	HIGH	LOW	HIGH	B/C	4	1	2
T34A-05404	Thina	HIGH	VERY LOW	LOW	HIGH	C	3	1	2
T34A-05408	Khohlong	HIGH	VERY LOW	HIGH	HIGH	C	3	1	2
T34A-05415	Thina	HIGH	VERY LOW	HIGH	HIGH	B/C	4	1	2
T34B-05269	Nxotshana	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	1	2
T34B-05275	Phiri-e-ntso	HIGH	VERY LOW	HIGH	HIGH	B/C	4	1	2
T34B-05351	Thina	HIGH	VERY LOW	HIGH	HIGH	C/D	3	1	2
T34B-05356	Thina	HIGH	LOW	MODERATE	HIGH	C/D	3	1	2
T34B-05385	Thina	HIGH	VERY LOW	LOW	HIGH	C/D	3	1	2
T34C-05168	Tinana	HIGH	VERY LOW	LOW	HIGH	B	5	1	2
T34C-05292	Tinana	MODERATE	LOW	HIGH	HIGH	C	3	1	2
T34D-05412	Thina	HIGH	LOW	HIGH	HIGH	C	3	1	2
T34D-05460	Thina	HIGH	LOW	MODERATE	HIGH	D	3	2	2
T34E-05495	Bradgate se Loop	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	0	2
T34E-05503	Luzi	HIGH	VERY LOW	LOW	HIGH	C	3	0	1

SQ PESEIS	Name	Wetland EI	Wetland ES	SCI	IIS	PES	IEI	WRUI	PRIORITY
T34E-05507	Luzi	HIGH	LOW	MODERATE	HIGH	C	3	1	2
T34F-05512	Luzi	HIGH	VERY LOW	HIGH	HIGH	C	3	1	2
T34G-05543	Thina	HIGH	LOW	MODERATE	HIGH	C	3	2	2
T34G-05634	Nxaxa	VERY HIGH	LOW	HIGH	VERY HIGH	C/D	3	1	2
T34G-05667	Thina	MODERATE	LOW	LOW	MODERATE	B/C	3	2	2
T34H-05598	Thina	HIGH	MODERATE	HIGH	HIGH	D	3	2	2
T34H-05772	Thina	HIGH	LOW	MODERATE	HIGH	B	5	2	3
T34H-05826	Ngcothi	HIGH	LOW	MODERATE	HIGH	B/C	4	2	3
T34K-05835	Thina	HIGH	MODERATE	HIGH	HIGH	B/C	4	2	3
T35A-05596	Tsitsana	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	1	2
T35A-05648	Tsitsa	HIGH	LOW	LOW	HIGH	B	5	1	2
T35A-05750	Tsitsa	HIGH	VERY LOW	MODERATE	HIGH	C/D	3	2	2
T35B-05709	Pot	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	1	2
T35B-05798	Pot	HIGH	LOW	MODERATE	HIGH	C/D	3	2	2
T35B-05815	Little Pot	VERY HIGH	LOW	MODERATE	VERY HIGH	C	5	1	2
T35C-05858	Mooi	HIGH	VERY LOW	MODERATE	HIGH	C	3	1	2
T35C-05874	Mooi	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C/D	3	3	3
T35C-05930	Klein-Mooi	HIGH	VERY LOW	MODERATE	HIGH	C	3	1	2
T35D-05721	Tsitsa	HIGH	LOW	HIGH	HIGH	D	3	2	2
T35D-05844	Mooi	HIGH	MODERATE	LOW	HIGH	B	5	2	3
T35E-05780	Gqukunqa	MODERATE	VERY LOW	MODERATE	MODERATE	B	4	1	2
T35E-05908	Tsitsa	HIGH	MODERATE	MODERATE	HIGH	C	3	4	4
T35E-05977	Tsitsa	MODERATE	HIGH	MODERATE	HIGH	C	3	4	4
T35F-05973	Kuntombizininzi	VERY HIGH	MODERATE	MODERATE	VERY HIGH	B	5	3	4
T35F-05999	Inxu	HIGH	LOW	MODERATE	HIGH	B/C	4	2	3
T35F-06020	Inxu	VERY HIGH	LOW	MODERATE	VERY HIGH	D	3	3	3
T35G-06002	Inxu	HIGH	LOW	LOW	HIGH	C	3	3	3
T35G-06021	Inxu	HIGH	VERY LOW	MODERATE	HIGH	C	3	3	3
T35G-06069	Gatberg	VERY HIGH	LOW	MODERATE	VERY HIGH	B/C	5	3	4
T35G-06074	Gatberg	HIGH	VERY LOW	MODERATE	HIGH	B/C	4	3	4
T35G-06099	Gatberg	VERY HIGH	LOW	MODERATE	VERY HIGH	B/C	5	2	3
T35G-06100		MODERATE	VERY LOW	MODERATE	MODERATE	C	3	2	2
T35G-06108	Inxu	HIGH	LOW	MODERATE	HIGH	B	5	3	4
T35G-06118	Gatberg	VERY HIGH	MODERATE	MODERATE	VERY HIGH	B/C	5	3	4
T35G-06133		HIGH	LOW	MODERATE	HIGH	C	3	3	3
T35G-06135	Gqaqala	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	3	4
T35G-06148		HIGH	VERY HIGH	LOW	VERY HIGH	A	5	3	4
T35G-06169	Gqaqala	HIGH	LOW	MODERATE	HIGH	C	3	1	2
T35G-06179		HIGH	LOW	MODERATE	HIGH	C	3	1	2
T35H-06024	Inxu	MODERATE	LOW	MODERATE	MODERATE	C	3	2	2
T35H-06053	Inxu	MODERATE	MODERATE	MODERATE	MODERATE	C	3	2	2
T35H-06186	Umnga	HIGH	HIGH	MODERATE	HIGH	C	3	2	2
T35H-06240	KuNgindi	VERY HIGH	MODERATE	MODERATE	VERY HIGH	C	5	2	3
T35H-06282	Umnga	HIGH	MODERATE	MODERATE	HIGH	B	5	1	2
T35J-06106	Ncolosi	MODERATE	MODERATE	MODERATE	MODERATE	D	2	2	2
T35K-05897	Culunca	MODERATE	HIGH	MODERATE	HIGH	D	3	2	2
T35K-05904	Tyira	MODERATE	HIGH	MODERATE	HIGH	D	3	2	2
T35K-06037	Tsitsa	MODERATE	VERY HIGH	MODERATE	VERY HIGH	C	5	4	4

SQ PESEIS	Name	Wetland EI	Wetland ES	SCI	IIS	PES	IEI	WRUI	PRIORITY
T35K-06167	Xokonxa	HIGH	MODERATE	MODERATE	HIGH	C	3	3	3
T35L-05976	Tsitsa	VERY HIGH	HIGH	HIGH	VERY HIGH	C	5	4	4
T35L-06190	Tsitsa	HIGH	LOW	MODERATE	HIGH	B	5	4	4
T35L-06226	Ngcolora	HIGH	HIGH	MODERATE	HIGH	D	3	2	2
T35M-06187	Tsitsa	MODERATE	MODERATE	MODERATE	MODERATE	B	4	4	4
T35M-06275	Ruze	HIGH	MODERATE	MODERATE	HIGH	B	5	1	2
T36A-06250	Mzimvubu	MODERATE	LOW	MODERATE	MODERATE	C	3	4	4
T36B-06391	Mzimvubu	VERY HIGH	MODERATE	HIGH	VERY HIGH	C/D	3	4	4

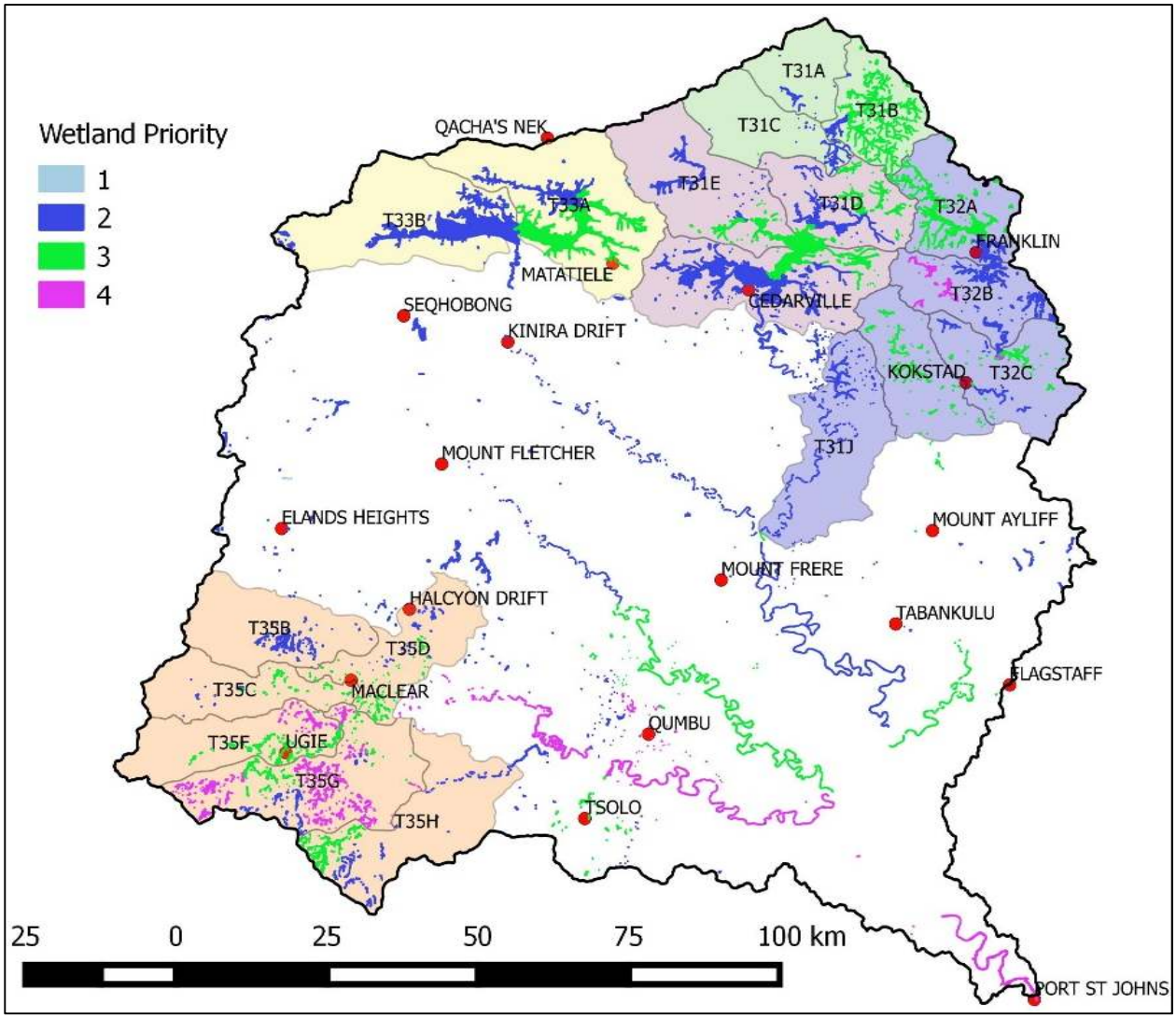


Figure 12.4 Wetland priority associated with each SQ

VOLUME C: DELINEATION OF RESOURCE UNITS

13 RIVER MANAGEMENT RESOURCE UNITS (HIGH PRIORITY)

13.1 APPROACH

If an Ecological Reserve determination is required for a whole catchment, it is necessary to delineate the catchment into Resource Units (RUs). These are each significantly different to warrant their own specification of the Reserve, and the geographic boundaries of each must be clearly delineated (DWAF, 1999, Volume 3).

Resource Units are required as it may not be appropriate to set the same numerical Reserve for the headwaters of a river as for the lowland reaches. These sections of a river frequently have different natural flow patterns, react differently to stress according to their sensitivity, and require individual specifications of the Reserve appropriate for that reach.

13.1.1 Natural Resource Units

Based on the above approach, the breakdown of a catchment into RUs for the purpose of determining the Reserve for rivers is therefore done primarily on a biophysical basis within the catchment and called NRU. EcoRegions and geomorphic zones are the major criteria that are considered.

13.1.2 Management Resource Units

Management requirements (DWAF, 1999, Volume 3) also play a role in the delineation. An example could be where large dams and/or transfer schemes occur. Furthermore, the type of disturbance/impact on a river plays a role to select homogenous river reaches from a biophysical basis under present circumstances. These are called MRUs.

The delineation process considers all the above issues. Overlaying all the data does not necessarily result in a logical and clear delineation and therefore expert judgement, a consultative process and local knowledge are required for the final delineation. The practicalities of dealing with numerous reaches within one study must also be considered to determine a logical and practical suite of MRUs.

MRUs can be further delineated into even smaller assessment units and the approach for this is described in DWAF (2008a).

The Ecological Water Requirements (EWRs) are determined for each MRU by means of the following (Louw and Hughes, 2002):

- An EWR site is selected within the MRU and represents a critical site within the relevant river section. Results generated at the EWR site will then be relevant for the MRU as a whole.
- If no EWR site can be selected within the MRU, extrapolated results from an adjacent MRU with an EWR site are used. The reasons for an EWR site not being selected within the MRU can be the following:
    - The characteristics of the river within the MRU do not meet the criteria for EWR sites.
    - Due to the number of MRUs within the study area, it is not practical and/or cost-effective to address EWR sites within each MRU.

13.2 RESOURCE UNIT CONSIDERATIONS

13.2.1 EcoRegions (Level II)

The EcoRegion typing approach developed in the USA (Omernik, 1987) was applied and tested at a preliminary level in South Africa. EcoRegional classification or typing will allow the grouping of rivers according to similarities based on a top-down approach. The purpose of this approach is to simplify and contextualise assessments and statements on EWRs. One of the advantages of such a system is the extrapolation of information from data rich rivers to data poor rivers within the same hierarchical typing context.

The first effort used available information to delineate EcoRegion boundaries at a very broad scale (i.e. Level I) for South Africa. Attributes such as physiography, climate, rainfall, geology and potential natural vegetation were evaluated in this process and 18 Level I EcoRegions were identified (Kleynhans *et al.*, 2005). The next Level II (Kleynhans *et al.*, 2007), used the same attributes but in more detail. Physiography can, for example, be explored in more detail by considering terrain morphological classes, slopes, relief, altitude, etc.

13.2.2 Geomorphological zonation

Rowntree and Wadeson (1999) have developed a zonal classification system for Southern African rivers modified from Noble and Hemens (1978). In their classification an attempt was made to give each zone a geomorphological definition in terms of distinctive channel morphological units and reach types. After working in a number of different rivers around the country it has become clear that channel gradient is a good indicator of channel characteristics and that probable or expected difference can be identified from an analysis of gradients (**Table 13.1**).

Table 13.1 Geomorphological zonation of river channels (adapted from Rowntree and Wadeson, 1999)

Longitudinal zone	Characteristic channel features	
	Zone	Description
Mountain headwater stream	A	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
Mountain stream	B	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, Approximate equal distribution of 'vertical' and 'horizontal' flow components.
Transitional	C	Moderately steep stream dominated by bedrock or boulder. Reach types include plain-bed, pool-rapid or pool riffle. Confined or semi-confined valley floor with limited flood plain development.
Upper foothills	D	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present.
Lower foothills	E	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool-riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.
Lowland river	F	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.

13.2.3 Land cover

The land cover is provided as part of the PESEIS project (DWS, 2014b), but in this case was updated by extensive Google Earth viewing and groundtruthing.

13.2.4 System operation

After identifying NRUs, which are based largely on natural hydrology, EcoRegions and geomorphological zonation, MRUs must be defined. The overriding aspects in terms of identifying MRUs are the land cover (a surrogate for land use) and the closely related management and operation of the water resources within the study area. Management Resource Units therefore have to consider the different operational structures, management and constraints regarding Reserve implementation. Mostly qualitative information is required to describe the operation and this is usually available at the onset of the Reserve study based on various previous studies.

13.2.5 Local knowledge

Any expert information that could contribute to the assessments are considered and used.

13.2.6 Present Ecological State

The Present Ecological State (PES) is also considered in the MRU delineation as it provides an indication of the response of the river to the operation of the system, land use and land cover. PES is determined following the procedures in Kleynhans and Louw (2007). PES has been provided at Sub-Quaternary (SQ) reaches (DWS, 2014b) and reviewed within this study (2016).

13.3 RESOURCE UNITS AND INTEGRATED UNITS OF ANALYSIS

Integrated Units of Analysis (IUAs) are homogenous catchments or linear river reaches that can be managed as an entity. IUAs normally represent a catchment or a linear section of river and therefore can differ from RUs which are always linear. Furthermore, an IUA can consist of many different ecological types of rivers (as this does not play a role in IUA selection). IUAs are therefore NOT the same or similar to RUs which are linear stretches of river that each are significantly different to warrant their own specification of the Reserve (DWAF, 1999, Volume 3). RUs are therefore nested within IUAs.

13.4 RIVERS SELECTED IN THE MZIMVUBU CATCHMENT FOR RU DELINEATION

High priority SQs were defined in **Chapter 11**. High priority SQs used in this context are defined as areas that warrant detailed investigations. Logically, these are the rivers in which key biophysical nodes or EWR sites are to be selected. EWR assessments at these sites will follow a Rapid III, Intermediate or Comprehensive level of EWR assessment which implies that results should have confidence which is higher than desktop level. All other biophysical nodes in the WMA will therefore be assessed at desktop level.

It must be noted that EWR sites have already been selected in this catchment, but no MRU determination process or selection of high priority SQs were assessed. Classification does however require these EWR sites and EWRs determined to put into context within the whole river.

The rivers where High Priority SQs dominate are the Mzimvubu, Tsitsa, Thina, Inxu, Gatberg and the Mzintlava. EWR sites were selected during the Ntabelanga Dam Feasibility study in the Tsitsa, Thina and Kinira rivers. As future developments and potential future scenarios are part of the

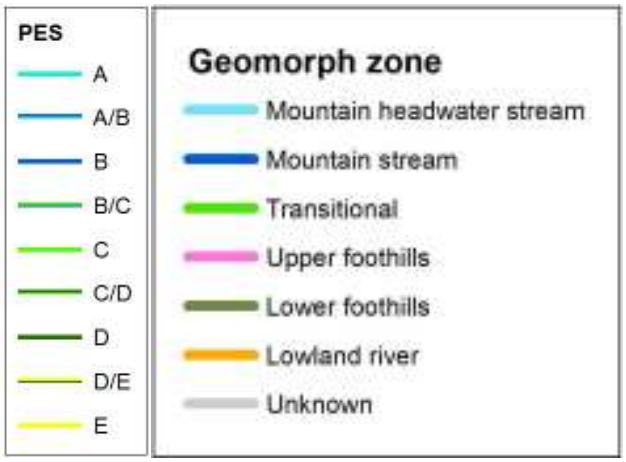
reasoning for the selection of the Mzimvubu, Tsitsa and Thina Rivers, MRUs were delineated for these rivers. Existing EWR sites were selected on the Tsitsa and Thina Rivers. No EWR site existed on the Lower Mzimvubu which is high priority and will be impacted on by the proposed developments. Therefore, an additional EWR site was selected on the Lower Mzimvubu. Historical EWRs exist on the Inxu and Gatberg Rivers and will be used as is. As there is unlikely to be any specific dam developments and operational scenarios on these rivers, MRU delineation is not required.

The results of the assessment for each of these rivers are described in the following chapters.

14 MANAGEMENT RESOURCE UNITS: TSITSA RIVER

The PES and geomorphic zone legends for standard colours are provided below and not repeated on maps further in this document. The purpose of different colours in all other maps (NRU, EcoRegions, MRU, and land use) ONLY illustrates the delineation changes from, e.g. one land use to another). The colours are not specific to, e.g. any type of land use.

Table 14.1 Generic PES and geomorphic zone legends and standard colours



14.1 NATURAL RESOURCE UNITS

The SQ reaches (representing hydrological zones), EcoRegions and geomorphic zones of the Tsitsa are described in **Figure 14.1**. The NRUs are derived from the EcoRegions and the geomorphic zones. The study area falls within four EcoRegions (Level 2), i.e. 15.07. 16.05, 16.06 and 31.01 and is dominated by the upper and lower foothills geomorphic zone. The geomorphic zones are very variable and therefore the EcoRegions were used to delineate the NRUs. The NRUs are described as NRU Tsitsa A, B, C and D and the delineation information is provided in **Table 14.2**.

14.2 MANAGEMENT RESOURCE UNITS

The river is divided into MRUs as illustrated in **Figure 14.2**. The description of the MRUs and the rationale for selection is provided below and in **Table 14.3**.

14.2.1 System operation and land use

There are no major dams in the Tsitsa catchment. The land use is characterised by commercial farming operations, forestry. The few urban centres are on tributaries. The land use in the lower portion of the zone includes some forestry plantations, cultivation, grazing, as well as numerous rural villages. High levels of erosion and sedimentation are prominent throughout the zone as a result of poor land use practices. Two major developments which are likely to happen are the proposed Ntabelang and Lalani dams.

14.2.2 Present Ecological State

At desktop level, the bulk of the main river was set at a B PES. The rest of the river was at a B/C PES with a short section at C PES. The main reason for the PES is overgrazing and sedimentation from erosion. The river is generally in good condition due to the lack of flow modification and the large section of steep valley sides.

Table 14.2 Tsitsa River: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU Tsitsa A	15.07 (94%)	Mountain headwater stream: 5% Mountain stream: 9% Transitional: 13% Upper foothills: 23% Lower foothills:50%	The break is formed by the change in EcoRegion Level II and linked to the closest end of SQ (i.e. tributary inflow).	From the source of the Tsitsa River to the end of T35A-05750 Start: E28.133202; S-30.830125 End: E28.429668; -30.942263
NRU Tsitsa B	16.05 (100%)	Transitional: 2% Upper foothills:27% Lower foothills: 70%	The downstream break is formed by the change in EcoRegion Level II and linked to the closest end of SQ (i.e. tributary inflow).	To the end of T35E-05908. End: E28.660386; -31.115117
NRU Tsitsa C	16.06 (79%)	Upper foothills: 19% Lower foothills: 57% Lowland: 23%	The downstream break is formed by the change in EcoRegion Level II and linked to the closest end of SQ (i.e. tributary inflow).	To the end of T35L-06976 End: E28.988465; -31.299469
NRU Tsitsa D	31.01 (100%)	Upper foothills: 61% Lower foothills: 39%	The downstream break is formed by the change in EcoRegion Level II and linked to the closest end of SQ (i.e. tributary inflow).	To the end of T35M-06187 (confluence with the Thina) End: E29.226818; -31.298449

Table 14.3 Tsitsa River: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
MRU Tsitsa A	15.07 (94%)	Mountain headwater stream: 5% Mountain stream: 9% Transitional: 13% Upper foothills: 23% Lower foothills:50%	There are no obvious changes in operation of the system, land use and PES to indicate the delineation. However, a separate MRU is warranted as this represents the source and upper areas for which an EWR set for lower reaches will not be relevant. The delineation therefore coincides with the NRU Tsitsa A	From the source of the Tsitsa River to the end of T35A-05750 Start: E28.13320; S-30.83013 End: E28.42967; S-30.94226
MRU Tsitsa B	16.05 (100%)	Transitional: 2% Upper foothills:27% Lower foothills: 70%	MRU Tsitsa B stretches to the proposed Ntabelanga Dam site as the operation downstream of the proposed dam will be significantly different than upstream. There are no obvious other indications from land use or PES that warrants a different delineation. This stretch also coincides largely with NRU Tsitsa B.	End: E28.66039; S-31.11512
MRU Tsitsa C	16.06 (76%)	Upper foothills: 9% Lower foothills: 66% Lowland: 26%	This MRU is delineated between Ntabelanga Dam site and the proposed Lalini Dam site. The reasons provided for MRU Tsitsa B is also applicable. This stretch also coincides largely with NRU Tsitsa C.	End: E28.92084; S-31.26129
MRU Tsitsa D	31.01 (85%)	Upper foothills: 67% Lower foothills: 31%	Downstream from the Lalini Dam site to the source with the Thina River. This stretch also coincides largely with NRU Tsitsa D.	End: E29.22682; S-31.29845

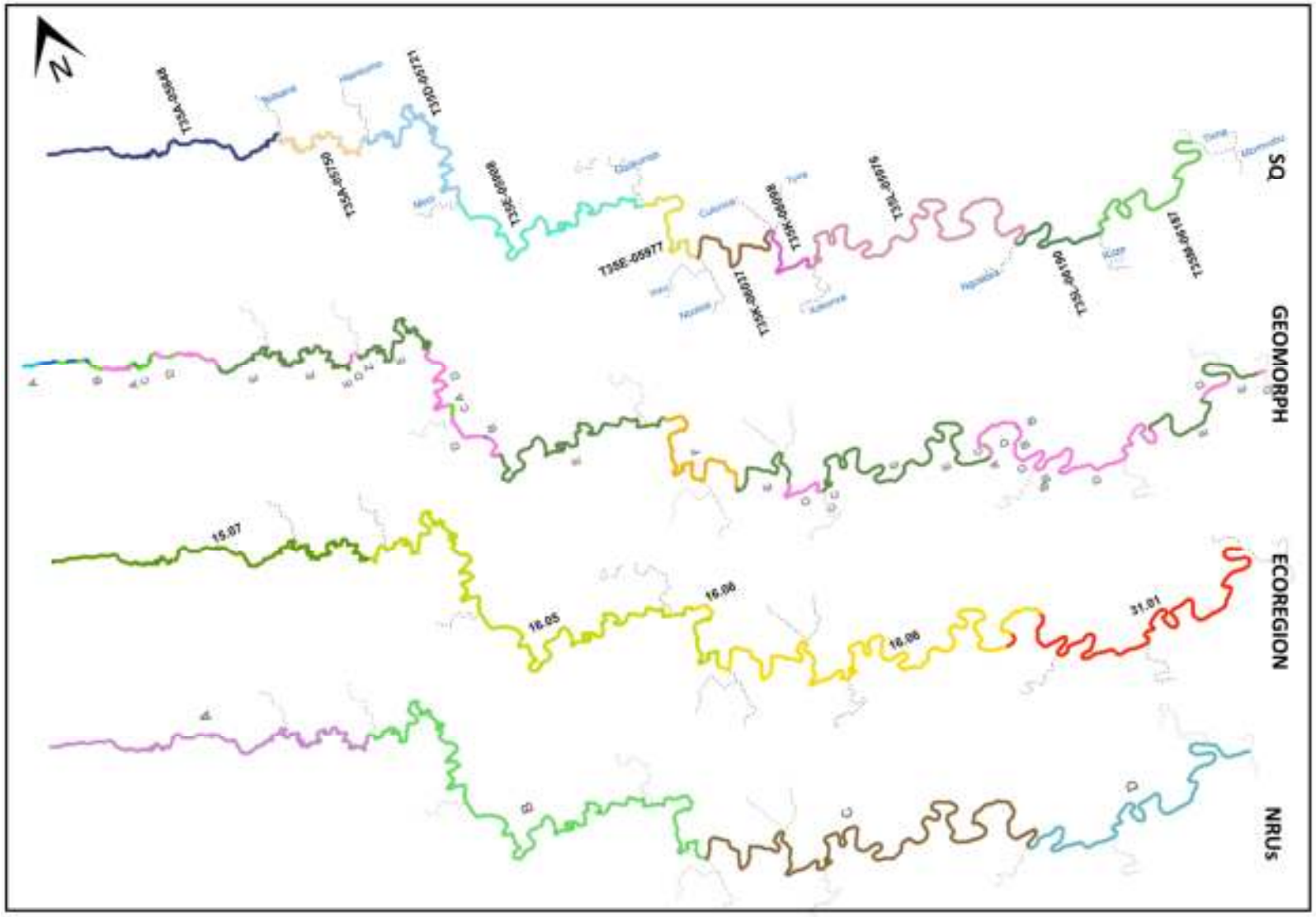


Figure 14.1 Tsitsa River: EcoRegions, geomorphological zones and NRUs

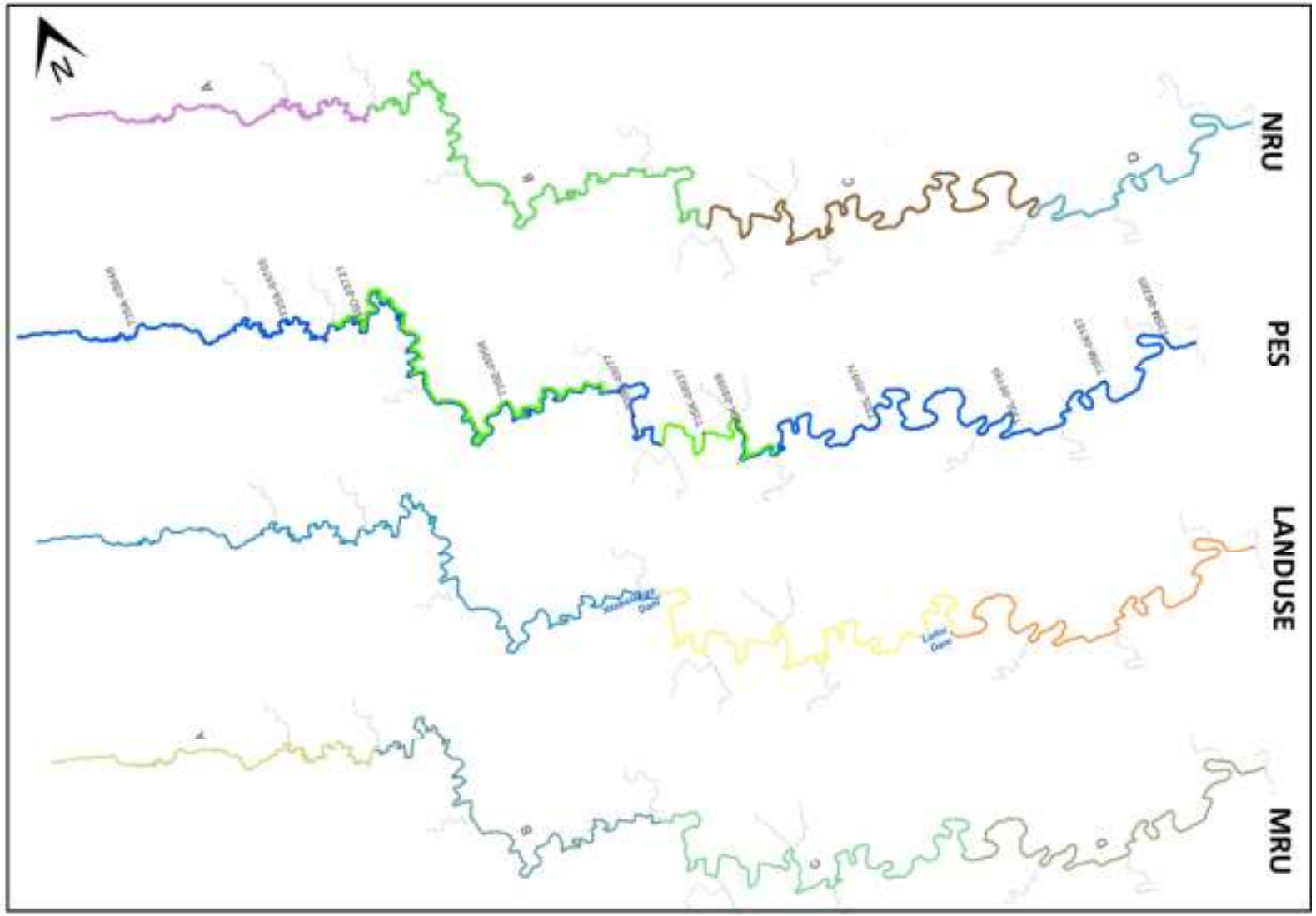


Figure 14.2 Tsitsa River: PES, operation, land use and MRUs

15 MANAGEMENT RESOURCE UNITS: THINA RIVER

15.1 NATURAL RESOURCE UNITS

The SQ reaches (representing hydrological zones), EcoRegions and geomorphic zones of the Thina River are described in the **Figure 15.1**. The NRUs are derived from the EcoRegions and the geomorphic zones.

The study area falls within six EcoRegions (Level 2), i.e. 15.06 (insignificant length), 15.07, 16.08, 16.05, 16.06 and 31.01 and is dominated by the upper and lower foothills geomorphic zone. The geomorphic zones are very variable and therefore the EcoRegions were used to delineate the NRUs. The NRUs are described as NRU Thina A, B, C and D and the delineation information are provided in **Table 15.2**.

15.2 MANAGEMENT RESOURCE UNITS

The river is divided into MRUs as illustrated in **Figure 15.2**. The description of the MRUs and the rationale for selection is provided below and in **Table 15.3**. It must be noted that MRUs represent High Priority RUs and where EWR sites are situated in the MRUs, the RQOs determined after Classification will be at a detailed level.

15.2.1 System operation and land use

There are no major dams in this zone but the smaller Mount Fletcher Dam, which supplies water to the Mount Fletcher town. This is not on the main river, but will impact the Thina River.

The land use in the zone is characterised by moderate and extensive dryland cultivation, some grazing, a few plantations and numerous rural villages. High levels of erosion and sedimentation are prominent throughout the zone as a result of poor land use practices in the lower portion of the zone.

15.2.2 Present Ecological State

At desktop level, the bulk of the main river was set at a B and B/C PES. The main reason for the PES is overgrazing and sedimentation from erosion. The river is generally in good condition due to the lack of flow modification and the large section of steep valley sides.

Table 15.1 Thina River: Description and rationale for the Natural Resource Units

NRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
NRU Thina A	15.06 (4%) 15.07 (96%)	Mountain headwater stream: 10% Mountain stream: 18% Transitional: 5% Upper foothills: 32% Lower foothills:35%	The break is formed by the change in EcoRegion Level II and linked to the closest end of SQ (i.e. tributary inflow).	From the source of the Thina River to the end of T34B-05356 Start: E28.120465; S-30.625516 End: E28.549649; S -30.691609
NRU Thina B	16.08 (55%) 16.05 (45%)	Transitional: 2% Upper foothills:18% Lower foothills: 79%	The downstream break is formed by the change in EcoRegion Level II and linked to the closest end of SQ (i.e. tributary inflow). Two EcoRegions were grouped together as they largely fall into the Lower Foothills geomorph zone.	To the end of T34G-06205. End: E28.815920; S -30.934818
NRU Thina C	16.06 (99%)	Upper foothills: 0% Lower foothills: 25% Lowland: 75%	The downstream break is formed by the change in EcoRegion Level II.	End: E28.815920; S -30.934818
NRU Thina D	31.01 (100%)	Upper foothills: 48% Lower foothills: 52%	The downstream break is formed by the change in EcoRegion Level II and linked to the closest end of SQ (i.e. tributary inflow).	To the end of T34K-05835 (confluence with the Tsitsa) End: E29.190597; S -31.274796

Table 15.2 Thina River: Description and rationale of the Management Resource Units

MRU	EcoRegion Level 2	Geomorphic zone	Rationale	Delineation
MRU Thina A	15.06 (2%) 15.07 (48%) 16.08 (50%)	Mountain headwater stream: 5% Mountain stream: 10% Transitional: 5% Upper foothills: 24% Lower Foothills:56%	The system operation and land use are different downstream of Mount Fletcher. The PES is mostly in a B/C and a B.	From the source of the Thina River to the end of T34D-05412 Start: E28.120465; S-30.625516 End: E28.549649; S -30.691609
MRU Thina B	16.05 (52%)	Transitional: 0% Upper foothills:15% Lower Foothills: 85%	MRU Tsitsa B is delineated due to the change in PES from a B/C to a B. This coincides with a more gorge like type of river. There are no obvious system operation changes.	End of T34H-05595 End: E28.815920; S -30.934818
MRU Thina C	31.01 (45%)	Upper foothills: 38% Lower Foothills: 61% Lowland: 0%	MRU Thina C stretches to the confluence with the Mzimvubu	To the end of T34K-05835 (confluence with the Tsitsa) End: E29.190597; S -31.274796

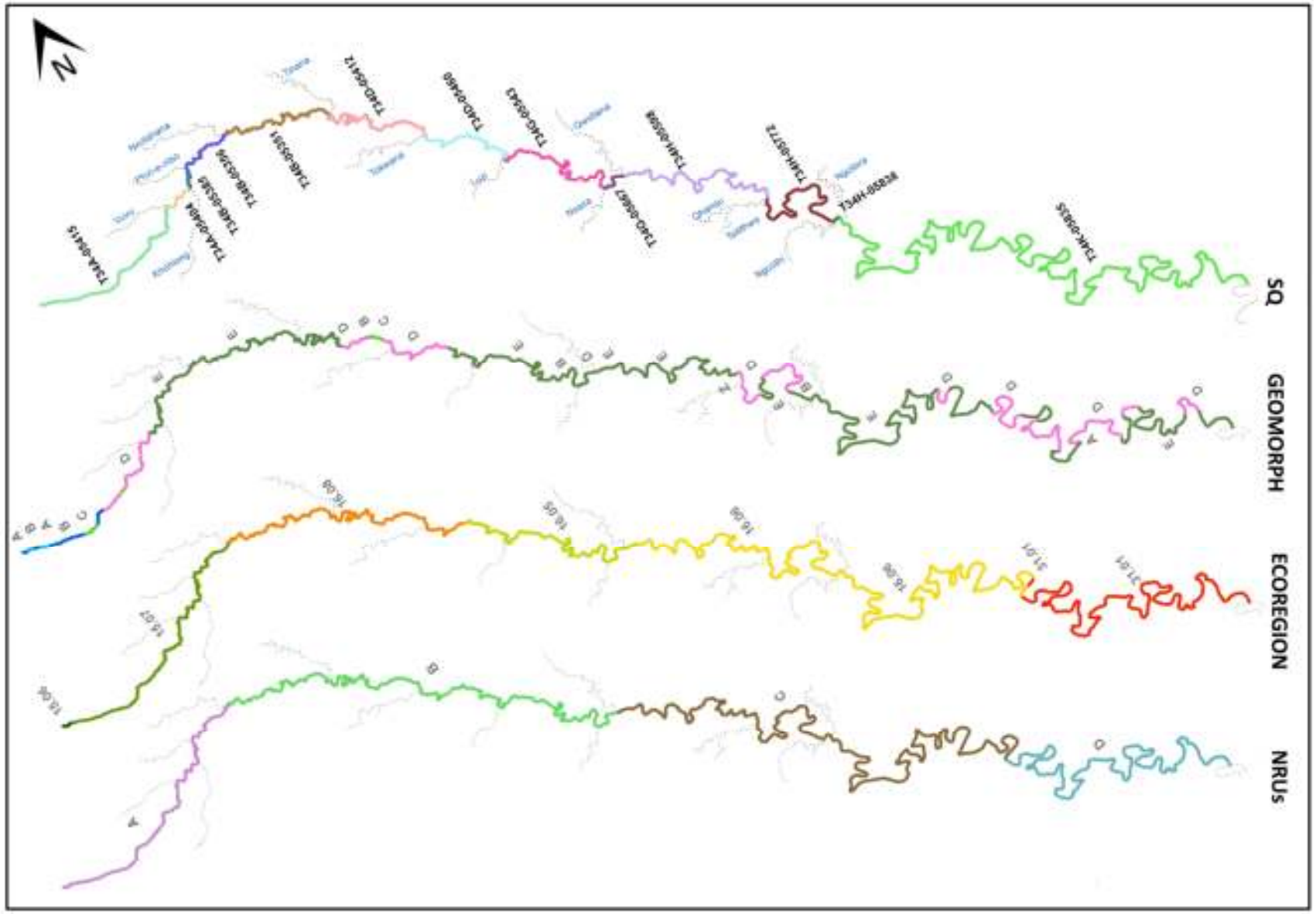


Figure 15.1 Thina River: EcoRegions, geomorphological zones and NRUs

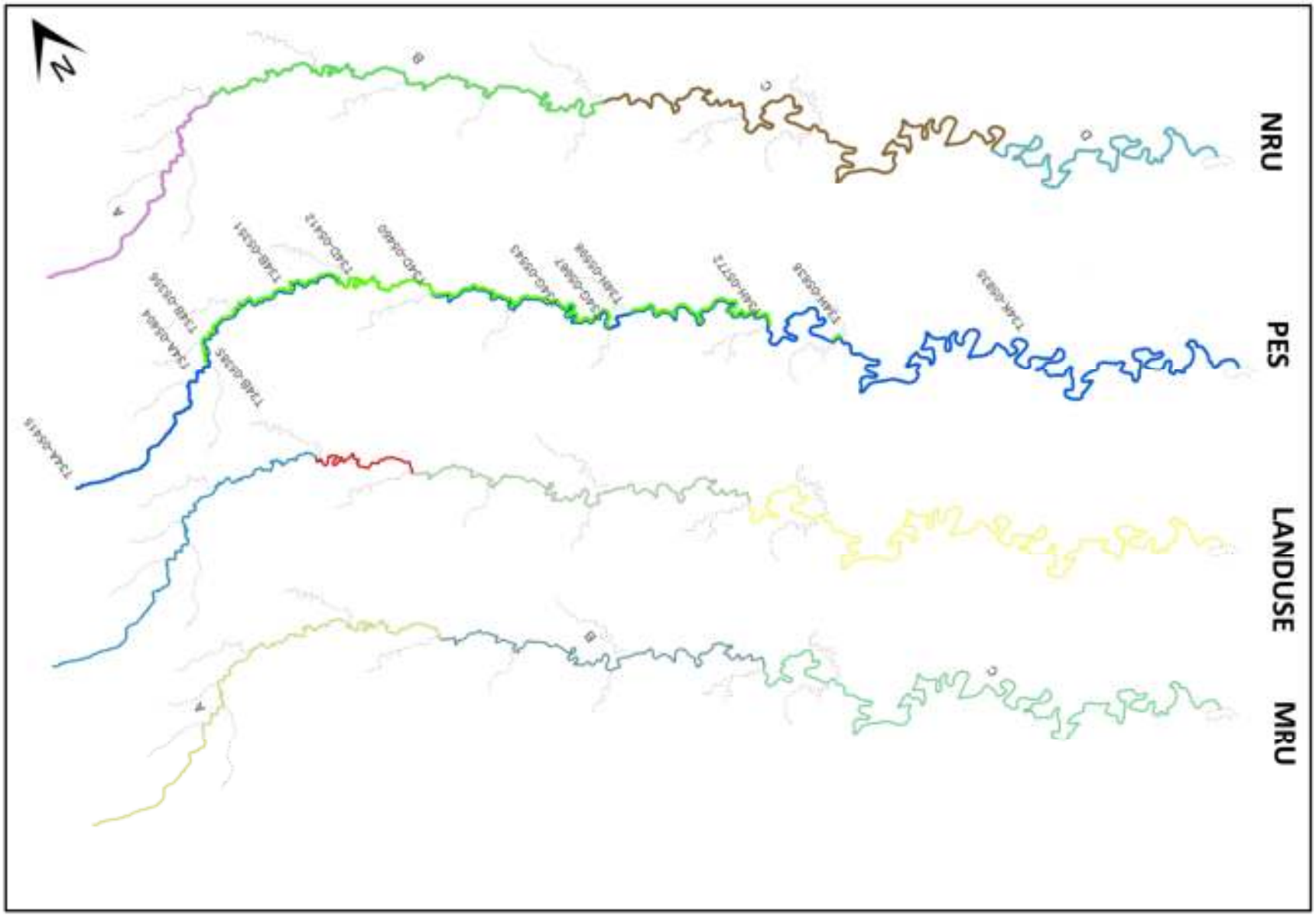


Figure 15.2 Thina River: PES, operation, land use and MRUs

16 RIVER RESOURCE UNITS

Priorities are set for the river RUs (those not addressed through the Management Resource Units). These are largely low and moderate priority RUs. SQs are combined to form the RUs. The basis for combining the RUs is the following:

- Similar EC
- Similar land use

Originally, the intent was to use the SQs as surrogate RUs. However, the SQs are numerous and many reaches are very short, implying that it does not warrant its own set of RQOs; therefore the process of combining them. .

The table below provides the grouped SQs into RUs and their priorities. The column headings are explained below.

- **Column 1**: RU numbers.
- **Column 2**: SQ numbers.
- **Column 3**: River names (if blank, then no names are provided in the PESEIS database).
- **Column 4**: SQ Priority (1 – 4). These represent the SQ priority as determined and reported on in Volume B.
- **Column 5**: RU Priority. The SQ with the highest priority will represent the priority for the RU.
- **Column 6**: REC (RU). The REC for the RU based on the highest REC of the SQs.

Appendix A will indicate in which IUA all the MRUs and RUs fall.

Table 16.1 RU priorities

RU	SQ number	River	SQ Priority	RU Priority	REC (RU)
T31: MZIMVUBU					
T31-1	T31A-04712	Mzimvubu	2	**2**	**B/C**
T31-2	T31B-04745	Krom	2	**2**	**B**
	T31B-04868	Krom	2		
	T31B-04873		2		
T31-3	T31C-04796	Mngeni	3	**3**	**B**
	T31C-04866	Mzimvubu	2	**2**	
T31-4	T31C-04879	Nyongo	2	**2**	**C**
T31-5	T31D-04926	Mzimvubu	2	**2**	**B**
	T31D-05076	Mzimvubu	2		
T31-6	T31D-04936	Riet	2	**2**	**C**
	T31D-05030	Riet	2		
	T31D-05060		2		
T31-7	T31E-04836	Tswereka	2	**2**	**B**
T31-8	T31E-04910	Malithasana	2	**3**	**B/C**
	T31E-04931	Tswereka	3		
T31-9	T31E-05055		2	**2**	**C**
T31-10	T31E-05013	Tswereka	3	**3**	**D**
T31-11	T31F-05108		2	**2**	**B/C**
T31-12	T31F-05112	Mzimvubu	2	**2**	**C**

RU	SQ number	River	SQ Priority	RU Priority	REC (RU)
	T31F-05134		2		
T31-13	T31G-05071	Mzimvubu	3	3	B/C
	T31J-05257	Mzimvubu	2		
T31-14	T31H-05177	Mvenyane	2	2	B
	T31H-05304		2		
T31-15	T31H-05324	Mvenyane	2	2	B/C
T31-16	T31H-05296	Mkemane	**2**	2	B
T31-17	T31H-05445		2	2	B/C
T31-18	T31H-05437	Mkemane	2	2	B/C
	T31H-05516	Mvenyane	1		C/D
T31-19	T31J-05551	Mzimvubu	**2**	3	B
	T31J-05582	Ngwekazana	**2**		
	T31J-05588	Mzimvubu	**3**		
T32: MZINTLAVA					
T32-1	T32A-04965	Mzintlava	2	2	B/C
T32-2	T32A-04907	Mzintlanga	2	2	C
	T32B-05103	Mzintlava	2		
T32-3	T32B-05116		3	3	B/C
	T32B-05184	Mzintlava	2		
T32-4	T32C-05219	Mill Stream	2	2	B/C
T32-5	T32C-05243	aManzamnyama	3	3	B/C
T32-6	T32C-05273	Mzintlava	3	4 (WQ)	B
	T32C-05313	Mzintlava	4	4	
T32-7	T32C-05378		3	3	B/C
T32-8	T32D-05172	Droewig	2	2	C
T32-9	T32D-05352	Mzintlava	3	4 (WQ)	D
T32-10	T32D-05373	Mzintlava	3	4 (WQ)	D
T32-11	T32E-05446	Mvalweni	2	3	C
	T32F-05464	Mzintlava	3		
T32-12	T32G-05536	Mzintlavana	3	3	B
	T32G-05609	Mbandana	2		
	T32G-05747	Mzintlavana	2		
T32-13	T32H-05842	Mzintlava	3	3	B
T33: KINIRA					
T33-1	T33A-04887	Mafube	2	2	B
	T33A-04928		2		
T33-2	T33A-04892	Kinira	2	3	B/C
	T33A-04898	Makomorin	2		
	T33A-04903	Kinira	3		
T33-3	T33A-04990	Kinira	3	3 3 (WQ)	C
	T33A-04991		3		
T33-4	T33B-05005	Jordan	2	2	B
	T33B-05072		2		
T33-5	T33B-04912	Seeta	3	3	B/C
	T33B-05051	Mabele	2		

RU	SQ number	River	SQ Priority	RU Priority	REC (RU)
T33-6	T33B-04939	Mabele	2	**2**	**C**
	T33B-04956	Mosenene	2		
T33-7	T33C-05131	Morulane	2	**2**	**C**
	T33D-05063	Kinira	2		
	T33D-05106	Pabatlong	2		
	T33D-05150	Kinira	2		
T33-8	T33E-05367	Somabadi	2	**2**	**C**
T33-9	T33F-05285	Rolo	2	**2**	**B/C**
	T33F-05398	Kinira	2		
T33-10	T33F-05439	Ncome	2	**2**	**C**
T33-11	T33G-05587	Cabazi	2	**2**	**C**
T33-12	T33H-05638	Mnceba	2	**2**	**C**
	T33H-05638	Mnceba	2		
T33-13	T33H-05803	Caba	2	**2**	**B**
T33-14	T33G-05659	Mzimvubu	3	**3**	**B**
	T33H-05680	Mzimvubu	2		
	T33H-05821	Mzimvubu	2		
	T33J-05834	Mzimvubu	2		
	T33K-06051	Mzimvubu	2		
T34: THINA					
T34-1	T34C-05168	Tinana	2	**2**	**B**
	T34C-05238	Phinari	2		
	T34C-05292	Tinana	2		
T34-2	T34A-05354	Zindawa	**2**	**2**	**B**
	T34A-05362	Vuvu	**2**		
	T34A-05394	Vuvu	**2**		
	T34A-05404 (MRU Thina A)	Thina	**2**		
	T34A-05415(MRU Thina A)	Thina	2		
T34-3	T34A-05408	Khohlong	2	**2**	**B/C**
	T34B-05385 (MRU Thina A	Thina	2		
T34-4	T34B-05269	Nxotshana	2	2	B
	T34B-05275	Phiri-e-ntso	2		
	T34B-05351 (MRU Thina A)	Thina	2		
	T34B-05356 (MRU Thina A)	Thina	2		
T34-5	T34D-05412	Thina	2	**2**	**B/C**
T34-6	T34D-05433	Tokwana	1	**4 (WQ)**	**C**
	T34D-05462	Khalatsu	**2**		
	T34D-05463	Tokwana	**3**		
T34-7	T34E-05495	Bradgate se Loop	2	**2**	**B**
	T34E-05503	Luzi	2		
	T34E-05507	Luzi	2		

RU	SQ number	River	SQ Priority	RU Priority	REC (RU)
T34-8	T34F-05512	Luzi	2	2	B/C
	T34F-05585		2		
T34-9	T34G-05504	Qwidlana	2	2	B/C
	T34G-05634	Nxaxa	2		
T34-10	T34H-05714	Qhanqu	2	2	B
	T34H-05769	Tsilithwa	2		
	T34H-05791	Tsilithwa	2		
T34-11	T34H-05826	Ngcothi	3	3	B
T34-12	T34H-05699	Mvuzi	2	2	C
	T34H-05738	Ngcibira	2		
	T34H-05809	Mvumvu	2		
T35: TSITSA					
T35-1	T35A-05596	Tsitsana	2	3	B
	T35A-05648 (MRU Tsitsa A)	Tsitsa	2		
	T35A-05657	Hlankomo	2		
	T35A-05750 (MRU Tsitsa A)	Tsitsa	3		
T35-2	T35B-05709	Pot	2	3	B
	T35B-05798	Pot	3		
	T35B-05815	Little Pot	2		
T35-3	T35C-05858	Mooi	2	2	B
	T35C-05930	Klein-Mooi	2		
T35-4	T35C-05874	Mooi	3	3	C
T35-5	T35E-05780	Gqukunqa	2	2	B
T35-6	T35F-05999	Inxu	3	4	B
	T35F-06000	Fontana	4		
	T35F-06080	Inxu	2		
	T35F-06112	Rondadura	2		
T35-7	T35G-06135	Gqaqala	**4**	4	B
	T35G-06169	Gqaqala	**2**		
	T35G-06179		**2**		
T35-8	T35F-05973	Kuntombizininzi	4	4	B
MRU Inxu EWR1	T35F-06020	Inxu	3	4 (WQ)	C
	T35G-06021	Inxu	4	4	B
MRU Gat IFR1	T35G-06069	Gatberg	4	4	B
	T35G-06074	Gatberg	4		
	T35G-06099	Gatberg	3		
	T35G-06100		3		
	T35G-06118	Gatberg	4		
	T35G-06133		4		
MRU NXU	T35H-06024	Inxu	2	3	B/C
	T35H-06053	Inxu	2		
	T35J-06088	Inxu	3		
T35-9	T35H-06186	Umnga	2	2	B/C
	T35H-06240	KuNgindi	2		

RU	SQ number	River	SQ Priority	RU Priority	REC (RU)
	T35H-06282	Umnga	2		
T35-10	T35H-06158	Qwakele	2	**2**	**B/C**
T35-11	T35J-06106	Ncolosi	2	**2**	**C**
T35-12	T35K-05897	Culunca	2	**2**	**B/C**
T35-13	T35K-05904	Tyira	**2**	**2**	**C/D**
T35-14	T35K-06167	Xokonxa	3	**3 (WQ)**	**C**
T35-15	T35L-06226	Ngcolora	2	**2**	**C**
T35-16	T35M-06275	Ruze	2	**2**	**B**
T36: MZIMVUBU					
T36-1	T36A-06216	Mzintshana	2	**2**	**B**
T36-2	T36A-06220	Mkata	3	**3**	**B**

17 GROUNDWATER RESOURCE UNITS

17.1 OBJECTIVE

The objective of Groundwater Resource Unit (GRU) delineation is to group areas of similar geohydrological properties. Areas of similar character are grouped and mapped into distinct units, termed GRUs based on quaternary catchment boundaries, aquifer type, and other physical, management and/or functional criteria.

Quaternary catchments form the basic unit of delineation. These can be subdivided if significant geohydrological features cut through catchments.

Criteria utilised to group or disaggregate catchments to form GRUs include:

- Interaction with other components of the hydrological cycle such as wetlands and rivers.
- Nature of the aquifers (primary, secondary dolomitic, alluvial etc.).
- Lithology when it affects borehole yields and groundwater quality.
- Topography.
- Groundwater dependence and use.
- Groundwater quality.
- Recharge and available groundwater resources.

The key outcome of this delineation process is a map demarcating GRUs and a description. The approach followed in this study for grouping and delineation in hierarchical order is:

- An original primary delineation by quaternary catchment boundary as demarcated in Water Resources South Africa 2012 (WR2012).
- Geological age and lithology based on the Geological Society of South Africa (GSSA) (John *et al.,* 2006).
- Identification of groundwater regions based on geological considerations.
- Identification of catchments with baseflow to surface water bodies, as listed in Groundwater Resource Assessment Phase II (GRAII) (DWAF, 2006).
- Climate, recharge, and Harvest Potential (DWAF, 2006).

17.2 GEOLOGY

The Geology consists of Paleozoic to Jurassic age rocks of the Cape Supergroup and Karoo Supergroups. The lithologies consist of sedimentary rocks and intrusive dolerites.

The geologic units present are described in **Table 17.1** and their distribution is shown in **Figure 17.1**.

The following geological units are identified:

- Msikaba Formation: These rocks of the Cape Supergroup outcrop only near the coast near Port St Johns and are of Devonian age. They consist of quartzitic sandstone with grit and conglomerate layers deposited in a shallow amrine environment.
- Dwyka Group: Late Carboniferous to early Permian diamictites unconformably overlie the Msikaba Formation northwest of Port St Johns.
- Ecca Group: Permian Ecca Group rocks overlie the Dwyka Group and consist largely of shales. They outcrop on the southeast margin of the WMA.

- Adelaide Subgroup: These rocks of the Beaufort Group consist of late Permian continental mudstones that are generally massive and show blocky weathering. The Adelaide Subgroup consist of upward fining cycles of sandstone grading into mudstones, with some lenticular sandstone bodies.
- Tarkastad Subgroup: These rocks of the Beaufort Group consist of early Triassic mudstones and sandstones. The Tarkastad Subgroup has a higher abundance of sandstone with a higher quartz fraction than the underlying Adelaide Subgroup.
- Molteno Formation: These late Triassic rocks consist of alternating sandstone and mudrocks, in roughly equal proportions.
- Elliot Formation: These late Triassic rocks consist of alternating mudrocks and subordinate sandstone.
- Clarens Formation: These late Triassic to early Jurassic rocks represent the final phase of Karoo sedimentation and consist of fine grained aelion sand, forming siltstone and fine grained sandstone, with sandstones greatly dominating the Formation.
- Drakensberg Group: These Mesozoic rocks consist of stacked basaltic lavas.
- Karoo Dolerite: These intrusions represent the feeder systems of the basaltic eruptions and form dykes sills and saucer-like basins which are widespread, particularly in the Beaufort Group.
- Quaternary deposits: These consist of mainly alluvial and aeolian sands. Alluvial slope (sheet-wash) and valley (channel-transported) deposits vary in thickness from a thin veneer to a few metres thick.

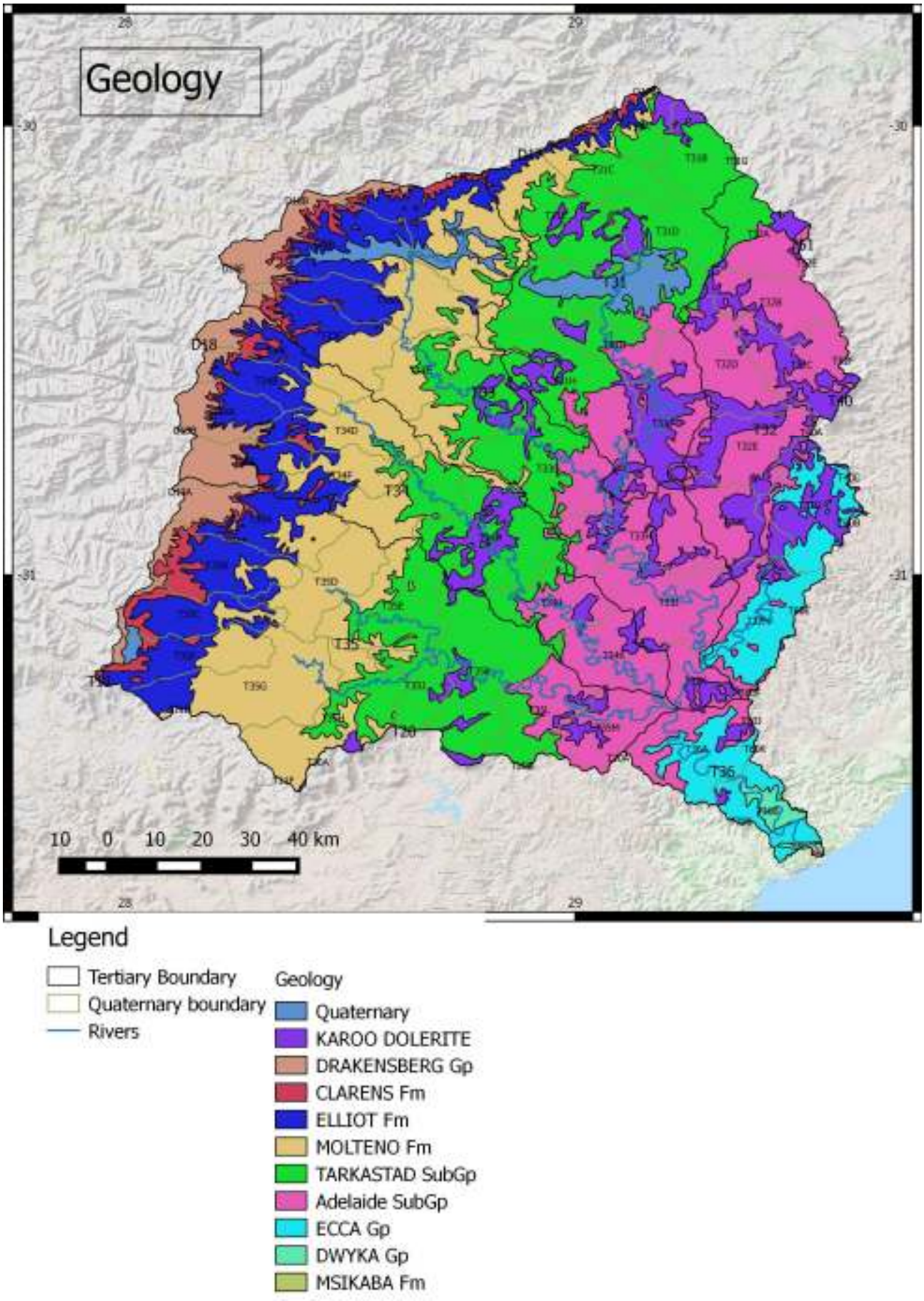


Figure 17.1 Geology of the Mzimvubu catchment

Table 17.1 Stratigraphy of the Mzimvubu catchment

Age	Supergroup	Group	Subgroup	Formation/Suite	Lithology
Jurassic	Karoo			Karoo dolerite	Dolerite
Mesozoic		Drakensberg			Basalt
Triassic		Stormberg		Clarens	Sandstone and siltstone
				Elliot	Mudstones and sandstone
				Molteno	Sandstone and mudstone
		Beaufort	Tarkastad	Katberg Burgersdorp	Mudstones and sandstones
Permian			Adelaide	Balfour Middleton Koonap	Mudstones and sandstones
		Ecca			Shales
Carboniferous		Dwyka			Diamictities
Devonian	Cape			Msikaba	Sandstones

17.3 GROUNDWATER REGIONS

The Vegter groundwater regions (Vegter, 2001) are shown in **Figure 17.2**. The underlying geology in each region and the quaternary catchments incorporated are described in **Table 17.2**.

The KwaZulu-Natal Coastal Foreland approximates the outcrop area of the Msikaba Formation and Dywka Group. The Transkeian Coastal Foreland and Middelveld approximates the area of the shales and mudstones of the Ecca and Beaufort Groups. The Southeastern Highland covers the area of the sandstones and mudstones of the upper Karoo.

Table 17.2 Groundwater regions of the Mzimvubu catchment

Groundwater region	Stratigraphy	Quaternary catchment
KwaZulu-Natal Coastal Foreland	Msikaba Formation, Dwyka Group	T36B
Transkeian Coastal Foreland and Middelveld	Ecca Group	T32G, T32H T36A, T36B
	Adelaide Subgroup	T31F, T31G, T31H, T31J T32A, T32B, T32C, T32D, T32E, T32F, T32G, T32H T33G, T33H, T33J, T33K T34J, T34K T35K, T35L, T35M T36A
	Tarkastad Subgroup	T31A, T31B, T31C, T31D, T31E, T31F, T31G, T31H, T32A, T33A, T33E, T33F, T33G, T33H T34D, T34G, T34H, T34J T35E, T35H, T35J, T35K, T35L
Southeastern Highland	Molteno and Elliot Formations	T31A, T31C, T31E T33A, T33B, T33C, T33D, T33E, T33F T34A, T34B, T34C, T34D, T34E, T34F, T34G T35A, T35B, T35C, T35D, T35E, T35G, T35H,
	Clarens Formation	T31A, T31C, T31E T33AT33BT33C, T33D T34A, T34B, T34C, T34D, T34E, T34F T35A, T35B, T35C, T35F
	Drakensberg Group	T31A,T31C T33A, t33B, T33C, T33D T34A, T34B, T34C, T34E T35A, T35C, T3fF

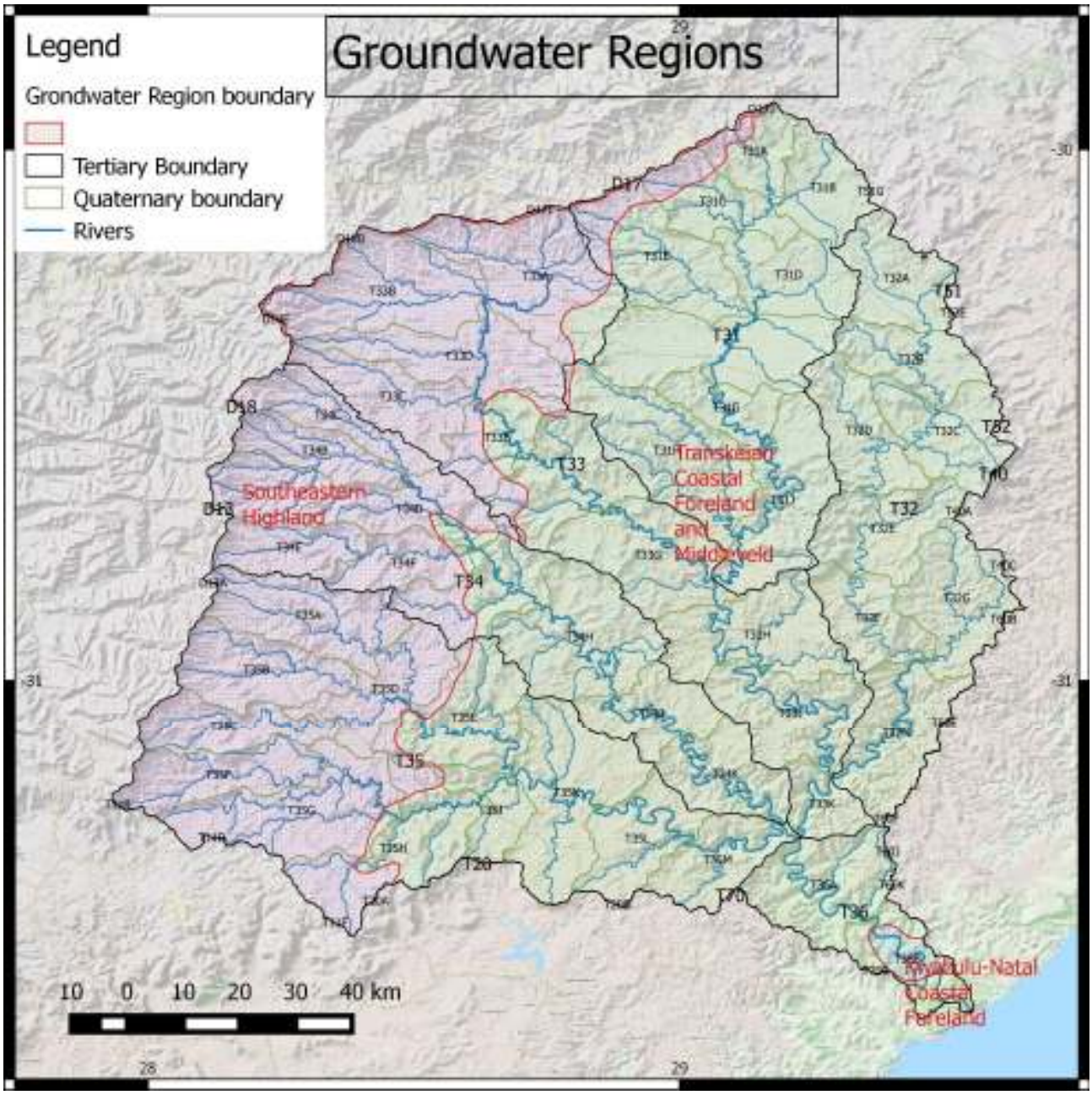


Figure 17.2 Groundwater regions

17.4 AQUIFER TYPES

Aquifer types are found in the Mzimvubu catchment are intergranular and fractured (weathered and fractured), and fractured for the Dwyka Group. The distribution of aquifer types is shown in **Figure 17.3**.

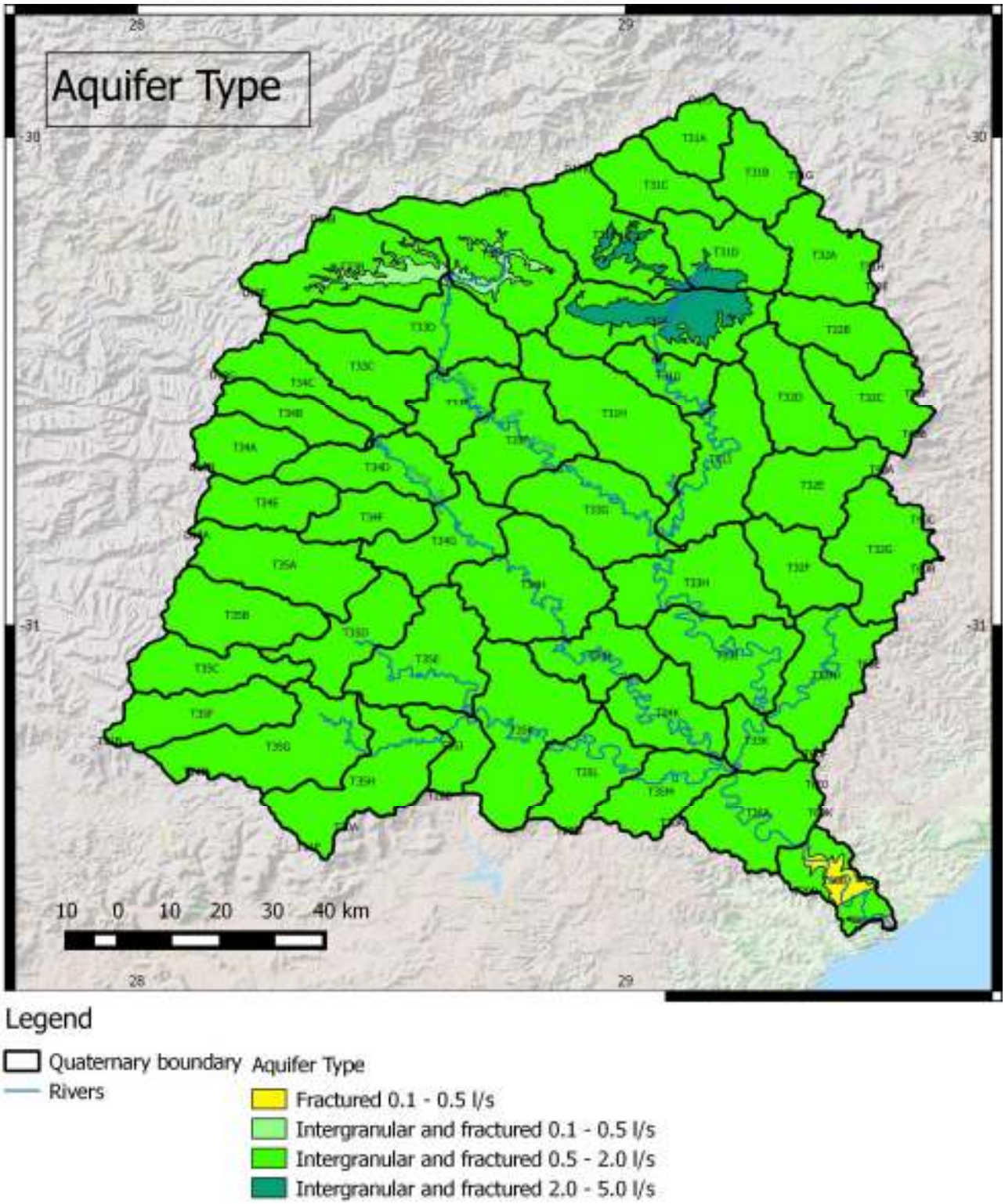


Figure 17.3 Aquifer types in the Mzimvubu catchment

Intergranular and fractured aquifers

Secondary fractured and weathered aquifers are found throughout the study area. Weathering gives rise to low to moderately-yielding aquifers where groundwater is stored in the interstices in the weathered saturated zone and in joints and fractures of competent rocks. Borehole yields range from 0.5-2.0 L/s, except where quaternary cover occurs in the upper reaches of the Mzimvubu in T31D-F.

Fractured aquifers

Purely fractured aquifers are found only in the Dwyka Group in T36B. These rocks are low-yielding and boreholes yields are below 0.5 l/s.

17.5 HYDROGEOLOGY

The main variations in the Karoo Supergroup hydrogeology occur due to variations in degree of fracturing and weathering, variations in mudstone or shale percentages, the distribution and nature of dolerite intrusions, and the presence of quaternary deposits.

Significant dolerite dykes stretch NW-SE from the coast to inland. The weathering of these dykes has, to a large extent, controlled the orientation of erosion and water courses.

Dykes are the obvious and prevalent target for boreholes, however, drilling yields vary significantly. Although yields may be high, the groundwater flow along dykes is low due to the narrow nature of the associated fracture zone. Consequently, in terms of sustainability, the country rock adjacent to the dyke is important in terms of its ability to supply water to the dyke contact zone. This implies that the proportion of more permeable and higher porosity sandstone is of relevance when determining sustainable groundwater resources.

Dolerite sills are present in the Ecca and Beaufort Group, but their occurrence decreases up the Karoo Supergroup, becoming less prominent in the Molteno, and less so in the Elliot and Clarens Formations. These sills are generally thin and less than 40 m thick. They are flat flying in the Ecca and Adelaide rocks, whereas in the Tarkastad rocks they are thicker and there is a transition to large ring structures instead of flat sills.

Dolerite sills are generally associated with lower yields than dykes, especially away from the edges of the sill and the contact with sediments beneath the sill has poor hydrogeological properties.

Dolerite ring structures dominate in the Molteno and Elliot Formations, where dolerites tend to be present as both inclined sheets and small rings, which can be very thick (> 80 m).

The presence of dolerite affects the fracturing pattern of the surrounding rock, hence borehole yields display an association with the orientation of sills, dykes and ring structures.

Springs play a vital role in the groundwater resources of the region. Springs also provide important habitat for wildlife and vegetation, and can result in wetlands.

Springs can occur at the margins of dolerite ring structures, emerging at different places along the dolerite rings where the side slopes consisting of dolerite prevent deeper infiltration. These springs can form the origin of first order streams, where they are associated with wetlands. These springs usually occur on the lower slopes and the inner side of the ring, due to water flowing through shallow dipping fractures parallel to the walls of the intrusion. This type of spring implies a perched water table (interflow) that also feed the wetlands and marshy areas in the fractured dolerite.

Some springs occur below the outer sill, in the sedimentary rocks. They result from water seeping through the vertical cooling cracks of the sill, through the sediment. They emerge at a more impermeable sedimentary layer (mudstone) (**Figure 16.4**).

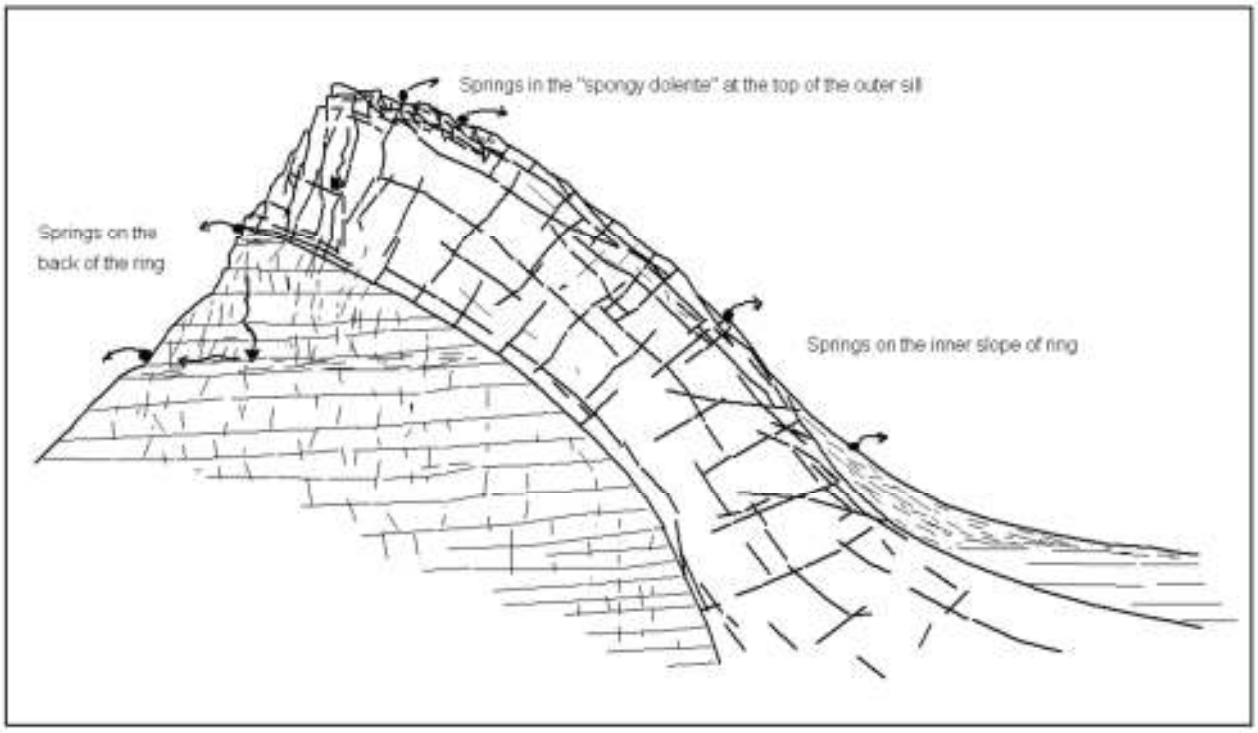


Figure 17.4 The different types of spring occurrences associated with dolerite sill and ring complexes (after Chevallier *et al.*, 2004)

Dolerite sills also generate discharge as high-lying springs since the recharge areas at the top of a sill, or trapped between the top of the sill and the overlying sediment, can form perched aquifers. This results in interflow at high elevation and forms elevated springs or seeps feeding the drainage system.

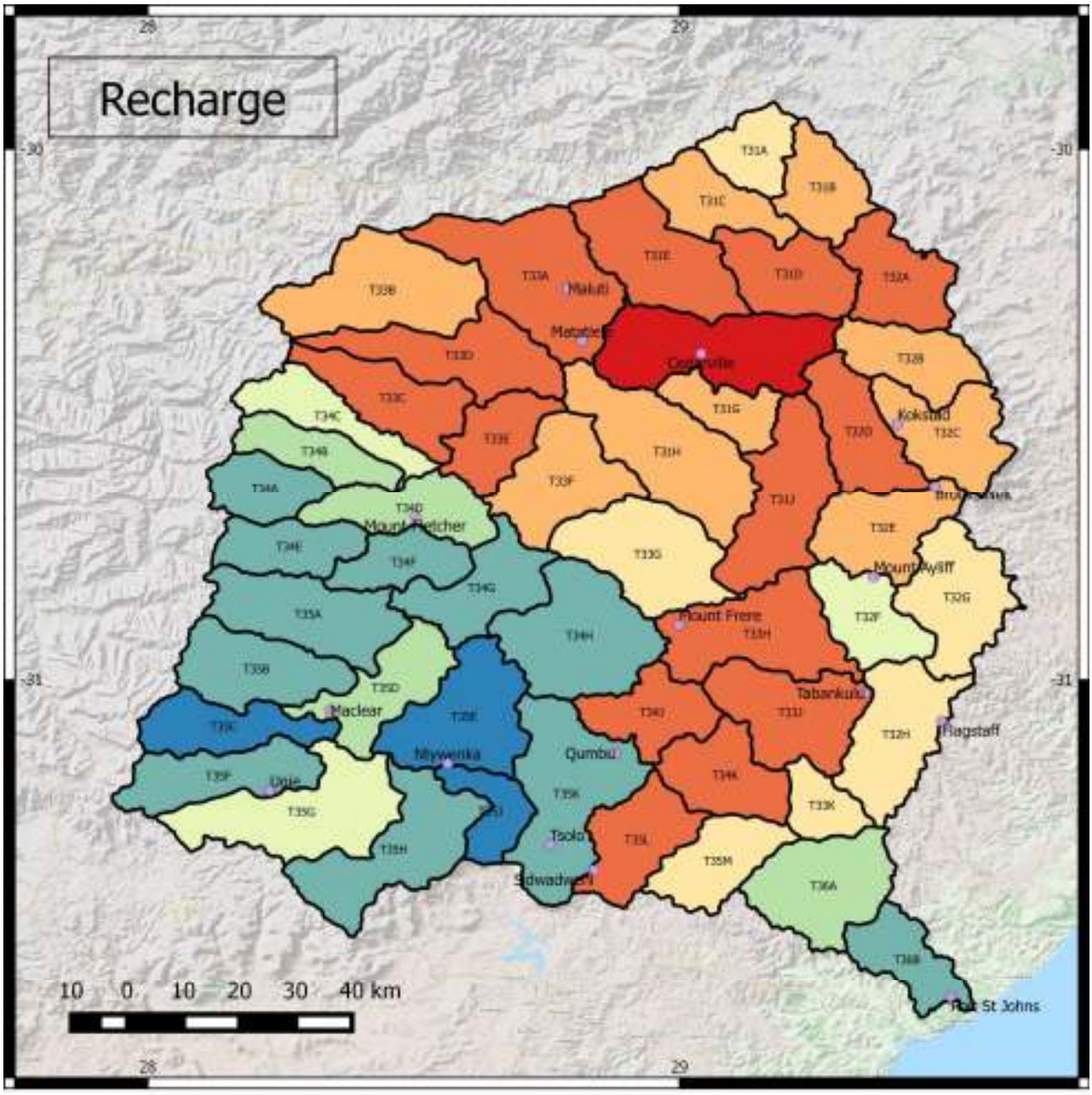
The transition between sandstone-rich formations and low permeability mudstone-rich layers, like the contact between the Molteno and Burgersdorp Formations, can also result in springs, where groundwater percolating through sandstone emerges above low permeability mudstone, resulting in interflow if of sufficient volume.

Some springs are also located alongside dykes, indicating compartmentalisation.

The distribution of springs, when analysed and compared with the presence of dolerite sills and rings, indicated that the dolerite sills in the area belong to the tectonic domain defined between 500 and 900 mamsl. This is where flat sills and large shallow ring-type structures start developing instead of dykes.

17.6 GROUNDWATER RECHARGE

The estimation of recharge is one the most important components within the GRDM process since it is used to calculate the available groundwater volume for allocation per unit. This allocable volume ultimately determines whether or not additional licence applications for groundwater can be approved. Based on GRAII, recharge varies from 30-115 mm/a (**Figure 17.5**).



Legend

Towns

Recharge (mm/a)

- 30 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 95
- 95 - 114

Figure 17.5 Recharge in the Mzimvubu catchment

Significantly higher recharge occurs in the southwest, in the T34 and T35 catchments compared to the T31 and T33 catchments. This pattern is also observed in rainfall (**Figure 17.6**).

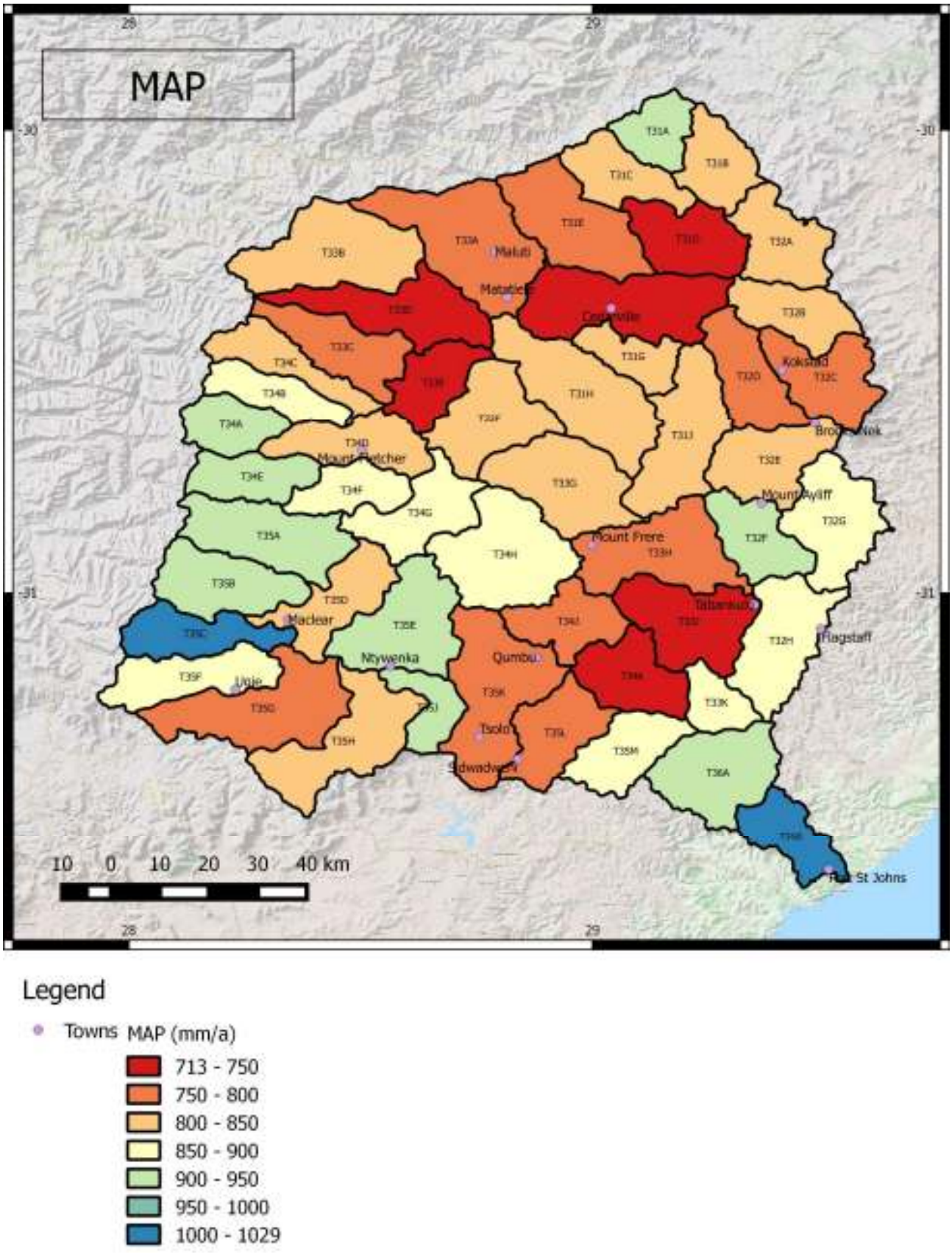


Figure 17.6 MAP for quaternary catchments

Because of the occurrence of high-lying springs, much of the recharge re-emerges in high-lying areas due to the presence of dolerite sheets. A large part of recharge is therefore lost as interflow before reaching the regional aquifer, hence total recharge in a catchment is not a good indicator of the groundwater resources. Consequently, the estimate of aquifer recharge (recharge that reaches

the aquifer after the subtraction of interflow) in GRAII should be utilised for deriving aquifer resources and stresses. However, total recharge should be used to derive baseflow.

17.7 DELINEATION OF GROUNDWATER RESOURCE UNITS

The Vegter groundwater regions match the delineation between the shales and mudstones of the Lower Karoo and the Upper Karoo, which has far more sandstones. It also separates the fractured aquifers of the Dwyka and Msikaba Formations from the fractured and weathered aquifers of the Lower Karoo. Consequently, it was decided to use the Vegter regions as a first tier basis for delineation. However, the Vegter regions run across quaternary boundaries. The following modifications were made to alter the groundwater regions and further refine them into GRUs:

- Shift the border of groundwater regions to match quaternary boundaries, using the dominant geology where only minor portions of a quaternary were in a region.
- Subdivide the groundwater regions by tertiary catchment
- Subdivide the groundwater regions to incorporate variations in recharge and baseflow.

The delineation of GRUs is shown in **Figure 17.7**. The GRUs are described in **Table 17.3**.

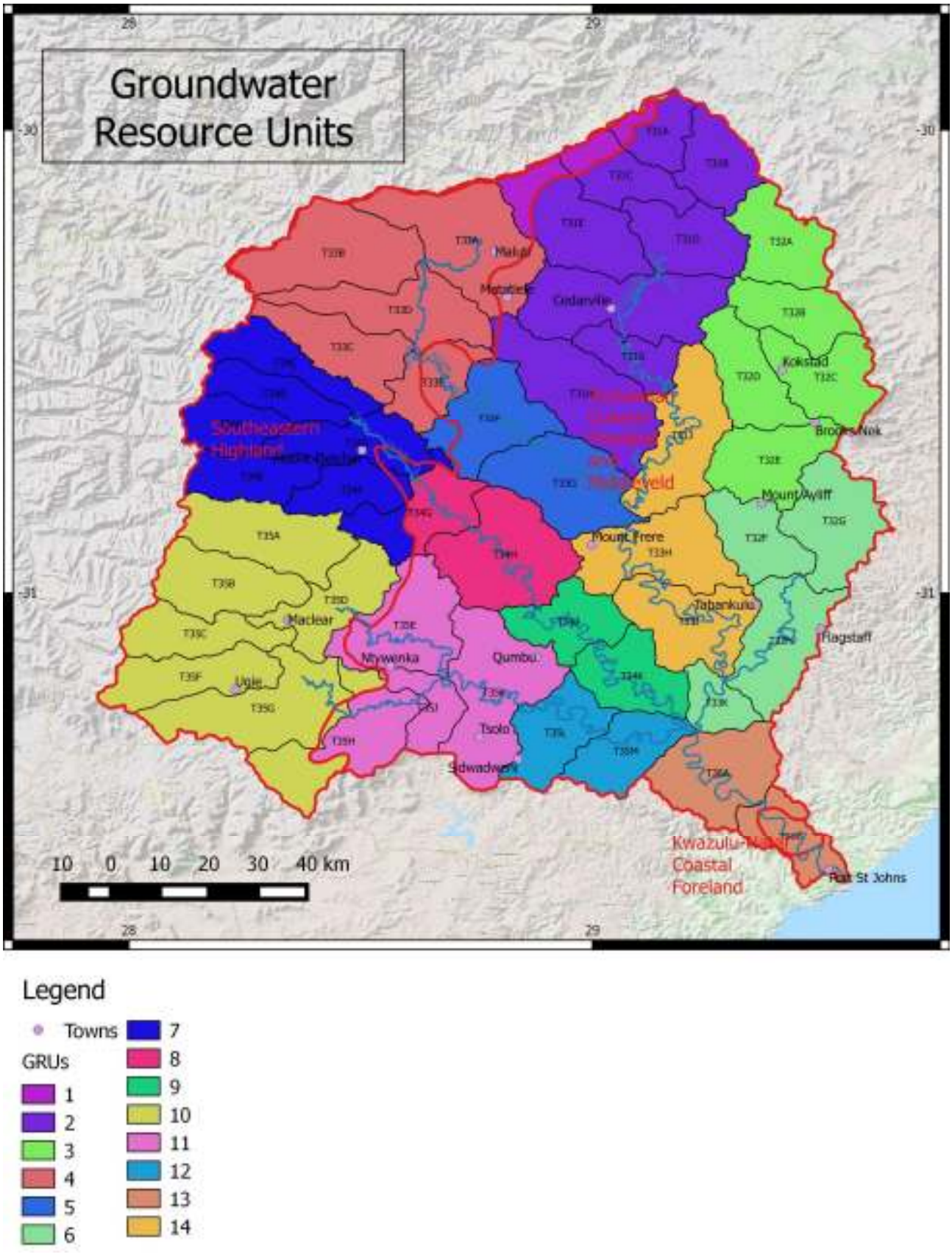


Figure 17.7 Delineation of GRUs

Table 17.3 GRUs in the Mzimvubu catchment

GRU	Quaternaries	Catchment	Geology	Baseflow (mm/a)	Description
1	T31A,T31C, T31E	Upper Mzimvubu	Clarens, Elliot, Molteno	33-54, increasing to the NE	South-eastern highlands with valley bottom wetlands. Baseflow is largely interflow driven.
2	T31A, T31BT31C, T31D, T31E, T31F, T31G, T31H	Upper Mzimvubu	Tarkastad, Dolerite, Quaternary	27-54	Transkei coastal foreland and middleveld with valley bottom wetlands and seeps. Baseflow is interflow driven with a component from the regional aquifer.
3	T32A, T32B, T32C, T32D, T2E	Mzintlava	Adelaide, Dolerite	30-50	Transkei coastal foreland and middleveld with valley bottom wetlands and seeps. Baseflow is interflow driven with a component from the regional aquifer.
4	T33A, T33B, T33C, T33D, T33E	Upper Kinira	Drakensberg, Clarens, Elliot, Molteno, Quaternary	30-40	South-eastern highlands in the upper Kinira catchment with flood plain wetlands and valley head seeps. Baseflow is interflow driven with a component from the regional aquifer.
5	T33F, T33G	Lower Kinira	Moteno, Tarkastad, Adelaide, Dolerite	40-50	Transkei coastal foreland and middleveld of the lower Kinira with valley bottom wetlands. Baseflow is interflow driven with a component from the regional aquifer.
6	T32F, T32G, T32H, T33K	Lower Mzintlava, Middle Mzimvubu, Mzintlavana	Adelaide, Ecca, Dolerite	50-70	Transkei coastal foreland and middleveld with valley bottom wetlands. Baseflow is interflow driven with minor groundwater baseflow from the regional aquifer.
7	T34A, T34B, T34C, T34D, T34E, T34F	Upper Thina	Drakensberg, Clarens, Elliot, Molteno	60-90	South-eastern highlands with few wetlands. Baseflow is interflow driven with a component from the regional aquifer.
8	T34G, T34H	Middle Thina	Tarkastad, Dolerite	80-90	Transkei coastal foreland and middleveld with valley bottom wetlands. Baseflow is interflow driven with a component from the regional aquifer.
9	T34J, T34K	Lower Thina	Adelaide	27-40	Transkei coastal foreland and middleveld with valley bottom wetlands. Baseflow is interflow driven with a component from the regional aquifer.
10	T35A, T35B, T35C, T35D, T35F, T35G, T35H	Upper Tsitsa and Inxu	Drakensberg, Clarens, Elliot, Molteno	60-112	South-eastern highlands with valley bottom wetlands, seeps. Baseflow is interflow driven with a component from the regional aquifer.
11	T35E, T35H, T35J, T35K	Middle Tsitsa and lower Inxu	Molteno, Tarkastad, Dolerite	70-110	Transkei coastal foreland and middleveld with valley bottom wetlands. Baseflow is interflow driven with a component from the regional aquifer.
12	T35L, T35M	Lower Tsitsa	Tarkastad, Adelaide, Dolerite	30-60	Transkei coastal foreland and middleveld with valley bottom seeps. Baseflow is interflow driven with a component from the regional aquifer.
13	T36A, T36B	Lower Mzimvubu	Ecca, Dwyka,	60-90	Coastal belt with no significant wetlands. Baseflow is dominated by interflow.
14	T31J, T33H, T33J	Middle and lower Mzimvubu	Adelaide, Dolerite	30-40	Transkei coastal foreland and middleveld. Baseflow is interflow driven with a component from the regional aquifer valley bottom wetlands.

18 MZIMVUBU ESTUARY DELINEATION

18.1 APPROACH

In 2010, the Estuarine Functional Zone – encapsulating not only the estuary water body but also supporting physical and biological processes and habitats necessary for that estuarine function and health – was listed as Notice 3 (GN R 546) under the National Environmental Management Act (NEMA), Environmental Impact Assessment (EIA) Regulations (2010). This notice stipulates that estuaries (defined by the spatial delineation of the estuarine functional zone) are “sensitive areas” that require environmental authorisation before developments within this zone may proceed. These regulations are meant to curb inappropriate future development in the estuarine functional zone.

Estuaries have little permanent habitat structure unlike, for example, a rainforest as estuarine habitats are constantly forming and eroding at various temporal and spatial scales. However, over longer time scales the total habitat area occupied by the various estuarine habitat types tend to remain more or less constant, while the precise spatial location of the various estuarine habitats is highly likely to change between resetting events (e.g. larger floods).

The relatively ephemeral nature of estuarine habitat presents an assessment and planning challenge. Resource protection requires the protection of habitat and ecological and evolutionary processes. In order to do this it is important to define the space within which estuaries function to ensure their present and future health.

In this assessment, an estuary is defined as ‘‘a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action or salinity penetration. During floods an estuary can become a river mouth with no seawater entering the formerly estuarine area, or when there is little or no fluvial input an estuary can be isolated from the sea by a sandbar and become a lagoon or lake which may become fresh or hypersaline” (van Niekerk and Turpie, 2012).

In 2010 mapping was undertaken for nearly 300 functional estuarine systems along the South African coastline and refined in in 2015 based on vegetation (van Niekerk and Turpie 2012; Veldkornet, Adams and van Niekerk 2015). For each estuary, the Estuarine Functional Zone (estuarine ecosystem area) and open water areas were digitised using SPOT 5 imagery (2008) and Google Earth. For the most part the images were relatively cloud free, but where cloudy conditions occurred on SPOT 5 images, Google images were used. The lateral boundaries include all the associated wetlands, intertidal mud and sand flats, beaches and foreshore environments that are affected by riverine or tidal flood events. The 5 m topographical contour (obtained from Chief Directorate Surveys and Mapping) was used as the boundary to delineate the estuarine functional zone. Where the 5 m contour was not available in digital format, orthophotos (1:10 000) were scanned, georeferenced and the 5 m contour was digitised. Where no orthophotos were available (e.g. Groen and Spoeg Estuaries), floodplains were mapped from SPOT 5 imagery using changes in topography and vegetation types as indicators. From the estuarine functional zone delineation, spatial data such as area, length and perimeter (estuary coastline) and distance to the next system can be inferred.

The estuary mouth was taken as the downstream boundary of an estuary or, where the mouth was closed, the middle of the sand berm between the open water and the sea. The upstream boundary was determined as the limits of tidal variation or salinity penetration, whichever penetrates furthest. This is in line with recent scientific studies and the administrative definition of a South African estuary (Van Niekerk and Turpie 2012, DWAF 2008b).

Wherever possible the upstream boundary was derived from the literature, expert judgment or field observations. In a number of systems no data were available and the upper boundary was taken as the 5 m topographical contour (bearing in mind that the tidal range in South Africa is microtidal (< 2 m) and sand bars at closed estuary mouths can sometimes build up as high as + 4.5 m MSL). The upper boundaries were also screened against other existing spatial delineations, e.g. the KwaZulu-Natal Estuaries database (Version 1.00.02), with preference given to data from the larger scale studies. Spatially files were converted to GoogleEarth (KMZ formats) and mailed for review to members of the Consortium for Estuarine Research and Management (CERM) for comment.

18.2 MZIMVUBU ESTUARY DELINEATION

The Mzimvubu Estuary (31°37'52" S, 29°32'59" E) is the only estuary within the study area. It falls within the subtropical biogeographical coastal region of South Africa and enters the Indian Ocean at Port St. Johns (Van Niekerk & Turpie, 2012).

The Estuarine Functional Zone (EFZ) of the Mzimvubu Estuary is indicated below in **Figure 18.1**.

Downstream boundary:	31°37'52" S, 29°32'59" E (Estuary mouth)
Upstream boundary:	31°29'7.15"S, 29°22'59.66"E
Lateral boundaries:	5 m contour above Mean Sea Level (MSL) along each bank

Figure 18.1 Geographical boundaries of the Mzimvubu estuary based on the EFZ (highlighted in green)

VOLUME D: DELINEATION OF IUAs AND STATUS QUO

19 IDENTIFICATION OF PRELIMINARY IUAs

19.1 PROCESS TO DETERMINE IUAs

An Integrated Units of Analysis (IUA) is a broad scale unit (or catchment area) that contains several biophysical nodes. These nodes define at a detail scale specific attributes that together describe the catchment configuration of the IUA. Scenarios are assessed within the IUA and relevant implications in terms of the Management Classes (MCs) are provided for each IUA. The objective of defining IUAs is therefore to establish broader-scale units for assessing the socio-economic implications of different catchment configuration scenarios and to report on ecological conditions at a Sub-Quaternary (SQ) scale under these scenarios.

Zones have been established for water resource use, economics, ecosystem services and ecology. All of these zones are based on the concept of identifying areas that are similar in terms of these specific components, have similar land use (and resulting impacts), and can be managed as a logical entity. Overlaying these zones leads to the identification of IUAs that have similar components and can be managed as an entity, and are thus a logical unit for which scenarios can be designed and evaluated.

The process of IUA delineation is summarised in a flow diagram, **Figure 19.1**. Once the IUAs are delineated, biophysical nodes must be identified for different levels of EWR assessment.

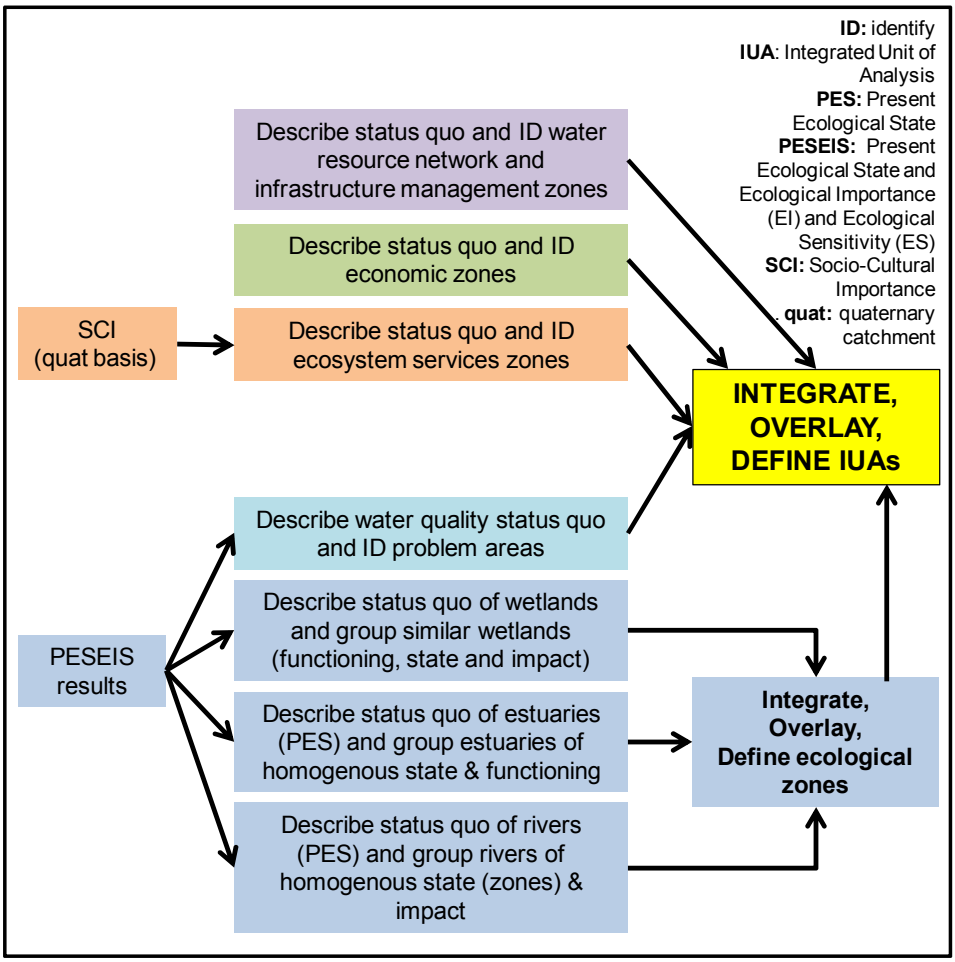


Figure 19.1 Summary of process to identify IUAs

19.2 IUA DESCRIPTIONS

A map of the IUAs is provided in **Figure 19.2**. A table in **Appendix A** provides the RUs and MRUs which are included in each IUA.

19.2.1 IUA T31

This IUA consists of the T31 tertiary catchment that includes quaternary catchments T31A to T31G and all the sub quaternaries within those. No further delineation was required as the area is largely similar in land use. There are no distinct changes in the ecological state, neither in the socio-economic state. There are also no future water resource management plans that would require further delineation.

19.2.2 IUA T32_a

The IUA was delineated as the upper area which includes T32A, T32B, T32C, T32D-05352 and T32D-05172 (i.e. only part of T32D). The break is due to Kokstad impacts and resulting water quality impacts as well as the change in operation of water resources from urban to irrigation.

19.2.3 IUA T32_b

This IUA consists of the rest of T32, i.e. excluding T32_a. This IUA is similar in all aspects and did not require further delineation. The IUA therefore consisted of the lower section of T32 which includes T32D-05373 (i.e. only part of T32D) and T32E to T32H.

19.2.4 IUA T33_a

This IUA corresponds with wetland groups which relate to areas of oxbows resulting in specific land use practises and localised water use. The IUA was delineated as the upper area which includes T33A and T33B.

19.2.5 IUA T33_b

This IUA consists of the rest of T33, i.e. excluding T33_a. This IUA is similar in all aspects and did not require further delineation. The IUA therefore consisted of the lower section of T33C to T32J.

19.2.6 T34 IUA_a

This IUA is delineated due to the similar ecological state [mostly good condition (B EC)]. The IUA break is due to the town of Mount Fletcher and as the land use and state is significantly different further downstream. The IUA was delineated as the upper area which includes T34A, T34B and T34C. The break (as the quaternary catchment borders are problematic) lies at the upstream point of T34D-05412 (i.e. the IUA excludes this SQ).

19.2.7 IUA T34_b

This IUA consists of the rest of T34, i.e. excluding T34_a. This IUA is similar in all aspects and did not require further delineation. Abstractions and return flows from Mount Fletcher indicate a change from the upstream IUA. The IUA therefore consists of the lower section of T34, i.e T34D – T34K.

19.2.8 IUA T35_a

Large sections of the upper T35 consist of forestry. However, due to the proposed Ntabelanga Dam, this IUA has been selected separate to the other areas with forestry. In future the operation

of the system will be significantly different downstream of the proposed dam. The IUA consists of T35A, T35B, T35C, T35D, T35E-05780 and T35E-05908, i.e. the IUA consists of sections of T35E and not the complete quaternary catchment as the dam is positioned within T35E.

19.2.9 IUA T35_b

The IUA consists of the Wildebees and Gatberg systems (T35F and T35G) which are dominated by forestry and large wetlands.

19.2.10 IUA T35_c

Includes quats T35H, T35J, and tributaries in T35K, T35L and T35M (T35K-06167, T35K-05897, T35K-05904, T35L-06226, T35M-06275). These tributaries are distinct from the main river (IUA T35_d) as they will not be influenced by the proposed development and they are of similar ecological state and land use.

19.2.11 IUA T35_d

This IUA consists of the main Tsitsa River downstream of the Ntabelanga Dam, i.e. downstream of IUA T35_a, to the end of T35. As can be seen from the above rationale, the main river forms a separate IUA as it is distinct from the upstream section in terms of the different operation resulting from the operation of Ntabelanga Dam.

19.2.12 IUA T36_a

This IUA includes the Mzimvubu catchment downstream of all the tributaries to the estuary. It excludes the estuary which, due to its significant size, forms an IUA on its own. This IUA is similar in all respects.

19.2.13 IUA T36_b

This IUA consists of the Mzimvubu estuary, i.e. the mouth to coordinates E 31.484898 S 29.382722 (upstream section of the estuary functional zone) within T36B-06391.

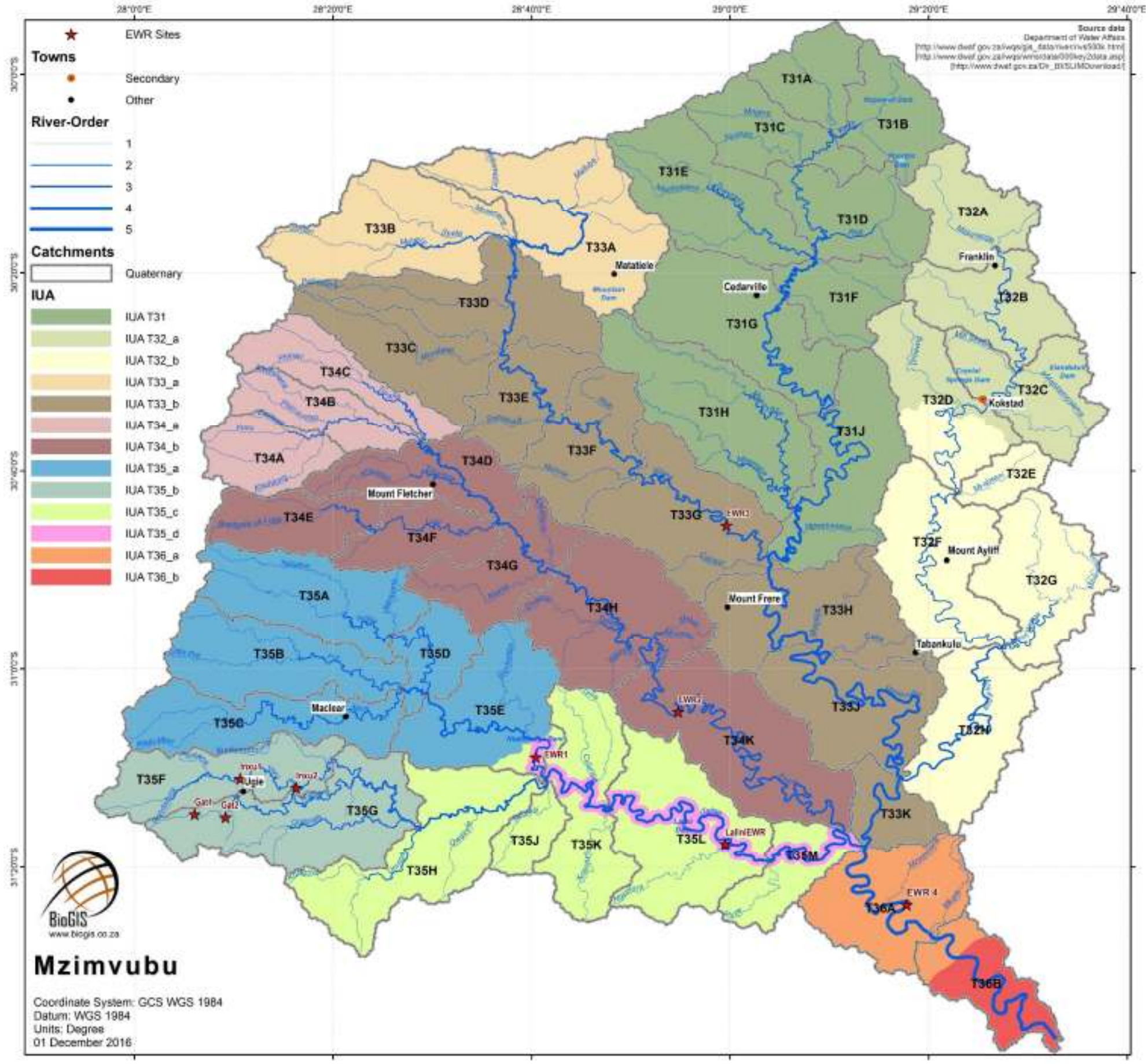


Figure 19.2 IUA delineation

20 STATUS QUO OF IUAs

The selected IUAs are illustrated in **Figure 19.2.** The status quo for all the different components is described for each IUA below.

20.1 IUA T31

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. There are no surface water developments planned in the IUA. The land use activities include intensive commercial irrigation farming, dryland cultivation as well as subsistence farming. There are a large number of minor instream and off-channel farm dams located in some parts of the IUA. The IUA is predominantly rural with commercial farming activities (including irrigation) and scattered rural and informal settlements in the lower portion of the IUA.

GRAII lists the groundwater Harvest Potential as over 58 Mm^3/a, and the Exploitation Potential as over 79 Mm^3/a. Recharge is over 188 Mm^3/a, of which 26.7 Mm^3/a is discharged as baseflow under natural conditions (11-16%). Only small scale abstraction of less than 2 Mm^3/a occurs, mostly in T31F.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T31A	3 460 400	0.390300	0.850000	1 573 300	0	13 908 400	5 761 370
T31B	5 026 800	0.425000	0.850000	2 027 450	0	15 061 700	6 825 780
T31C	4 803 700	0.406100	0.850000	2 093 520	4 069	15 688 700	6 559 440
T31D	6 170 400	0.424100	0.850000	2 624 220	17 930	16 579 500	7 551 130
T31E	8 389 300	0.406400	0.850000	3 762 700	0	24 958 700	10 638 000
T31F	10 447 400	0.419400	1.000000	4 604 400	1 838 400	27 978 300	12 719 500
T31G	3 291 900	0.399400	0.950000	1 560 940	0	11 025 400	4 750 490
T31H	9 878 200	0.388100	0.850000	4 531 020	0	34 132 200	13 978 800
T31J	6 922 400	0.359800	0.850000	3 971 670	0	28 873 900	10 889 700
TOTAL	58 390 500			26 749 220	1 860 399	188 206 800	79 674 210

Water quality:

Water quality issues in this tertiary catchment are related to the commercially farmed areas around Cedarville (and down to Matatiele in T33). No water quality hotspots are located in this IUA, although agricultural return flows are expected.

Economy:

The total irrigated area in the IUA is estimated at 6 227 hectares with cultivated products: maize, grazing and winter vegetables, mainly cabbages. Milk and mutton production is the main consumer of the maize and grazing produce. In the last number of years all the cheese factories in the IUA have closed down. The milk is transported out of the area to Ixopo where it is re-directed to either Durban or Estcourt.

The table below presents the results of the water-dependent activities in the IAU with milk and mutton produce included as part of the irrigation products.

The following table presents the results of the irrigation, commercial forestry and sawmill activities in the IUA.

Table 20.1 Economic activities in IUA T31 expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	**Indirect and Induced**	**Total**	**Direct**	**Indirect and Induced**	**Total**	**Total**	**Medium**	**Low**
Irrigation agriculture	R 157.3	R 329.0	R 486.3	2 664	3 649	6 313	R 473.0	R 346.1	R 127.0
Commercial forestry	R 4.2	R 3.5	R 7.7	26	31	57	R 4.4	R 2.6	R 1.8
Industry	R 4.9	R 5.4	R 10.3	43	43	86	R 6.7	R 3.9	R 2.9
Total	**R 166.4**	**R 337.8**	**R 504.3**	**2 733**	**3 723**	**6 456**	**R 484.1**	**R 352.5**	**R 131.6**

The table shows that the direct GDP of the irrigation activities are estimated at R157.3 million, 95% of the total. The total direct employment is 2 734 with 2 664 jobs in irrigation, with a total dependency on water of around 6 456 employment opportunities.

The total salaries paid comes to around R131.6 million to low-income households, out of a total of R484.1 million per annum, 27%. The total payments include a management fee.

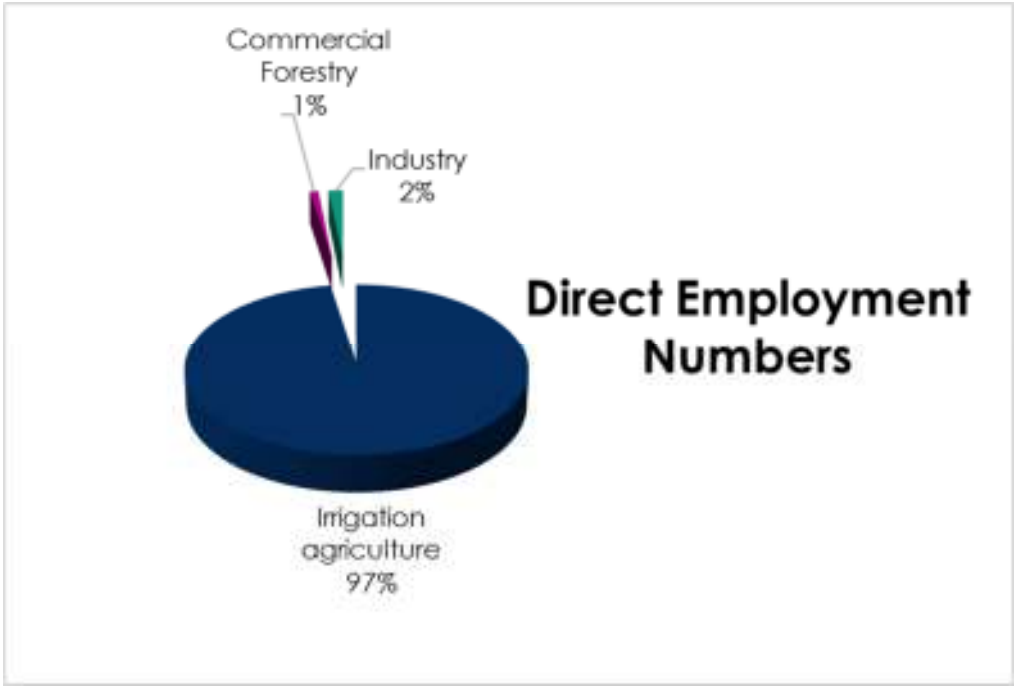


Figure 20.1 Contribution of the different water-dependent activities to employment in IUA T31

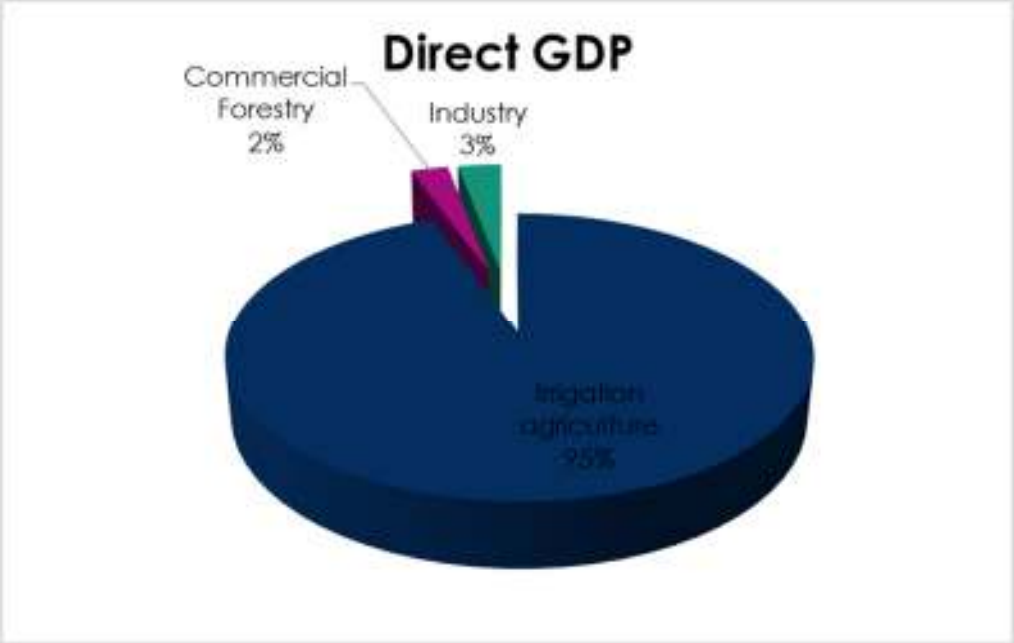


Figure 20.2 Contribution of the different water-dependent activities to GDP in IUA T31

The graphs reflect the very large contribution of irrigation activities to the employment and GDP in the IUA T31.

Ecosystem services:

This IUA consists of a mix of farmland with commercial and subsistence aspects. The town of Cedarville is included in the IUA. Several SQs scored “High” in terms of SCI features in the IUA. Key ecosystem services important in the IUA include the following:

- Recreational fishing.
- Subsistence fishing and other recreational aspects associated with the rivers.
- Thatch grass harvesting.
- Reed harvesting.
- Waste water dilution.
- The aesthetic value of the river and associated aquatic systems in their intersection with the recreation value of the upper catchment areas.

Ecology (rivers):

The upper reaches are mostly inaccessible due to the steep slopes of the mountainous area, resulting in limited use and hence fewer impacts on these river reaches. Primary land use and impacts are associated with limited farming (agriculture), grazing, erosion and alien vegetation encroachment. The predominant ecological state is slightly to moderately modified from natural conditions (B/C). The middle and lower reaches include formal farming activities (agriculture including dryland and irrigated fields as well as livestock farming practices) with a mostly C Ecological Category. The upper mountainous reaches of quaternary catchments T31H and T31J occurring to the south-east of the town of Matatiele have steep slopes and mountainous characteristics and hence few impacts on the uppermost river reaches in this zone. Lower reaches of this zone fall within more occupied rural areas where increased dryland agriculture and grazing result in notable erosion. The predominant ecological state of the upper reaches is slightly modified from natural conditions (B) while the lower reaches are moderately to largely modified (C/D).

Ecology (wetland):

This IUA contains both wetland groups 1 and 2 and has 38.3% of the wetlands that occur in T3. Group 1 (T31A, B, C) is dominated by channelled valley-bottom and seep wetlands. The area is generally largely impacted by farming activities, notably agriculture and the construction of farm dams, often with associated clumps of alien plant species such as wattle or gum. It is evident from aerial satellite data that wetland integrity in the area is generally moderate to low, but wetland proximity is mostly high. Group 2 (T31D, E, F) comprises an extensive complex of floodplain, depressional and channelled valley-bottom wetlands, together with flats and valleyhead seeps in the regions surrounding Cedarville, commonly known as the Cedarville Flats. In places there is extensive meandering with variously sized oxbow lakes common on floodplains. Predominant impacts in the area include agricultural activities, farm dams and scattered centre pivots. Grazing on wetlands is also a common use. In most places, alien willows line the active channel, with scattered clumps of poplars or gum in places, but most wetlands seem to be mostly alien free and dominated by the grassland that they should be. The wetlands in T31F (near Cedarville) amount to 11532 Ha which is 14.4% of the total wetland area in T3.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T31A	193	0.2
T31B	2541	3.2
T31C	221	0.3
T31D	4263	5.3
T31E	4081	5.1
T31F	11532	14.4
T31G	2135	2.7
T31H	78	0.1
T31J	849	1.1

20.2 IUA T32_A

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. There are no major surface water developments planned in the IUA. Some development includes the projected increase in water supply and return flows associated with Kokstad's future growth. The land use activities include intensive commercial farming (irrigation and dryland cultivation). A large number of minor instream and off-channel farms dams are located in the IUA. The IUA is predominantly rural with commercial farming activities (including irrigation) and both Franklin Town and the larger Kokstad town are also located in the IUA.

GRAII lists the groundwater Harvest Potential as over 14 Mm^3/a, and the Exploitation Potential as over 25 Mm^3/a. Recharge is over 62 Mm^3/a, of which 8.3 Mm^3/a is discharged as baseflow under natural conditions (13-14%). Only small scale abstraction of 0.22 Mm^3/a occurs, mostly in T32C.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T32A	5 207 300	0.393800	1.000000	2 801 560	0	20 359 100	8 580 590
T32B	4 107 200	0.375000	1.000000	2 468 200	0	18 896 500	7 487 490
T32C	5 113 600	0.375000	0.875000	2 984 140	205 946	22 830 700	9 155 170
TOTAL	14 428 100			8 253 900	205 946	62 086 300	25 223 250

Water quality:

This IUA has irrigation (centre pivots along the Droewig and Mzintlava rivers) and dryland farming along the Mzintlava River, with an industrial hub at Kokstad. Although the IUA ends at Kokstad, industrial impacts will extend to this IUA. Irrigation return flows and elevated turbidities can be expected. Two water quality hotspots were identified.

Economy:

The total irrigated area in the IUA is estimated at 4267 hectares with cultivated products: maize, grazing and winter vegetables, mainly cabbages. Milk and mutton production are the main consumers of the maize and grazing production. In recent years all the cheese factories in the IUA have closed down. The milk is transported to destinations to Ixopo where it is re-directed to either Durban or Estcourt. Milk tankers collect milk from the entire area and first take it to the old Rocky Ridge cheese factory outside Kokstad where the milk is tested for quality and cooled to the correct temperature before being transported.

In the Kokstad town two registered abattoirs operate:

- Meadow Meats Kokstad Abattoir with a registered capacity 95 head of cattle per day
- Greenlands Abattoir cc with a registered capacity of 25 head of cattle per day

The operational percentage is estimated at 75%, 90 animals per working day.

Included in the table below are the results of the water-dependent activities in the IUA, with milk and mutton included as part of the irrigation products.

The following table presents the results of the irrigation, commercial forestry (including sawmill) and abattoir activities in the IUA.

Table 20.2 Economic activities in IUA T32_a expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	Indirect and Induced	Total	Direct	Indirect and Induced	Total	Total	Medium	Low
Irrigation agriculture	R 112.2	R 236.6	R 348.8	1 827	2 663	4 490	R 343.1	R 250.8	R 92.3
Commercial Forestry	R 2.5	R 2.1	R 4.6	16	19	35	R 2.6	R 1.6	R 1.1
Industry	R 83.8	R 96.6	R 180.4	78	817	895	R 119.8	R 71.1	R 48.7
Total	**R 198.5**	**R 335.2**	**R 533.8**	**1 921**	**3 499**	**5 420**	**R 465.5**	**R 323.5**	**R 142.0**

The table shows that the direct GDP of the irrigation activities is estimated at R112.2 million, 58% of the total. The total direct employment is 1 921 jobs with 1 827 in irrigation, with a total dependency on water of around 5 420 employment opportunities.

The total salaries paid is around R142 million to low-income households out of a total of R465.5 million per annum, 30.5%. The total payments include a management fee.

The following graphs show the macro-economic impact of the different activities.

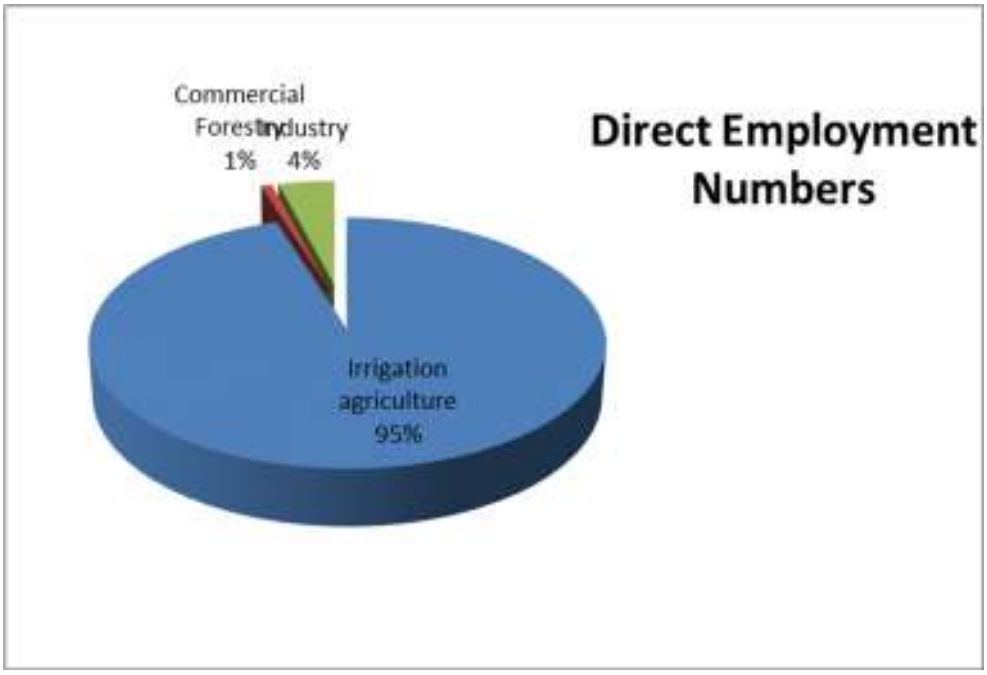


Figure 20.3 Contribution of the different water-dependent activities to employment in IUA T32_a

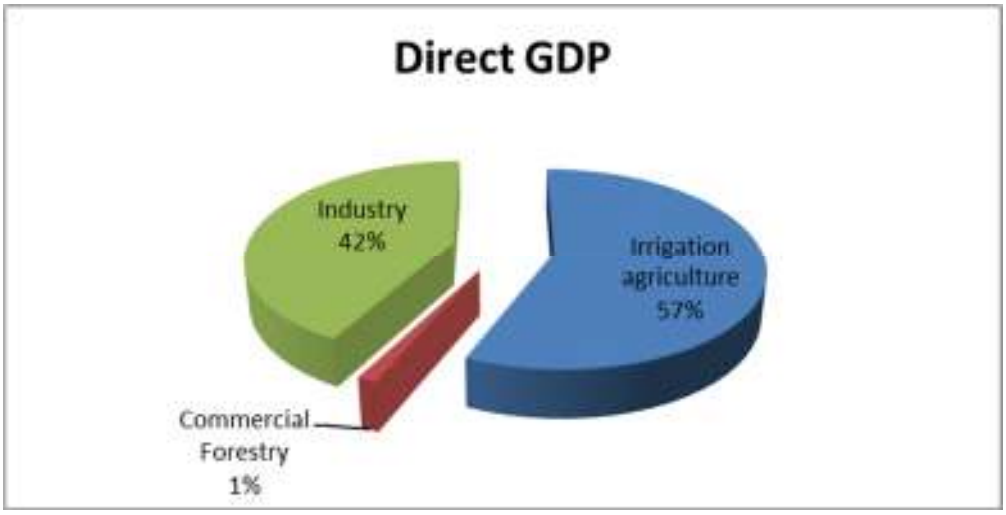


Figure 20.4 Contribution of the different water-dependent activities to GDP in IUA T32_a

The graphs show that although irrigation contributes 95% of the employment, it only contributes 57% of the GDP.

Ecosystem services:

This IUA consists of commercial farming and includes parts of Kokstad. Key ecosystem services important in the IUA are recreational fishing, plus other recreational aspects associated with the aesthetic value of the rivers and their associated aquatic systems in their intersection with the recreational value of the upper catchment areas.

Ecology (rivers):

The IUA consists primarily of the area upstream of Kokstad and Kokstad itself. Although some sections are relatively mountainous with steep slopes, this area is largely utilised for farming. Dryland and irrigated (centre pivots) agriculture and livestock farming make out the predominant

land use within this zone while the lower reaches also reflects the impact from the large formal settlements of Kokstad (including water quality deterioration). The predominant ecological state of this zone is moderately modified from natural conditions (C) although the lower reaches around Kokstad are largely modified (category D).

Ecology (wetland):

This IUA contains part of the wetland group 3 (T32A, B, C), which together have 10.4% of the wetlands present in the T3 catchment. The area in the vicinity of Franklin and Kokstad has extensive floodplain wetlands (upstream of Franklin in T32A) and extensive channelled valley-bottom and seep wetlands in quaternary catchments T32B and C. The area is mostly dominated by agricultural activities with a high degree of disturbance of wetland areas, with scattered farm dams and some centre pivots. Clumps of alien tree species occur, with some of them lining the active channel in places.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T32A	4081	5.1
T32B	3197	4.0
T32C	1091	1.4

20.3 IUA T32_B

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. There are no surface water developments planned in the IUA. The land use activities include intensive commercial farming (irrigation and dryland cultivation) with a large number of minor instream and off-channel farms dams. The upper portion (T32D) of the IUA is characterised by intense commercial farming activities (including irrigation). The lower portion of the IUA is predominantly rural with a large number of scattered rural and informal settlements and high levels of erosion and sedimentation are prominent as a result of poor land use practices.

GRAII lists the groundwater Harvest Potential as over 26 Mm^3/a, and the Exploitation Potential as over 61 Mm^3/a. Recharge is over 153 Mm^3/a, of which 10.6 Mm^3/a is discharged as baseflow under natural conditions (4-15%). Only small scale abstraction of 0.6 Mm^3/a occurs, mostly in T32D.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T32D	4 732 800	0.375000	0.875000	2 810 240	621 265	19 078 100	7 687 410
T32E	5 208 800	0.375000	0.850000	3 105 000	0	27 133 500	11 005 400
T32F	4 025 600	0.356800	0.850000	1 144 640	0	25 062 400	9 802 910
T32G	5 956 800	0.375000	0.920000	1 759 970	0	41 919 900	17 039 500
T32H	6 174 400	0.368100	0.850000	1 778 650	0	40 410 500	16 103 400
TOTAL	26 098 400			10 598 500	621 265	153 604 400	61 638 620

Water quality:

The industrial hub at Kokstad will result in impacts experienced downstream. Limited commercial forestry is also found between Mount Ayliff and Tabankulu on the eastern boundary of the catchment, with subsistence farming with dryland crops and cattle grazing in the rest of T32. Some

centre pivots and irrigation is seen down to Mount Ayliff. Irrigation return flows, elevated turbidities and industrial impacts are expected. One water quality hotspot was identified.

Economy:

This IUA starts below Kokstad and although a number of small towns are present in the IUA no industrial activities are taking place.

The total irrigated area in the IUA is estimated at 1 068 hectares with cultivated products: maize, grazing and winter vegetables, mainly cabbages. Milk and mutton are the main consumers of the maize and grazing production. In recent years all the cheese factories in the IUA have closed down and the milk is transported to destinations outside of the area.

The following table presents the results of the irrigation, commercial forestry and sawmill, and abattoir activities in the IUA.

Table 20.3 Economic activities in IUA T32_b expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	Indirect and Induced	Total	Direct	Indirect and Induced	Total	Total	Medium	Low
Irrigation agriculture	R 28.1	R 59.2	R 87.3	457	667	1 124	R 85.9	R 62.8	R 23.1
Commercial forestry	R 8.7	R 7.2	R 16.0	55	65	120	R 9.1	R 5.5	R 3.6
Industry	R 10.2	R 11.2	R 21.4	90	89	180	R 14.0	R 8.0	R 6.0
Total	**R 47.0**	**R 77.7**	**R 124.7**	**602**	**821**	**1 424**	**R 109.0**	**R 76.3**	**R 32.7**

The table shows that the direct GDP of the irrigation activities are estimated at R28.1 million, 59% of the total. The total direct employment is 602 jobs with 457 in irrigation, with a total dependency on water of around 1 424 employment opportunities.

The total salaries paid is around R32.7 million to low-income households out of a total of R109 million per annum, 30.0%. The total payments include a management fee.

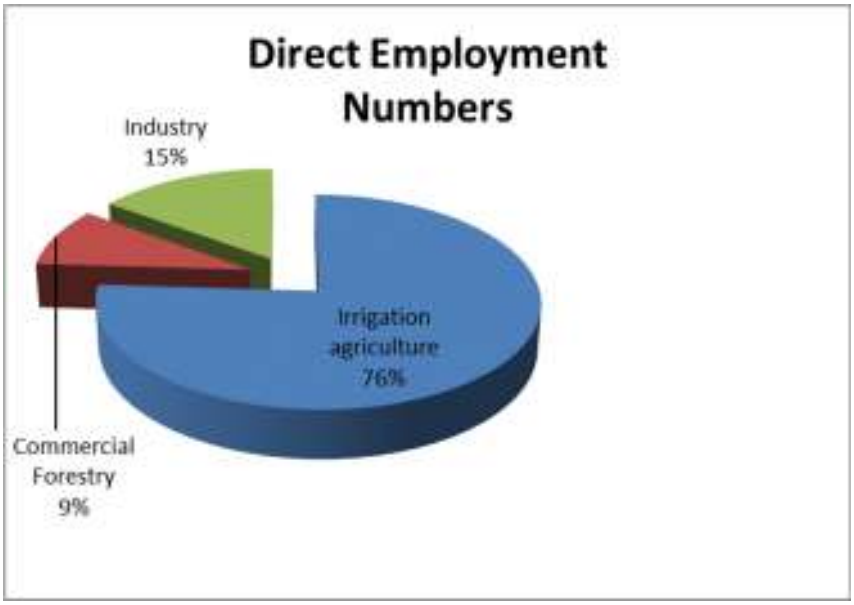


Figure 20.5 Contribution of the different water-dependent activities to employment in IUA T32_b

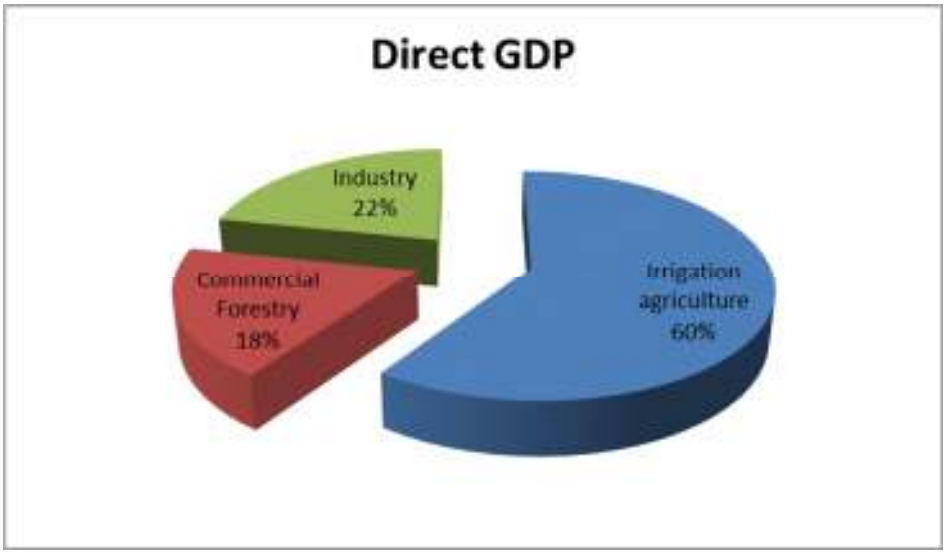


Figure 20.6 Contribution of the different water-dependent activities to GDP in IUA T32_b

The graphs show that although irrigation contributes 76% of the employment, it only contributes 60% of the GDP.

Ecosystem services:

Other than a small part of the IUA given over to commercial farming (T32D-05373) the remnant is subsistence agriculture and provisioning services are potentially of critical importance to many of the residents. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture and limited sand mining is also evident. Ritual use is also regarded as an important aspect of ecosystem services in some parts of the IUA.

Ecology (rivers):

The predominant land use is rural villages with dryland farming practices (mostly subsistence) and livestock farming. Extensive erosion is evident in this zone due to the above-mentioned activities, resulting in moderately to largely modified conditions (predominantly category C and D).

Ecology (wetland):

This IUA does not have extensive wetlands with only 1.5% of the wetlands within T3, except for T32D which is part of wetland group 3 and supports 563 ha of mostly channelled valley-bottom wetlands. The area is mostly dominated by agricultural activities with a high degree of disturbance of wetland areas, with scattered farm dams and some centre pivots. Clumps of alien tree species occur, with some of them lining the active channel in places.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T32D	563	0.7
T32E	40	0.0
T32F	3	0.0
T32G	202	0.3
T32H	356	0.4

20.4 IUA T33_A

Water resources:

The storage regulation in this IUA is low with no major dams located in the area while smaller dams include the Mountain Dam and Belfort Dam which supply water to Matatiele and the Maluti Scheme respectively. There are no surface water developments planned in the IUA. Some development incudes the projected increase in water supply and return flows associated with Matatiele and the surrounding area's future growth. The lower portion of the IUA is predominantly rural with a large number of scattered rural and informal settlements. High levels of erosion and sedimentation are prominent due to poor land use practices.

GRAII lists the groundwater Harvest Potential as over 21 Mm^3/a, and the Exploitation Potential as over 21.6 Mm^3/a. Recharge is over 62 Mm^3/a, of which 9.3 Mm^3/a is discharged as baseflow under natural conditions (15%). Only small scale abstraction occurs.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T33A	9 380 400	0.374600	0.850000	4 932 920	0	33 188 800	12 509 900
T33B	11 692 000	0.363200	0.850000	4 334 910	0	29 282 100	9 103 570
TOTAL	21 072 400			9 267 830	0	62 470 900	21 613 470

Water quality:

The area is mountainous with limited dryland farming; cattle farming is located around Matatiele. Elevated turbidities and nutrients are expected. One water quality hotspot was identified.

Economy:

Although the T33 sub-catchment is divided into two IUAs it was decided to estimate the water dependant economic activities as a single entity. The town of Matatiele is the only sizeable

commercial centre in the sub-catchment and is an important link to the south-eastern part of Lesotho.

In the two IUAs no irrigation is taking place and only a number of small sawmill activities are active. In Matatiele a registered abattoir with a capacity of 20 head of cattle per day is operational.

The following table presents the results of the irrigation, commercial forestry (including sawmill) and abattoir activities in the IUA.

Table 20.4 Economic activities in IUA T33_a and T33_b expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	Indirect and Induced	Total	Direct	Indirect and Induced	Total	Total	Medium	Low
Irrigation agriculture	R 0.0	R 0.0	R 0.0	–	–	–	R 0.0	R 0.0	R 0.0
Commercial forestry	R 5.0	R 5.0	R 10.0	47	49	96	R 6.4	R 3.9	R 2.5
Industry	R 19.5	R 22.2	R 41.7	53	186	239	R 27.6	R 16.3	R 11.4
Total	**R 24.5**	**R 27.2**	**R 51.8**	**101**	**234**	**335**	**R 34.0**	**R 20.1**	**R 13.8**

The total direct employment of 101 jobs provided by the commercial forestry, sawmills and abattoir is the only direct water-dependent employment. If the indirect and induced jobs are added the total employment comes to 335.

The salaries paid to low-income households are estimated at R13.8 million, 40.6% of the total of R34 million. The total payments include a management fee.

Ecosystem services:

This IUA is entirely subsistence agriculture and provisioning services are potentially of critical importance to many of the residents. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture associated with the oxbows and limited sand mining is also evident. Aesthetic aspects of the IUA are also important particularly in the higher reaches. Ritual use is also deemed to be important in some areas.

Ecology (rivers):

The IUA consists of the upper reaches of the Kinira River which is mostly in a C to B EC. The area is mountainous with dryland cultivation in lower areas and extensive oxbows. The key impacts are associated with sedimentation and erosion.

Ecology (wetland):

This IUA contains wetland group 4, with extensive wetlands that comprise 27.3% of the wetlands within T3. This IUA contains an extensive complex of floodplain and channelled valley-bottom wetlands, flats and valleyhead seeps in the vicinity of Matatiele, with over 21900 ha of wetland. Predominant impacts to wetlands in this area are agricultural activities and physical disturbance,

including roads within the wetlands in places. Alien tree species are common along the main channel, mostly alien willows (*Salix fragilis*). An extensive review of wetlands in this region was conducted by Job and Walters (2013) and outlines detail baseline wetland information.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T33A	9182	11.5
T33B	12723	15.9

20.5 IUA T33_B

Water resources:

The storage regulation in this IUA is low with no major dams located in the area while smaller dams include the Ntenyana Dam and Forest Dam which supply water to the Kwa Bacha Scheme and Tabankulu respectively. There are no major surface water developments planned in the area. The IUA is predominantly rural with a large number of scattered rural and informal settlements and some cultivation and subsistence farming. Some of the larger towns/villages include Mount Frere and Tabankulu. High levels of erosion and sedimentation are prominent due to poor land use practices.

GRAII lists the groundwater Harvest Potential as over 47 Mm^3/a, and the Exploitation Potential as over 60 Mm^3/a. Recharge is over 153 Mm^3/a, of which 24.4 Mm^3/a is discharged as baseflow under natural conditions (10-19%). Only small scale abstraction occurs.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T33C	5 488 800	0.373000	0.850000	2 653 100	0	16 085 600	6 771 540
T33D	6 520 800	0.375000	0.850000	3 421 320	0	18 375 700	6 271 810
T33E	4 176 500	0.400100	0.850000	2 035 270	0	11 381 600	5 175 120
T33F	7 528 400	0.418200	0.850000	3 210 060	0	23 861 400	10 883 500
T33G	7 926 200	0.380800	0.850000	3 671 110	0	25 497 900	10 265 000
T33H	7 059 900	0.326900	1.000000	4 213 380	0	23 918 800	8 521 800
T33J	6 174 400	0.326400	0.850000	3 847 610	0	22 095 400	7 921 270
T33K	2 312 000	0.326500	0.850000	1 300 850	0	12 415 400	4 223 910
TOTAL	47 187 000			24 352 700	0	153 631 800	60 033 950

Water quality:

Dryland farming takes place and a number of small sawmill activities are active. No water quality hotspots were identified.

Economy:

The economic input for IUA T33_b is included as a single entity under IUA T33_a.

Ecosystem services:

This IUA is entirely subsistence agriculture and provisioning services are potentially of critical importance to many of the residents. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture and limited sand mining is also evident. Aesthetic aspects of the IUA are also important particularly in the gorge areas. Parts of the IUA are relatively inaccessible. Ritual use is also deemed to be important in some areas.

Ecology (rivers):

This IUA is in a C EC and consists of areas with mixed gorge areas and dryland cultivation.

Ecology (wetland):

This IUA does not contain one of the wetland groups but nevertheless supports some wetlands; 9.5% of wetlands within T3, with most of those in T33D (which are a continuation of wetlands in wetland group 4 and IUA T33_a near Matatiele). The wetlands in this large area are mostly channelled valley-bottom wetlands associated with the main stem of the Kinira and Mzimvubu rivers.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T33C	360	0.4
T33D	5719	7.1
T33E	33	0.0
T33F	122	0.2
T33G	245	0.3
T33H	345	0.4
T33J	802	1.0
T33K	0	0

20.6 IUA T34_A

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. The IUA is predominantly rural with the upper reaches being largely natural and the middle to lower reaches largely rural with a number of scattered rural and informal settlements and some cultivation and subsistence farming. Erosion and sedimentation are prominent due to poor land use practices.

GRAII lists the groundwater Harvest Potential as over 16 Mm^3/a, and the Exploitation Potential as over 22 Mm^3/a. Recharge is over 55 Mm^3/a, of which 5.8 Mm^3/a is discharged as baseflow under natural conditions (9-12%). Only small scale abstraction occurs.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T34A	6 467 200	0.375000	0.850000	1 766 500	0	19 491 500	8 457 320
T34B	4 084 800	0.373500	0.850000	1 835 200	0	18 118 800	7 317 620
T34C	5 684 000	0.370900	0.850000	2 205 490	0	18 090 100	7 002 030
TOTAL	16 236 000			5 807 190	0	55 700 400	22 776 970

Water quality:

The area is mountainous with very limited dryland irrigation. Some commercial forestry with associated sawmill activities is found in this area. Elevated turbidities are expected.

Economy:

The sub-catchment T34 is very rural with no identified irrigation activities, but 3 080 hectares of commercial forestry with associated sawmills as the only water-dependent activities.

The following table presents the results of forestry and sawmill activities.

Table 20.5 Economic activities in the IUA T34_a and T34_b expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	Indirect and Induced	Total	Direct	Indirect and Induced	Total	Total	Medium	Low
Irrigation agriculture	R 0.0	R 0.0	R 0.0	–	–	–	R 0.0	R 0.0	R 0.0
Commercial forestry	R 14.9	R 14.8	R 29.7	140	144	284	R 18.9	R 11.5	R 7.3
Industry	R 15.2	R 16.7	R 31.9	134	133	267	R 20.8	R 11.9	R 8.9
Total	**R 30.1**	**R 31.5**	**R 61.6**	**274**	**277**	**551**	**R 39.7**	**R 23.5**	**R 16.3**

The total direct employment of 274 jobs are provided by the commercial forestry and sawmills and are the only direct water-dependent employment opportunities. If the indirect and induced jobs are added, the total employment comes to 551 jobs.

The salaries paid to low-income households are estimated at R16.3 million, 41% of the total of R39.7 million. The total payments include a management fee.

Ecosystem services:

This IUA is entirely subsistence agriculture and provisioning services are potentially of critical importance to many of the residents. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture and limited sand mining is also evident. Aesthetic aspects of the IUA are also important particularly in the higher reaches. Ritual use is also deemed to be important in some areas.

Ecology (rivers):

This IUA is largely mountainous in its upper reaches with confined streams mostly in B and B/C categories. The upper portions of most mountainous streams are near natural. Generally, PES drivers are predominantly non-flow related and include dryland cultivation in flatter areas, wattle patches associated with steeper valleys and along confined streams, and scattered alien willows. This IUA includes Mount Fletcher along the Tokwana River, which is a predominant PES driver affecting water quality and has resulted in PES categories as low as a D. Other impacts include some weirs, dryland cultivation in some areas usually associated with moderate to severe erosion, and the presence of alien vegetation in the riparian zone. PES categories range from B/C to D in the lower reaches of the IUA.

Ecology (wetland):

This IUA does not contain one of the wetland groups and supports very little wetland area; 0.35% of wetlands within T3. The wetlands that do occur in this IUA are mostly channelled valley-bottom wetlands associated with the main stem of rivers, but some flats and seeps also occur in the upper portion of catchments.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T34A	113	0.1
T34B	148	0.2
T34C	17	0.0

20.7 IUA T34_B

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. There are no major surface water developments planned in the IUA. Some development includes projected increase in water use and return flows associated with Mount Fletcher's growth. The IUA is predominantly rural with a large number of scattered rural and informal settlements and some cultivation and subsistence farming. High levels of erosion and sedimentation are prominent due to poor land use practices.

GRAII lists the groundwater Harvest Potential as over 40 Mm^3/a, and the Exploitation Potential as over 72 Mm^3/a. Recharge is over 171 Mm^3/a, of which 18.6 Mm^3/a is discharged as baseflow under natural conditions (9-23%). Only small scale abstraction occurs.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T34D	4 902 200	0.381600	0.850000	2 571 730	0	26 166 000	11 399 900
T34E	6 681 600	0.375000	0.850000	1 975 560	0	21 887 200	9 411 860
T34F	3 348 600	0.377900	0.850000	1 749 060	0	19 125 300	8 252 530
T34G	5 729 800	0.404300	0.950000	2 708 940	0	29 808 100	13 039 900
T34H	10 425 300	0.425000	0.850000	4 487 290	0	48 610 800	21 257 400
T34J	4 432 800	0.357300	0.850000	2 406 600	0	10 651 700	4 293 000
T34K	4 542 400	0.325000	0.850000	2 700 190	0	14 987 200	5 271 310
TOTAL	40 062 700			18 599 370	0	171 236 300	72 925 900

Water quality:

The area is mountainous with very limited dryland irrigation. Some commercial forestry with associated sawmill activities is found in this area. One water quality hotspot was identified.

Economy:

The economic input for IUA T34_b is included as a single entity under IUA T34_a.

Ecosystem services:

This IUA is almost entirely subsistence agriculture and provisioning services are potentially of critical importance to many of the residents. A small portion of commercial agriculture is evident in T34E-05507. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture and limited sand mining is also evident. Aesthetic aspects of the IUA are also important particularly in the gorge areas. Parts of the IUA are relatively inaccessible. Ritual use is also deemed to be important in some areas.

Ecology (rivers):

This IUA comprises mainly the Luzi and Thina rivers and tributaries and includes mountain streams, kloofs and lower lying areas. Some gorge areas exist and are frequently in a better condition than more accessible areas. PES categories range from B to C but are mostly B/Cs. The area is predominantly impacted by dryland cultivation, livestock grazing and alien vegetation. Isolated patches of forestry occur along the Qhanqu River. Due to intense cultivation and grazing in places, erosion is moderate to severe and gully erosion is common. The area that includes the Ngcibira River and upstream tributaries is near the N2 freeway and is characterised by high human density near Mount Frere. PES categories are all Cs and predominant impacts are overgrazing and resultant erosion, which is severe in places. The downstream Thina River meanders through extensive gorge areas and is in a B state.

Ecology (wetland):

This IUA does not contain one of the wetland groups but nevertheless supports some wetlands; 2.8% of wetlands within T3, with most of those in T34G, K. The wetlands in this large area are mostly channelled valley-bottom wetlands associated with the main stem of the Thina River, but some seeps also exist in T34G.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T34D	8	0.0
T34E	38	0.0
T34F	1	0.0
T34G	774	1.0
T34H	315	0.4
T34J	427	0.5
T34K	696	0.9

20.8 IUA T35_A

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. Some smaller dams include Nquandu Dam and Maclear Dam which supply water to the Sidwadeni Scheme and Maclear (including former townships) respectively. There are a number of small farm dams located in the IUA, particularly in T35D. Lalini Dam is a major surface water development planned on the Tsitsa River (T35E) to supply water to regional settlements, proposed irrigation developments and for hydropower generation. Other development include increased abstractions and return flows associated with the Maclear town's growth. The IUA is largely rural with commercial farming operations, forestry plantations as well as many scattered rural and informal settlements and some cultivation and subsistence farming. High levels of erosion and sedimentation are prominent as a result of poor land use practices.

GRAII lists the groundwater Harvest Potential as over 33 Mm^3/a, and the Exploitation Potential as over 79 Mm^3/a. Recharge is over 185 Mm^3/a, of which 14.2 Mm^3/a is discharged as baseflow under natural conditions (7-10%). Only small scale abstraction occurs.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T35A	9 430 400	0.375000	0.850000	3 354 360	0	43 520 500	18 304 400
T35B	6 057 600	0.375000	0.850000	2 791 070	0	36 660 500	15 458 300
T35C	4 793 600	0.375000	0.850000	2 058 290	0	31 135 100	12 883 000
T35D	4 692 000	0.375000	0.850000	2 547 600	0	26 422 700	11 440 200
T35E	8 321 700	0.415600	0.850000	3 439 860	0	47 920 800	20 935 700
TOTAL	33 295 300			14 191 180	0	185 659 600	79 021 600

Water quality:

Forestry is found in the upper region. No water quality hotspots were identified.

Economy:

The IUA includes the commercial town of Maclear which acts as the trade supply distribution point to the rural tribal areas.

Only 253 hectares of irrigation has been identified, however, the Mondi and other commercial forests in total come to around 14 993 hectares. A very small abattoir operates with a capacity of two animals per day.

The macro-economic parameters representing the water-based activities in the region are presented in **Table 20.6**.

Table 20.6 Economic activities in the IUA T35_a expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	Indirect and Induced	Total	Direct	Indirect and Induced	Total	Total	Medium	Low
Irrigation agriculture	R 7.1	R 9.0	R 16.1	202	69	271	R 12.1	R 9.0	R 3.2
Commercial forestry	R 69.9	R 58.1	R 127.9	439	521	961	R 73.1	R 43.8	R 29.3
Industry	R 81.9	R 90.0	R 171.9	724	716	1 440	R 112.4	R 64.3	R 48.1
Total	**R 158.9**	**R 157.1**	**R 315.9**	**1 365**	**1 307**	**2 672**	**R 197.6**	**R 117.1**	**R 80.5**

The table indicates that the commercial plantations and associated activities provides the most water-dependent employment opportunities, namely 1 163 out of 1 365 direct jobs. Irrigation provides 2 012 direct opportunities.

Forestry and related activities provide a total direct GDP of R151.8 million with irrigation at R7.1 million providing a total of R158.9 million annually.

The total payments to low-income households are R80.5 million, 40.7% of the total of R197.6 million annually paid to households.

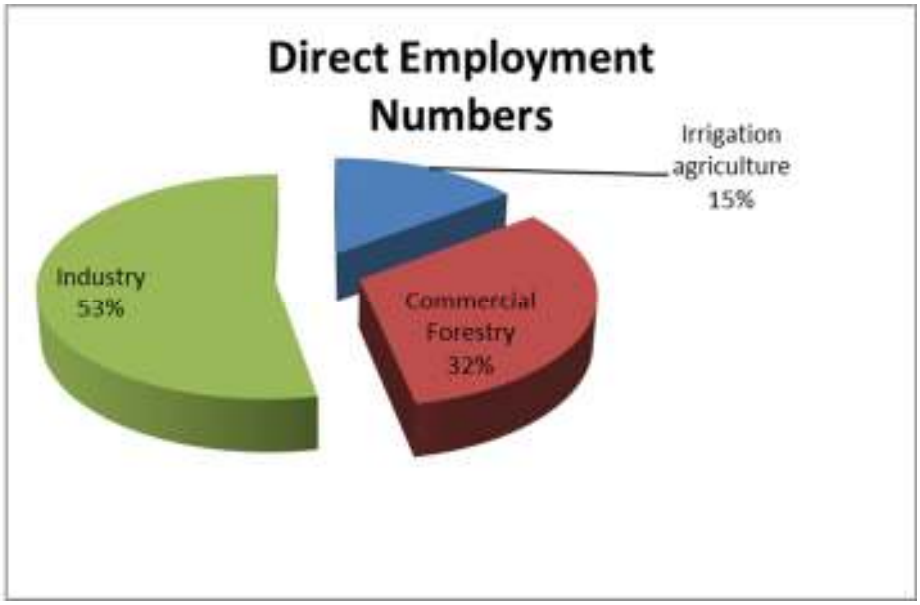


Figure 20.7 Contribution of the different water-dependent activities to employment in IUA T35_a

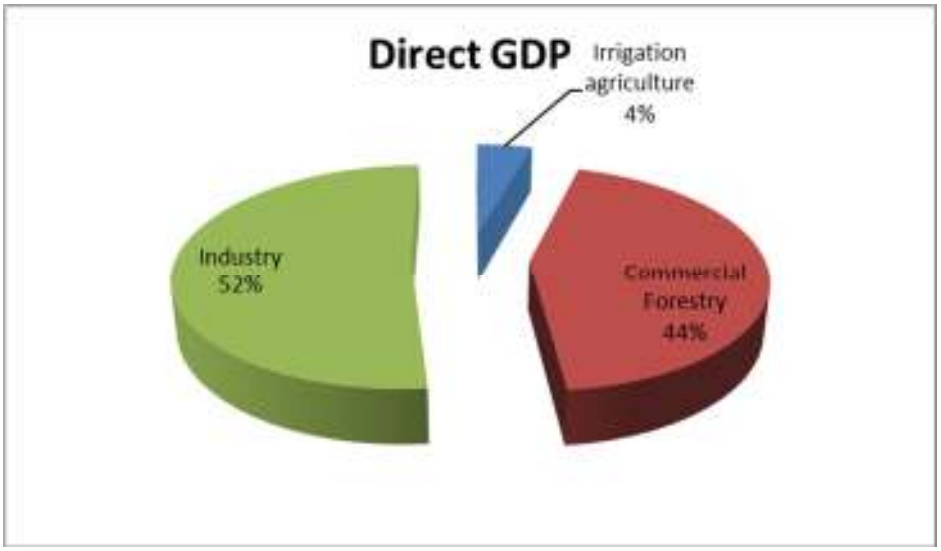


Figure 20.8 Contribution of the different water-dependent activities to GDP in IUA T35_a

The two graphs show the influence of the commercial forestry and related industrial activity (sawmills) on employment and GDP.

Ecosystem services:

This IUA includes a mix of land uses and settlement patterns. Forestry and commercial agriculture dominate much of the IUA but there are parts given over to subsistence agriculture and closer rural settlement. Key ecosystem services important in the IUA include the following:

- Recreational fishing.
- Subsistence fishing and other recreational aspects associated with the rivers.
- Thatch grass harvesting.
- Reed harvesting.
- Waste water dilution.

Ritual use is also deemed to be important in some areas.

Ecology (rivers):

This is a large zone which includes the Tsitsa, Mooi and Pot rivers and tributaries, and includes mountainous streams, gorge and kloof areas and some flatters areas. PES categories are mostly Bs and B/Cs, but the upper Mooi River is an A/B and the lower Mooi River, which includes Maclear, is a C ecological category. In higher mountainous areas, forestry is extensive, mainly Pinus species but also some Eucalyptus species. The predominant PES driver in these areas is alien vegetation, but some cultivation and grazing also occurs. Lower down along the Tsitsa River dryland cultivation and erosion are extensive and are predominant impacts.

Ecology (wetland):

This IUA contains portion of wetland group 5 (T35B, C, D) and supports 2.9% of wetlands within the T3 catchment. This IUA comprises an extensive and dispersed array of various wetland types (channelled valley bottoms, depressions, flats, floodplains and seeps) in the Maclear and Halcyon Drift region, and associated with the Tsitsa River and its tributaries. The predominant land use in the area is forestry, particularly in the Maclear region. Most grasslands have been manipulated in some way and are subject to annual fires. Alien tree species (such as *S. fragilis*) frequently line the active channel, but are limited in wetland areas.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T35A	143	0.2
T35B	828	1.0
T35C	225	0.3
T35D	523	0.7
T35E	571	0.7

20.9 IUA T35_B

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. A smaller dam includes Ugie Dam which supplies water to Ugie Town. There are a number of small farm dams located in the IUA, particularly in T35G. There are no major surface water developments planned in the area. Other development includes increased abstractions and return flows associated with the Ugie town growth. The IUA is largely rural with commercial farming operations, including irrigation and forestry plantations as well as some scattered rural villages in the lower part of the IUA.

GRAII lists the groundwater Harvest Potential as over 13 Mm^3/a, and the Exploitation Potential as over 28 Mm^3/a. Recharge is over 65 Mm^3/a, of which 7.1 Mm^3/a is discharged as baseflow under natural conditions (13-14%). Only small scale abstraction occurs.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T35F	5 544 800	0.375000	0.850000	2 627 480	0	29 659 700	12 523 300
T35G	8 033 900	0.376600	0.850000	4 449 880	175	36 201 600	16 369 800
TOTAL	13 578 700			7 077 360	175	65 861 300	28 893 100

Water quality:

Commercial forestry and associated activities dominate in this area. Irrigation is found along rivers, with expected irrigation return flows. One water quality hotspot was identified around Ugie.

Economy:

This IUA is, in terms of water-dependent activities, the largest of those identified in the catchment. The identified irrigation hectares is around 1 428, the commercial plantations occupy around 24 680 hectares and included in the area is the very large Bison board unit outside the town of Ugie.

The macro-economic parameters representing the water-based activities in the region are presented in **Table 20.7**.

Table 20.7 Economic activities in IUA T35_b expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	**Indirect and Induced**	**Total**	**Direct**	**Indirect and Induced**	**Total**	**Total**	**Medium**	**Low**
Irrigation agriculture	R 22.3	R 33.2	R 55.4	499	286	785	R 45.0	R 33.2	R 11.8
Commercial forestry	R 115.0	R 95.6	R 210.6	723	858	1 581	R 120.3	R 72.2	R 48.2
Industry	R 760.1	R 838.2	R 1 598.4	2 392	6 624	9 016	R 1 046.3	R 602.2	R 444.1
Total	**R 897.5**	**R 966.9**	**R 1 864.4**	**3 615**	**7 768**	**11 383**	**R 1 211.6**	**R 707.5**	**R 504.0**

The sawmilling and Bison board activities contribute 2 392 of the 3 615 jobs created. Irrigation adds a further 499 jobs and plantations 723 jobs.

The total direct GDP is R897.5 million of which R760.1 million comes from the industry activities. The payments to low-income households are R504 million, 41.6% of the total of R1 211.6 annually.

The following graphs show the macro-economic impact of the different activities and the impact of the Bison board factory.

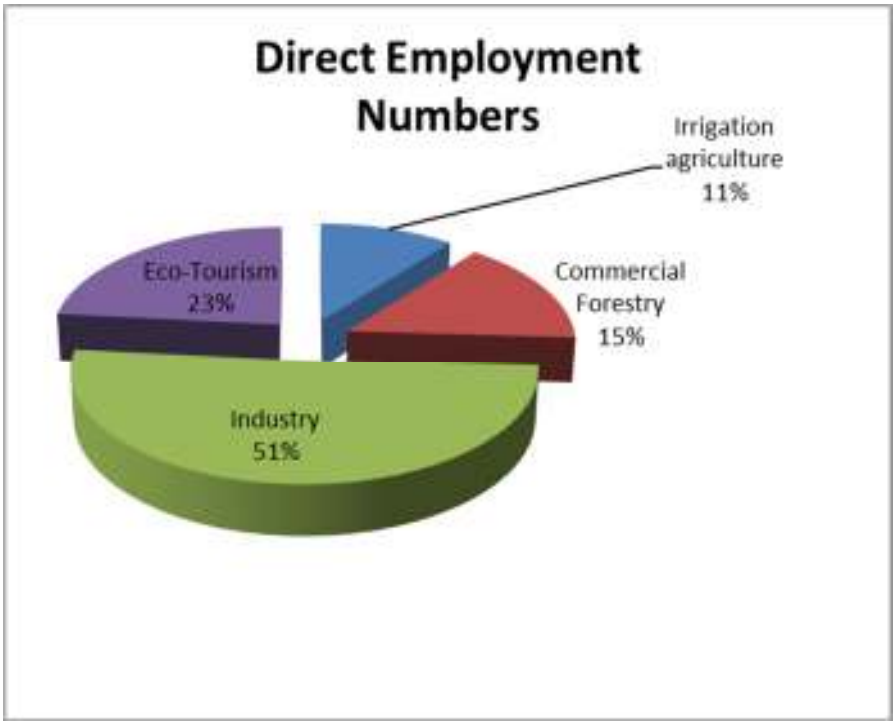


Figure 20.9 Contribution of the different water-dependent activities to employment in IUA T35_b

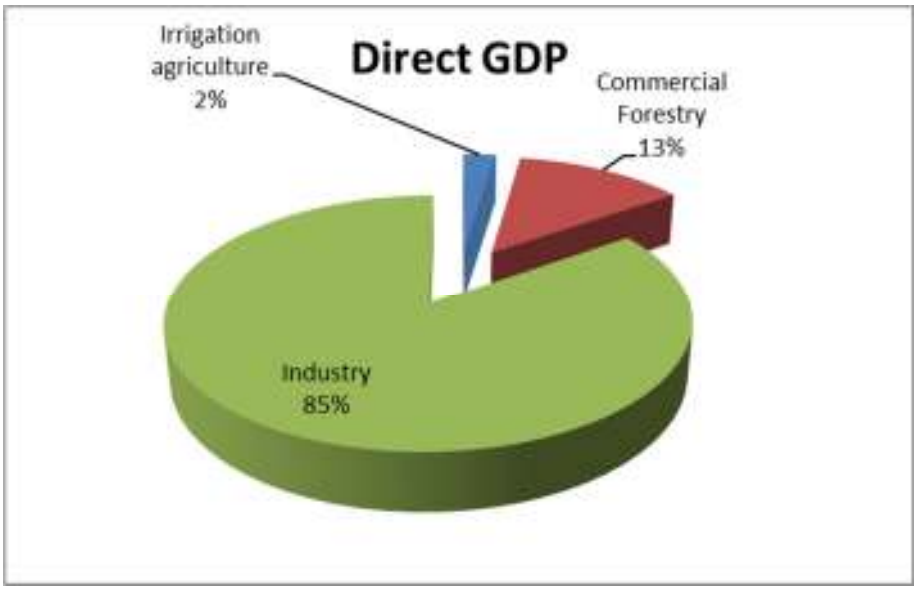


Figure 20.10 Contribution of the different water-dependent activities to GDP in IUA T35_b

Although the industry activity contributes only 51% of the employment in the IUA, its share of the GDP is 85%.

Ecosystem services:

The IUA consists of the Wildebees and Gatberg systems and is dominated by forestry and large wetlands. Some pockets of land use given over to subsistence agriculture are also evident, but this is relatively limited. Key ecosystem services important in the IUA are recreational fishing, as well as other recreational aspects associated with the rivers and the aesthetic value of the river and associated aquatic systems in their intersection with the recreational value of parts of the catchment areas.

Ecology (rivers):

The PES categories range from B to C and predominant impacts include forestry, with plantation species invading wetlands and the riparian zone, and alien vegetation (mainly along the channel characterised by alien willow species). Water quality is affected around Ugie, where weirs also exist. The lower Inxu River ranges from a B to C/D categories, but is mainly a C. Main impacts include dryland cultivation and overgrazing, both with resultant severe erosion. Gully erosion is common and severe.

Ecology (wetland):

This IUA contains portion of wetland group 5 (T35F, G) and supports 5.3% of wetlands within the T3 catchment. This IUA comprises an extensive and dispersed array of various wetland types (channelled valley bottoms, depressions, flats, floodplains and seeps) in the Ugie region, and associated with the Inxu (Wildebeest) River and its tributaries. The predominant land use in the area is forestry, particularly in the Ugie area, while agricultural activities are more dominant along the Gatberg River wetlands. Most grasslands have been manipulated in some way and are subject to annual fires. Alien tree species (such as *S. fragilis*) frequently line the active channel, but are limited in wetland areas.

Quaternary catchment	Wetland Area (ha)	Proportional area (% of T3)
T35F	1168	1.5
T35G	3098	3.9

20.10 IUA T35_C

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. There are a number of small farm dams located throughout the IUA. The proposed Lalini Dam on the Tsitsa River (T35L) to be used in conjunction with the proposed upstream Ntabelanga Dam for hydropower generation is a major surface water development planned in the IUA. The IUA is largely rural with scattered rural villages and informal settlements supplied by rural water supply schemes. High levels of erosion and sedimentation are prominent as a result of poor land use practices.

GRAII lists the groundwater Harvest Potential as over 31 Mm^3/a, and the Exploitation Potential as over 64 Mm^3/a. Recharge is over 154 Mm^3/a, of which 15.0 Mm^3/a is discharged as baseflow under natural conditions (7-15%). Only small scale abstraction occurs.

Quaternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T35H	8 124 800	0.402300	0.850000	3 774 690	696	44 730 500	19 445 900
T35J	3 413 300	0.423700	0.850000	1 316 510	0	20 021 600	8 795 630
T35K	10 935 600	0.422300	0.850000	4 719 640	0	48 037 600	21 193 600
T35L	5 124 200	0.361100	0.850000	2 805 880	0	18 726 600	7 056 030
T35M	4 182 100	0.326600	0.850000	2 394 960	0	22 775 700	7 952 220
TOTAL	31 780 000			15 011 680	696	154 292 000	64 443 380

Water quality:

Cattle grazing and subsistence dryland farming is prevalent, with urban impacts and elevated nutrient levels expected around Tsolo. One water quality hostpot was identified at Tsolo.

Economy:

The proposed Ntabalenga Dam irrigation area together with 5 340 hectares of commercial plantations form part of this IUA. The proposed crop division as proposed in the EIA report is retained.

The macro-economic parameters representing the water-based activities in the region are presented in **Table 20.8**.

Table 20.8 Economic activities in IUA T35_c expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	Indirect and Induced	Total	Direct	Indirect and Induced	Total	Total	Medium	Low
Irrigation agriculture	R 51.0	R 67.2	R 118.2	1 111	599	1 711	R 91.1	R 67.2	R 23.9
Commercial forestry	R 25.0	R 21.4	R 46.4	169	195	363	R 27.0	R 16.2	R 10.7
Industry	R 28.8	R 31.6	R 60.4	254	251	506	R 39.5	R 22.6	R 16.9
Total	**R 104.8**	**R 120.2**	**R 225.0**	**1 534**	**1 045**	**2 580**	**R 157.6**	**R 106.0**	**R 51.6**

Irrigation agriculture involves a high number of employment opportunities, namely 1 111 out of a total of job opportunities above 1 534. As far as the GDP is concerned the proposed agriculture will contribute R51 million to the total of R104.8 million.

It will also contribute R23.9 million annually to low-income households out of a total of R51.6 million. The proposed irrigation will make a very positive impact on the economic activities in the IUA.

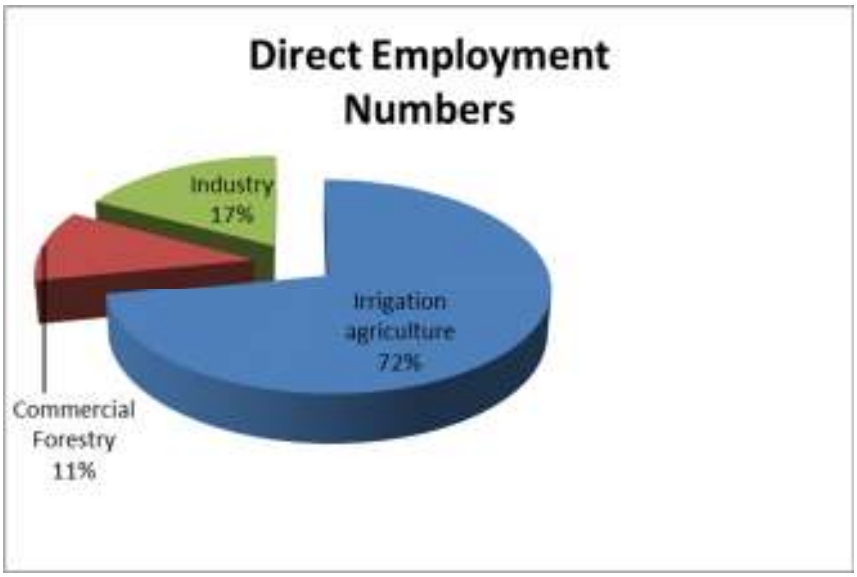


Figure 20.11 Contribution of the different water-dependent activities to employment in IUA T35_c

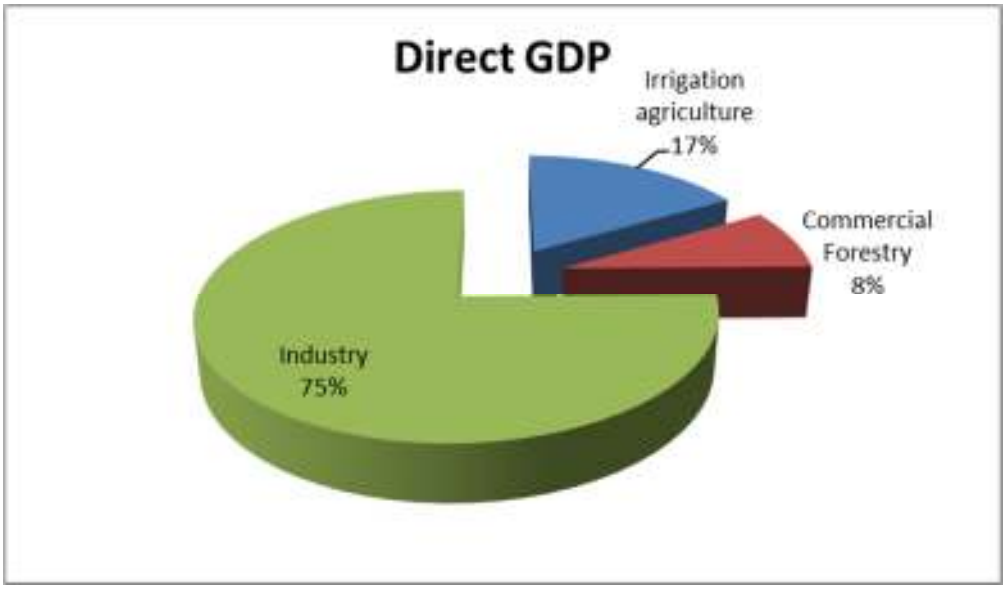


Figure 20.12 Contribution of the different water-dependent activities to GDP in IUA T35_c

The graphs indicate the expected large contribution of the proposed Ntabelanga Dam to employment and lesser impact on GDP.

Ecosystem services:

This IUA is entirely subsistence agriculture and provisioning services are potentially of critical importance to many of the residents. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture and limited sand mining is also evident. Ritual use is also deemed to be important in some areas.

Ecology (rivers):

The dominant category of these tributaries is a C due to erosions, overgrazing and alien vegetation.

Ecology (wetland):

This IUA does not contain one of the wetland groups except for T35H, which is part of wetland group 5, and supports 6.6% of wetlands within T3. The wetlands in this IUA are mostly channelled valley-bottom and floodplain wetlands associated with the main stem of the Tsitsa River, but quaternary T35H contains extensive seep wetlands and flats in headwater areas.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T35H	1426	1.8
T35J	562	0.7
T35K	1938	2.4
T35L	864	1.1
T35M	468	0.6

20.11 IUA T35_D

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. Lalini Dam is a major surface water development planned on the Tsitsa River (T35E) to supply water to regional settlements, proposed irrigation developments and for hydropower generation which will largely impact on the operational aspects of the IUA. The IUA is largely rural with scattered rural villages and informal settlements. High levels of erosion and sedimentation are prominent as a result of poor land use practices.

Water quality:

Dryland farming, cattle grazing and associated erosion is prevalent. No water quality hotspots were identified.

Economy:

This IUA will eventually, if constructed, accommodate the hydro-electric power unit below Lalini Dam. The generation of electricity is always interesting in estimating the macro-economic impact as the forward linkages are mostly very important and in this case it shows up again.

This will be the only water-dependent activity in the IUA.

The macro-economic parameters representing the water-based activities in the region are presented in **Table 20.9**.

Table 20.9 Economic activities in the IUA 35_d expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	Indirect and Induced	Total	Direct	Indirect and Induced	Total	Total	Medium	Low
Irrigation agriculture	R 0.0	R 0.0	R 0.0	–	–	–	R 0.0	R 0.0	R 0.0
Commercial forestry	R 0.0	R 0.0	R 0.0	–	–	–	R 0.0	R 0.0	R 0.0
Industry	R 202.3	R 249.3	R 451.5	12	2 172	2 184	R 312.6	R 94.7	R 119.7
Total	**R 202.3**	**R 249.3**	**R 451.5**	**12**	**2 172**	**2 184**	**R 312.6**	**R 94.7**	**R 119.7**

The table shows that although the direct employment on site will only be 12, the indirect and induced number will increase to 2 172. Electricity is a necessary component of a modern economy.

Ecosystem services:

Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture and limited sand mining is also evident. Aesthetic aspects of the IUA are also important and Tsitsa Falls is within this IUA. Parts of the IUA are incised and relatively inaccessible. Ritual use is also deemed to be important in some areas.

Ecology (rivers):

This zone includes the Tsitsa River, mainly a gorge area, and incorporates the Tsitsa Falls. PES categories are mainly Bs due to inaccessibility of the area.

Ecology (wetland):

This IUA does not contain any of the wetland groups. Most of this IUA is confined and deep valley and gorge areas are characteristic.

20.12 IUA T36_A

Water resources:

The storage regulation in this IUA is low with no major dams located in the area. A smaller dam, the Majola Dam, supplies water irrigation. The proposed upstream Ntabelanga Dam and Lalini Dam on the Tsitsa River to be developed for supplying water to regional settlements, proposed irrigation schemes and hydropower generation is a major upstream surface water development that will greatly impact on the water resources in the IUA. The IUA is largely rural with scattered rural villages and settlements with some cultivation. High sediment loads occur in the river as a result of upstream erosion and sedimentation.

GRAII lists the groundwater Harvest Potential as over 10 Mm^3/a, and the Exploitation Potential as over 34 Mm^3/a. Recharge is nearly 85 Mm^3/a, of which 2.9 Mm^3/a is discharged as baseflow under natural conditions (3-4%). Only small scale abstraction occurs.

Quarternary	Harvest Potential (m^3/a)	Exploitability Factor	Potability Factor	Mean Annual Baseflow (m^3/a)	Abstraction (m^3/a)	Mean Annual Recharge (m^3/a)	Exploitation Potential (m^3/a)
T36A	6 296 800	0.357800	0.850000	1 848 110	0.00	44 716 100	17 646 000
T36B	3 882 800	0.396900	0.400000	1 012 810	0.00	40 277 100	16 764 000
TOTAL	10 179 600			2 860 920	0	84 993 200	34 410 000

Water quality:

Water quality issues include high instream turbidities from erosion and possible point source pollution risks from the canalised creek that flows from the town of Port St Johns. Irrigation for vegetables may result in some elevated nutrients. No water quality hotspots were identified.

Economy:

As these two IUAs include the last stretch of the river and the very important estuary, they have been grouped together for the economic analysis.

Only 148 hectares of irrigation has been identified together with a commercial forestry base of 91 hectares. The macro-economic parameters representing the water-based activities in the region are presented in **Table 20.10.**

Table 20.10 Economic activities in the IUA T36_a and T36_b expressed as macro-economic parameters

	GDP (R mil)			Employment (Numbers)			Household Income (R mil)		
	Direct	Indirect and Induced	Total	Direct	Indirect and Induced	Total	Total	Medium	Low
Irrigation agriculture	R 9.3	R 10.3	R 19.5	343	72	415	R 13.9	R 10.2	R 3.6
Commercial forestry	R 0.4	R 0.4	R 0.8	4	4	8	R 0.5	R 0.3	R 0.2
Industry	R 0.4	R 0.4	R 0.8	3	3	7	R 0.5	R 0.3	R 0.2
Total	**R 10.0**	**R 11.1**	**R 21.2**	**351**	**79**	**430**	**R 14.9**	**R 10.8**	**R 4.1**

This small irrigation unit is the largest contributor to employment because of the volume of vegetables produced.

Ecosystem services:

This IUA includes the Mzimvubu catchment downstream of all the tributaries to the estuary. Parts are very inaccessible but there are some areas where access is available and where provisioning services are important. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Some floodplain agriculture and limited sand mining is also evident. Ritual use is also deemed to be important in some areas.

Ecology (rivers):

T36 is evaluated as one zone comprising the main Mzimvubu river upstream of the estuary and two tributaries. The main river is in a C EC and the tributaries in a B EC. The area consists mostly of a steep gorge. Land use where access is possible is associated with grazing.

Ecology (wetland):

This IUA does not contain one of the wetland groups. The wetlands in this IUA comprise the Mzimvubu floodplain estuary and are covered in the estuarine chapter.

Quaternary catchment	Wetland area (ha)	Proportional area (% of T3)
T36A	3	0.0
T36B	880	1.1

20.13 IUA T36_B

Water resources:

The IUA consists of the the Mzimvubu estuary, which is located at the outlet of T36B. The proposed upstream Ntabelanga Dam and Lalini Dam on the Tsitsa River to be developed for supplying water to regional settlements, proposed irrigation schemes and hydropower generation is a major upstream surface water development that will greatly impact on the water resources in the IUA.

Water quality:

The PES for water quality in the Mzimvubu estuary is estimated at a Category B/C. Nutrient concentrations in the estuary increased under Present state compared to Reference due to increased nutrient input from diffuse sources in the catchment, mainly settlements and cattle herds. Turbidity in the estuary increased due to erosion caused by catchment practices. However, it should be noted that this catchment has naturally and historically introduced turbid waters to the estuary. Urban development along the banks of the estuary may also have introduced some toxic substances (e.g. trace metals) to the system.

Economy:

The economic input for IUA T36_b is included as a single entity under IUA T36_a.

Ecosystem services:

Recreational aspects are key ecosystem services for the Mzimvubu estuary. Subsistence fishing, thatch grass harvesting, reed harvesting and other riparian vegetation usage are all important in terms of ecosystem services. Ritual use is also deemed to be important.

Ecology:

The Present Ecological State (PES) of the Mzimvubu estuary is Category B meaning that the system is "largely natural with few modifications".

The estuary is rated as a "Highly important" system in accordance with the estuary importance index for the estuary that takes into account the size, the rarity of the estuary type within its biographical zone, habitat, biodiversity and functional importance of the estuary into account (DWS, 2014d). A number of features contributed to the high importance score of the estuary, namely:

- This is the only WMA not linked to another WMAs through cross-catchment transfers and is largely unregulated.
- This catchment has been identified as supplying high levels of ecological services nationally, and SANBI is currently undertaking an assessment of the economic importance of the system.
- The confirmed use of the estuary by Zambezi sharks (*Carcharhinus leucas*), white steenbras (*Lithognathus lithognathus*) and dusky kob (*Argyrosomus japonicus*) species as a pupping/nursery ground, given that these are species of conservation and fisheries concern, and that available nursery habitat for these species is highly limited in South Africa.
- The significant role that this estuary plays in the delivery of sediments and nutrients/detritus to the marine environment, elevating the importance of this estuary in geological terms to the local beaches and marine environments.

21 REFERENCES

Berliner, D. and Desmet, P. 2007. Eastern Cape Biodiversity Conservation Plan: Technical Report. Department of Water Affairs and Forestry Project No 2005-012, Pretoria. 1 August 2007.

Department Water Affairs (DWA), South Africa. 2009. DWA Water Resource Study in Support of the AsgiSA-EC Mzimvubu Development Project: Volume 4 of 5 – Water Resource Assessment. Prepared by BKS (Pty) Ltd. P WMA 12/000/00/3609. June 2009.

Department of Water Affairs (DWA), South Africa. 2012. Green Drop Report, Chapters 5 and 8 – Eastern Cape and KwaZulu-Natal Province.

Department of Water Affairs (DWA), South Africa. 2013. Review and update of the Desktop Present Ecological State (PES) and Ecological Importance (EI) - Ecological Sensitivity (ES) of South African Rivers according to Sub-Quaternary catchments: Mvoti to Umzimkulu WMA.

Department of Water Affairs and Forestry (DWAF). 1999. Resource directed measures for the protection of water resources. Volume 3: River ecosystems, version 1.0.

Department of Water Affairs and Forestry (DWAF), South Africa. 2004a. Mzimvubu to Keiskamma Water Management Area: Internal Strategic Perspective of the Mzimvubu to Mbhashe ISP Areas. Prepared by Ninham Shand, Tlou and Matji, FST Consulting and Umvoto Consortium. DWAF Report No. P WMA 12/000/00/0304.

Department of Water Affairs and Forestry (DWAF), South Africa. 2004b. Reserve Determination Study - Thukela River System. Thukela System Resource Economics Report – Chapter 3. Authored by Mander, M. and Huggins, G. Prepared by IWR Source-to-Sea as part of the Thukela Water Project Decision Support Phase. DWAF Report No. PBV000-00-10311.

Department of Water Affairs and Forestry (DWAF), South Africa. 2006. Groundwater Resource Assessment Phase II (GRA II): Task 1D Groundwater Quantification. Version 2: Final. Prepared by DWAF, SRK, GEOSS and CSIR. Project 2003-150.

Department of Water Affairs and Forestry (DWAF), South Africa. 2007. Chief Directorate: Resource Directed Measures. Development of the Water Resource Classification System (WRCS) Volume 1 Overview and 7-step classification procedure. October 2006.

Department of Water Affairs and Forestry (DWAF), South Africa. 2008a. Comprehensive Reserve Determination Study for Selected Water Resources (Rivers, Groundwater and Wetlands) in the Inkomati Water Management Area, Mpumalanga. Sabie and Crocodile Systems: Resource Unit Delineation: Prepared by Water for Africa, authored by Louw, MD. Report no. 26/8/3/10/12/006.

Department of Water Affairs and Forestry (DWAF), South Africa. 2008b. Resource Directed Measures for Protection of Water Resources: Methodologies for the determination of ecological water requirements for estuaries. Version 2. Pretoria.

Department of Water Affairs and Forestry (DWAF), South Africa. 2009. DWAF Water Resource Study in Support of the AsgiSA-EC Mzimvubu Development Project. Prepared by BKS (Pty) Ltd. For: DWS Directorate: National Water Resources Planning. Report No: P WMA 12/000/00/3609, Pretoria, South Africa.

Department of Water and Sanitation (DWS), South Africa. 2014a. Environmental Impact Assessment for the Mzimvubu Water Project: Rapid Reserve Determination – Tsitsa River at Lalini. Prepared by GrondTruth Water, Wetlands and Environmental Engineering. DWS Report No: P WMA 12/T30/00/5314/17.

Department of Water and Sanitation (DWS). 2014b. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub-Quaternary Reaches for Secondary Catchments in South Africa. Secondary: T3 Compiled by RQIS-RDM: https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx.

Department of Water and Sanitation (DWS), South Africa. 2014c. Feasibility Study for the Mzimvubu Water Project: Volume 1 – Rivers. Prepared by Jeffares & Green (Pty) Ltd. for: DWS Directorate: Options Analysis. Report No: P WMA 12/T30/00/5212/7, Volume 1.

Department of Water and Sanitation (DWS), South Africa. 2014d. Feasibility Study for the Mzimvubu Water Project: Volume 2 – Estuary. Prepared by Jeffares & Green (Pty) Ltd. for: DWS Directorate: Options Analysis. Report No: P WMA 12/T30/00/5212/7, Volume 2.

Department of Water and Sanitation (DWS), South Africa. 2014e. Environmental Impact Assessment for the Mzimvubu Water Project: Water Quality Assessment Report. DWS Report No.: P WMA 12/T30/00/5314/13. Prepared for DWS Directorate Options Analysis by Scientific Aquatic Services.

Department of Water and Sanitation (DWS), South Africa. 2014f. Feasibility Study for the Mzimvubu Water Project: Water Resources. Prepared by Jeffares & Green (Pty) Ltd for DWS Directorate: Options Analysis. Report No: P WMA 12/T30/00/5212/5, Pretoria, South Africa.

Driver, A., Nel, J.L., Snaddon, K., Murray, K., Roux, D.J., Hill, L., Swartz, E.R., Manuel, J., Funke, N. 2011. Implementation manual for freshwater ecosystem priority areas. WRC Report No. 1801/1/11, WRC, Pretoria.

Environmental and Rural Solutions – Conservation South Africa (ERS/CSA). 2011. Umzimvubu overview. December 2011, Draft 2.

Huggins, G., Rydgren, B., Lappeman, G. 2010. Deliverable 7 & 13: The Assessment of Goods and Services in the Orange River Basin. Produced for WRP a**s** part of Support to Phase II ORASECOM Basin Wide Integrated Water Resources Management Plan.

Iversen, T.M., Madsen, B.L., and Bøgestrand, J. 2000. River conservation in the European Community, including Scandinavia. In: “Global Perspectives on River Conservation: Science Policy and Practice", Edited by P.J. Boon, B.R. Davies and G.E. Petts, John Wiley & Sons Ltd.

Job, N. and Walters, D. 2013. Wetland inputs to baseline information for the Upper Umzimvubu catchment, Eastern Cape. Report to Conservation South Africa.

John, M.R, Anhaeusser, C.R, and Thomas, R.J. 2006. The Geology of South Africa. Second edition. Prepared by the Geological Society of South Africa (GSSA).

Kleynhans, C.J. and Louw, M.D. 2007. Module A: EcoClassification and EcoStatus determination. In River EcoClassification: Manual for EcoStatus Determination (version 2) Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.

Kleynhans, C.J., Thirion, C. and Moolman, J. 2005. A Level I River EcoRegion classification System for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Kleynhans, C.J., Thirion, C., Moolman, J. and Gaulana, L. 2007. A Level II River Ecoregion classification System for South Africa, Lesotho and Swaziland. Report No. N/000/00/REQ0XXX. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Louw, M.D. and Hughes, D.A. 2002. Resource Directed Measures for Protection of Water Resources: River Ecosystems - Revision of a quantity component. Prepared for the Department of Water Affairs and Forestry, South Africa.

Louw, M.D. and Huggins, G. 2007. Desktop Assessment of the Importance and Ecological State of the Maputo River Quaternary catchments. Produced by Water for Africa as part of the Joint Maputo River Basin Water Resources Study – Moçambique, Swaziland and South Africa.

Louw, D., Kotze, P., and Mackenzie, J. 2010. Scoping study to identify priority areas for detailed EFR and other assessments. Produced for WRP as part of Support to Phase II ORASECOM Basin Wide Integrated Water Resources Management Plan.

MacKenzie, J.A. 2010. Construction of a New Storage and Supply Dam for Ugie - Specialist Report: Riparian, Wetland and Terrestrial Vegetation. Prepared for TERRECO CC.

Milner, A.M. 1994. System recovery. In, P.Calow & G.E. Petts (eds.): The rivers handbook. Vol. 2. Blackwell Scientific Publications. London.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L., and Nienaber, S. 2011. Technical Report for the National Freshwater Ecosystem Priority Areas Project. WRC Report No. 1801/2/11.

Noble, R.G. and Hemens, J. 1978. Inland water ecosystems in South Africa - a review of research needs. South African National Scientific Programmes Report No. 34: 150 pp.

Omernik, J.M. 1987. Ecoregions of the conterminous United Sites. Annals of the Association of American Geographers 77:118 – 125.

Perrings, C. 2006. Resilience and sustainable development. *Environment and Development Economics, 11*, 417-417.

Resh, V.H., Brown, A.V., Covich, A.P., Gurtz, M.E., Li, H.W., Minshall, G.W., Reice, S.R., Sheldon, A.L., Wallace, J.B. and Wissma,r R.C. 1988. The role of disturbance theory in stream ecology. Journal of the North American Benthological Society. 7: 433-455.

Robertson, M.P., Villet, M.H. and Palmer, A.R. 2004 A fuzzy classification technique for predicting species' distributions: applications using invasive alien plants and indigenous insects. Diversity and Distributions 10: 461–474.

Rowntree, K.M. and Wadeson, R.A. 1999. A hierarchical framework for categorising the geomorphology of river systems, Water Research Commission Report. Report No. 497/1/99. WRC, Pretoria.

Statistics South Africa. 2012. Census 2011. Statistical release – P0301.4 / Statistics South Africa. Published by Statistics South Africa, Private Bag X44, Pretoria 0001.

Statistics South Africa. 2016. Quarterly Labour Force Survey – Quarter 1: 2016. Statistical release P0211 / Statistics South Africa. Published by Statistics South Africa, Private Bag X44, Pretoria 0001.

Van Niekerk, L. and Turpie, J.K. (eds). 2012. National Biodiversity Assessment 2011: Technical Report. Volume 3: Estuary Component. CSIR Report No: CSIR/NRE/ECOS/ER/2011/0045/B. Council for Scientific and Industrial Research, Stellenbosch.

Vegter, J.R. 2001. Groundwater development in South Africa and an Introduction to the Hydrogeology of groundwater Regions. WRC report No. TT/134/00.

Veldkornet, D.A., Adams, J.B. and van Niekerk, L. 2015. Characteristics and landcover of estuarine boundaries: Implications for the delineation of the South African estuarine functional zone, African Journal of Marine Science, DOI: 10.2989/1814232X.2015.1072111.

APPENDIX A: LIST OF BIOPHYSICAL NODES

Table A.1 provides the RUs and MRUs that are included in each IUA. The SQs that are combined into the RUs are also indicated. Each RU is represented by a biophysical node. Note that where the REC is left as blank, it indicates that it must still be determined in a more detailed process other than the completed desktop assessment.

Table A.1 SQ, RU and IUA table

IUA	RU (biophysical node)	SQ number	River	REC (RU)
IUA T31: Mzimvubu				
IUA T31	T31-1	T31A-04712	Mzimvubu	B/C
	T31-2	T31B-04745	Krom	B
		T31B-04868	Krom	
		T31B-04873		
	T31-3	T31C-04796	Mngeni	B
		T31C-04866	Mzimvubu	
	T31-4	T31C-04879	Nyongo	C
	T31-5	T31D-04926	Mzimvubu	B
		T31D-05076	Mzimvubu	
	T31-6	T31D-04936	Riet	C
		T31D-05030	Riet	
		T31D-05060		
	T31-7	T31E-04836	Tswereka	B
	T31-8	T31E-04910	Malithasana	B/C
		T31E-04931	Tswereka	
	T31-9	T31E-05055		C
	T31-10	T31E-05013	Tswereka	D
	T31-11	T31F-05108		B/C
	T31-12	T31F-05112	Mzimvubu	C
		T31F-05134		
	T31-13	T31G-05071	Mzimvubu	B/C
		T31J-05257	Mzimvubu	
	T31-14	T31H-05177	Mvenyane	B
		T31H-05304		
	T31-15	T31H-05324	Mvenyane	B/C
	T31-16	T31H-05296	Mkemane	B
	T31-17	T31H-05445		B/C
	T31-18	T31H-05437	Mkemane	B/C
		T31H-05516	Mvenyane	C/D
	T31-19	T31J-05551	Mzimvubu	B
		T31J-05582	Ngwekazana	
		T31J-05588	Mzimvubu	
IUA T32: Mzintlava				
IUA T32_a	T32-1	T32A-04965	Mzintlava	B/C
	T32-2	T32A-04907	Mzintlanga	C
		T32B-05103	Mzintlava	
	T32-3	T32B-05116		B/C
		T32B-05184	Mzintlava	
	T32-4	T32C-05219	Mill Stream	B/C
	T32-5	T32C-05243	aManzamnyama	B/C
	T32-6	T32C-05273	Mzintlava	B
		T32C-05313	Mzintlava	
	T32-7	T32C-05378		B/C
	T32-8	T32D-05172	Droewig	C
	T32-9	T32D-05352	Mzintlava	D

IUA	RU (biophysical node)	SQ number	River	REC (RU)
IUA T32_b	T32-10	T32D-05373	Mzintlava	D
	T32-11	T32E-05446	Mvalweni	C
		T32F-05464	Mzintlava	
	T32-12	T32G-05536	Mzintlavana	B
		T32G-05609	Mbandana	
		T32G-05747	Mzintlavana	
	T32-13	T32H-05842	Mzintlava	B
IUA T33: Kinira				
IUA T33_a	T33-1	T33A-04887	Mafube	B
		T33A-04928		
	T33-2	T33A-04892	Kinira	B/C
		T33A-04898	Makomorin	
		T33A-04903	Kinira	
	T33-3	T33A-04990	Kinira	C
		T33A-04991		
	T33-4	T33B-05005	Jordan	B
		T33B-05072		
	T33-5	T33B-04912	Seeta	B/C
		T33B-05051	Mabele	
	T33-6	T33B-04939	Mabele	C
		T33B-04956	Mosenene	
IUA T33_b	T33-7	T33C-05131	Morulane	C
		T33D-05063	Kinira	
		T33D-05106	Pabatlong	
		T33D-05150	Kinira	
	T33-8	T33E-05367	Somabadi	C
	MRU Kinira (MzimEWR3)	T33E-05213	Kinira	
		T33F-05326	Kinira	
		T33G-05395	Kinira	
	T33-9	T33F-05285	Rolo	B/C
		T33F-05398	Kinira	
	T33-10	T33F-05439	Ncome	C
	T33-11	T33G-05587	Cabazi	C
	T33-12	T33H-05638	Mnceba	C
		T33H-05638	Mnceba	
	T33-13	T33H-05803	Caba	B
	T33-14	T33G-05659	Mzimvubu	B
		T33H-05680	Mzimvubu	
		T33H-05821	Mzimvubu	
		T33J-05834	Mzimvubu	
		T33K-06051	Mzimvubu	
IUAT34: Thina				
IUA T34_a	T34-1	T34C-05168	Tinana	B
		T34C-05238	Phinari	
		T34C-05292	Tinana	
	T34-2	T34A-05354	Zindawa	B
		T34A-05362	Vuvu	
		T34A-05394	Vuvu	
		T34A-05404 (MRU Thina_A)	Thina	
		T34A-05415 (MRU Thina_A)	Thina	
	T34-3	T34A-05408	Khohlong	B/C
		T34B-05385	Thina	
	T34-4	T34B-05269	Nxotshana	B
		T34B-05275	Phiri-e-ntso	
		T34B-05351	Thina	

IUA	RU (biophysical node)	SQ number	River	REC (RU)
		(MRU Thina_A)		
		T34B-05356 (MRU Thina_A)	Thina	
IUA T34_b	T34-5	T34D-05412	Thina	B/C
	T34-6	T34D-05433	Tokwana	C
		T34D-05462	Khalatsu	
		T34D-05463	Tokwana	
	T34-7	T34E-05495	Bradgate se Loop	B
		T34E-05503	Luzi	
		T34E-05507	Luzi	
	T34-8	T34F-05512	Luzi	B/C
		T34F-05585		
	T34-9	T34G-05504	Qwidlana	B
		T34G-05634	Nxaxa	
	MRU Thina_B	T34G-05543	Thina	
		T34G-05667	Thina	
		T34H-05598	Thina	
	T34-10	T34H-05714	Qhanqu	B
		T34H-05769	Tsilithwa	
		T34H-05791	Tsilithwa	
	T34-11	T34H-05826	Ngcothi	B
	T34-12	T34H-05699	Mvuzi	C
		T34H-05738	Ngcibira	
		T34H-05809	Mvumvu	
	MRU Thina_C	T34H-05772	Thina	
		T34H-05838	Thina	
		T34K-05835	Thina	
IUA T35: Tsitsa				
IUA T35_a	T35-1	T35A-05596	Tsitsana	B
		T35A-05648 (MRU Tsitsa_A)	Tsitsa	
		T35A-05657	Hlankomo	
		T35A-05750 (MRU Tsitsa_A)	Tsitsa	
	T35-2	T35B-05709	Pot	B
		T35B-05798	Pot	
		T35B-05815	Little Pot	
	T35-3	T35C-05858	Mooi	B
		T35C-05930	Klein-Mooi	
	T35-4	T35C-05874	Mooi	C
	MRU Tsitsa_B	T35D-05721	Tsitsa	
		T35E-05908	Tsitsa	
	T35-5	T35E-05780	Gqukunqa	B
IUA T35_b	T35-6	T35F-05999	Inxu	B
		T35F-06000	Fontana	
		T35F-06080	Inxu	
		T35F-06112	Rondadura	
	T35-7	T35G-06135	Gqaqala	B
	T35-7	T35G-06169	Gqaqala	
		T35G-06179		
	T35-8	T35F-05973	Kuntombizininzi	B
	MRU Inxu (EWR1)	T35F-06020	Inxu	C
		T35G-06021	Inxu	B
	MRU Gat (IFR1)	T35G-06069	Gatberg	B
		T35G-06074	Gatberg	
		T35G-06099	Gatberg	
		T35G-06100		

IUA	RU (biophysical node)	SQ number	River	REC (RU)
		T35G-06118	Gatberg	
		T35G-06133		
IUA T35_c	MRU Inxu	T35H-06024	Inxu	B/C
		T35H-06053	Inxu	
		T35J-06088	Inxu	
	T35-9	T35H-06186	Umnga	B/C
		T35H-06240	KuNgindi	
		T35H-06282	Umnga	
	T35-10	T35H-06158	Qwakele	B/C
	T35-11	T35J-06106	Ncolosi	C
	T35-12	T35K-05897	Culunca	B/C
	T35-13	T35K-05904	Tyira	C/D
	T35-14	T35K-06167	Xokonxa	C
	T35-15	T35L-06226	Ngcolora	C
	T35-16	T35M-06275	Ruze	B
IUA T35_d	MRU Tsitsa_C	T35E-05977	Tsitsa	
		T35K-06037	Tsitsa	
		T35K-06098	Tsitsa	
		T35L-05976	Tsitsa	
	MRU Tsitsa_D	T35L-06190	Tsitsa	
		T35M-06187	Tsitsa	
		T35M-06205	Tsitsa	
IUA T36: Mzimvubu				
IUA T36_a	T36-1	T36A-06216	Mzintshana	B
	T36-2	T36A-06220	Mkata	B
	MRU Mzim	T36A-06250	Mzimvubu	
		T36A-06354	Mzimvubu	
		T36B-06391	Mzimvubu	
IUA T36_b	MRU Estuary	T36B-06391	Mzimvubu	

APPENDIX B: COMMENTS REPORT

Page / Section	Report statement	Comments	Changes made?	Author comment
DWS Project Management Committee – 24 January 2017				
Page ii		Provide signing space for Lawrence as supporting official.	Yes	Corrected
		General comment: The use of integrated steps is not supported as the operationalisation study is ongoing. Use of classification step as per ToR and your bid proposal is supported.	Yes	The steps are presented as the Project Plan, as approved for the final Inception Report.
		General comment: Don't understand exclusion of RUs for the dam and wetlands in the report.	No	As RQOs are not set for dams, Resource Units are not defined for dams. However, the presence of a dam is used to support delineation (e.g. in defining WRUI). Wetlands are not used as part of the hotspot process to delineate RUs (and recent information from wetland specialists is that wetland RUs will be wetland-specific). Wetlands were, however, considered in prioritisation of RUs and IUA delineation.
Page 1.1 / 1.3	an Integrated Framework of steps for undertaking Reserve, Classification and RQO studies was designed and finalised with the DWS (DWS, 2016).	The procedure to operationalise RDM is not gazetted yet nor finalised.	Yes	The steps are presented as the Project Plan, as approved for the final Inception Report.
Page 1.2 / 1.4	Volume D: Delineation of Integrated Units of Analysis (IUAs) and *status quo* of the area	What is difference from the status quo in Volume A?	No	The status quo in Volume A is per SQ or other groupings. With that information, IUAs are described, of which each consists of many SQs. Volume D therefore summarized this information as the status quo for the IUA.
Page 2.2 / 2.4.1	The DWS Water Resources Yield Model (WRYM) was configured for the entire Mzimvubu catchment by the *SA-*	Please give correct reference. This was a DWA study, in support of ASGISA-EC.	Yes	SA-EC changed to AsgiSA-EC throughout the document.

Page / Section	Report statement	Comments	Changes made?	Author comment
	EC Mzimvubu Development Project This latest WRYM configuration will be used for the Kinira and Tsitsa river catchments and will be integrated with the *SA-EC Mzimvubu Development Project*			
Page 2.5	Ntenetyana: Supplies water to the Kwa Bacha Scheme (T35K)	How can this dam be in two different quaternaries, or is the scheme it supplies in two different quaternaries?	Yes	Check and corrected throughout. It occurs in and supplies T33G.
Page 2.5	Maclear Dam: Supplies water to *former townships* and Maclear (T35D)	…former townships… What are they now?	Yes	The former township was Maclear Township which is in any case part of Maclear and forms part of the Maclear All Towns strategy.
Section 3: Status quo assessment (Economics) Page 3.1		Population distribution data used in the report is outdated. General comment: The main socio-economic factor in the study area is land tenure. Land tenure influences different forms of land use, population dynamics, infrastructure and economic activity in the Mzimvubu catchment. Commercial agriculture, tourism-related jobs and different forms of subsistence agriculture are the main sources of income to the majority of people in the study area. The area is characterised by largely rural communities living in scattered villages with a few regional towns that provide basic consumer services to the communities. The area reflects a low level of economic activity and related high levels of unemployment and poverty. Over 55% of households are female headed, with most rural households surviving on just over R600 per month, with most income derived from grants. Unemployment is higher than the national average of 26% and majority of residents are dependent on grants for survival.	Yes	1. Although it is accepted and understood that 2011 Census data may be out of date, it is the only official data available. All other available data are based on small surveys conducted in specific areas. 2. It is also agreed that land tenure is the main socio-economic driver in the catchment, but it is a highly sensitive issue that is not the focus of this report. 3. Changes have been made to the text below Table 3.1 to discuss old-age pensions and 2016 estimates according to the Division of Revenue Bill. 4. The expanded unemployment number of 4.5% is mentioned in the report. SA Reserve bank: According to the *strict definition* only those people who take active steps to find employment, but fail to do so, are regarded as unemployed. **The *expanded definition*, on the other hand, includes everyone who desires employment, irrespective of whether or not they actively tried to**

Page / Section	Report statement	Comments	Changes made?	Author comment
				obtain a job.
Page 3.1 / 3.1	…concerning the large water users such as irrigation agriculture, commercial forestry, sawmills, laminated board factory…	What about the domestic water-use sector?	Yes	Figures were updated.
Page 3.1 / 3.1	For the delineation of the IUAs and *status quo* see Volume D of this report.	But you are describing the *status quo* here?		The status quo is described for catchments and have to be amalgamated or disaggregated to be applicable to the IUAs. In this case, the description is provided on a tertiary catchment and smaller basis, which does not necessarily coincide with the IUAs.
Page 3.2 / 3.2	The rest of the catchment is still very rural with subsistence farming, with a number of *small villages* acting as commercial, education and health service centres.	Does this include towns like Ugie, Tsolo, Mt Ayliff, Maclear, Ntabankulu and Mt Frere – not really such small villages per se.	Yes	
Page 3.2 / 3.2	employment creation (number/Mm^3)	Mm^3 PLEASE do not use this monstrosity = $10^{18}m^3$!!! The M does NOT stand for million, but the suffix mega that goes with the unit, meter, so it results in the above ridiculous number. Use million or 106 m3.	Yes	Million/m^3 will be used throughout all study documentation.
Page 3.3 / 3.3.1	… the smaller town Franklin in the north, an urban economic service centre .	Not mentioned before?	Yes	The main economic activity in Franklin has been defined.
Page 3.4 / 3.3.2	Figure 3.1 Distribution of the population per ~~district~~ (*corrected to 'local')* municipality in the catchment (T3)	This is a misleading heading, as from the text these populations are the total population per LM, not that of the part of the LM in the catchment? See text below Fig 3.1	Yes	
Page 3.4 / 3.3.2	The expanded unemployment rate…	Expanded to what?	Yes	The expanded definition is provided as a footnote.
Page 3.5 /	…required agricultural	Why agricultural?	Yes	The sentence has been corrected

Page / Section	Report statement	Comments	Changes made?	Author comment
3.3.3	commodities, …			
Page 3.6 / 3.3.4	…compared with Water Resources of South Africa 2007 data.	Why such old data? Why not use WR2012 with 2009 data?	Yes	The data has been reworked, together with the actual irrigation data. Tables have been changed where necessary.
Page 3.6 / 3.3.4	…discrepancy between the official database …	Which database is this?	Yes	Sources are provided in Table 3.2
Page 3.6 / 3.3.4	Table 3.2 Comparison of official data versus Google Earth measurements	What official data?	Yes	Sources are provided in Table 3.2
Page 3.6 / 3.3.4	Third column of Table 3.2: Google Earth measurement	These areas are not necessarily irrigated areas. Could include dryland farming.	No	No dryland areas are included.
Page 3.6 / 3.3.4	… the surface of the pivots shown on the images was measured and the hectares calculated	Only centre pivot areas adding up to the areas shown in the table?	Yes	Figures on Table 3.2 have been reworked and updated, and text updated accordingly.
Page 3.6 / 3.3.4	In the EIA report, certain areas have been proposed for certain crops for the proposed irrigation from the Ntabelanga Dam.	This would originally have been proposed in the Feasibility Report, not the EIA report. The EIA would only confirm the areas suitability.	No	The later figures, as confirmed by the author of the economic section of this document and the specialist who undertook the economic component of the EIA, were used as he was asked to look at the feasibility of some of the proposed crops. Changes were made as for some there is no realistic market in Umtata or East London areas.
Page 3.7 / 3.3.4	Commercial forestry table	No table number and heading. What are the units of the numbers – ha? Source of info?	Yes	This section has been updated and clarified.
Page 3.7 / 3.3.4	As the current weighted growth in younger plantations in T35 could not be *accessed*, the *original* projected figures were used.	Assessed? Is not known? Could not be sourced? Original as in where shown? Where are these projected figures?	Yes	This section has been updated and clarified.
Page 4.1 / 4.2	Bridges and roads (low-level bridges and gravel roads within *100 m of the river)*	*100 m of the river* From the centre of the river or the river bank?	Yes	
Page 4.1 /	Reserve data, as received from	There is no such office and never was. Please	Yes	

Page / Section	Report statement	Comments	Changes made?	Author comment
4.2	the DWS Reserve office	get correct name		
Page 4.1 / 4.2	(ERS/CSA, 2011)	There is no list of references or bibliography to this report. Should have one, as this is a stand-alone volume.	No	See the following reference in the reference list, and the acronym in the List of Acronyms: *Environmental and Rural Solutions – Conservation South Africa (ERS/CSA). 2011. Umzimvubu overview. December 2011, Draft 2.*
Page 4.1 / 4.2	Ntabelanga-Lalini Dam Feasibility Study (DWS, a; c and d)	Year of report?	Yes	
Page 4.2 / 4.2	The water quality scores of the Water Resource Use Importance (WRUI) conducted for *this study*	Which study – the Classification study or the PES/EI/ES study?	Yes	
Page 4-2 / 4.2		Table not numbered (and no heading).	No	This is not a formal table but explanatory text extracted from the Green Drop Report of 2013.
Page 4.3 / 4.2		Figure not numbered (and no heading).	No	This is not a formal table but explanatory text extracted from the Green Drop Report of 2013.
Page 4.3 / 4.3	The high silt loads are also due to the numerous road crossings and cultivation along river banks and in the wider catchment .	What about over-grazing?	Yes	
Page 4.3 / 4.3	Non-point source discharge of diffuse agricultural waste	Waste or return flows from irrigation? What about pesticides?	No	Return flows are non-point source discharges, which would include pesticides if part of the waste profile
Page 4.5 / 4.4.2		Green Drop rating is outdated; the impact of Mount Ayliff WWTW is very severe compared to Green Drop rating (of 2012) which rated Mount Ayliff WWTW as medium risk. The Mount Ayliff WWTW is discharging pollutants directly into Mzintlava River which is causing serious health risk to human beings and aquatic organisms. The newly built Waste Water Treatment (WWTW) in Mount Ayliff is discharging pollutants directly into the water resource. The discharge of wastewater	Yes	It is strongly agreed that Green Drop data is outdated but the DWS has not produced more recent and updated information. Note that this document presents a desktop water quality overview. The comments made here will be incorporated into the notes and input to the Technical Task Group (TTG) meeting on river water quality, and have identified an additional water quality hotspot based on this information.

Page / Section	Report statement	Comments	Changes made?	Author comment
		into the water resource has contributed much higher loadings of nutrients such as NH4+and NO3-. The presence of high level NH4+ and NO3- in the water resource could lead to long term effects which could lead to proliferation of algae and other unwanted aquatic plants.		
Section 5: Status quo assessment (Ecosystem services) Page 5.1		The study is based on Census 2011 which is outdated. The report doesn't link relationship between people and services provided by the water resources in the Mzimvubu catchment. Water in the study area is still directly used by animals and surrounding communities for recreational, domestic and irrigational purposes. The river still supports diverse aquatic life such as fish, plants, crocodiles, frogs and other species.	Yes	Census 2011 is the most recent Census. A note has been inserted under *provisioning services*. It should be noted that the BHN study is a separate component. A footnote has been added to this effect. Irrigation is important but most of it is small scale and linked to vegetable gardens and not part of ecosystem services unless it is part of floodplain drawn-down cultivation where water is not abstracted. Where irrigation is substantial it is part of the economic assessment. It is acknowledged that the river still supports diverse aquatic life and these are considered under the rubric of provisioning services where they are consumed. These are noted in the text under each of the Zones considered. Recreational use is indeed important and this is considered as part of cultural services.
Section 13: River Management Resource Units Page 13.1		The approach doesn't show how delineation of RUs was undertaken. IUA delineation process was clearly defined and shown in Page 19.1. Why were RU considerations such as socio-economic zone, hydrological characteristics and catchment boundaries not considered during RU delineation process. They are also significant when delineating water resource into different units	No	MRU are done for the purposes of the ECOLOGICAL Water Requirements, therefore socio-economic aspects do not play a role. Indirectly it plays a role as similar land use and operation are a factor. Hydrological characteristics are incorporated into the EcoRegions etc. Catchment boundaries: not sure which boundaries are being referred to? As MRUs is set for one single main river, it does not cross catchment boundaries, although it can cross quaternary catchments etc. as these are not a delineation based on ecological aspects. This delineation process is a DWS method

Page / Section	Report statement	Comments	Changes made?	Author comment
				developed by specialists in DWS and others and have been followed exactly. It is possible that there has been some misunderstanding of the basis and purposes of Resource Units.
Page 17.14 / 17.7		Additional column of summary description will be significant to Table: 17.3 GRUs in the Mzimvubu catchment.	Yes	Description comment added, including relevance of wetland types to each GRU
Page 19.1 / 19.1		Identification of preliminary IUAs: An IUA table with IUA name, IUA description, quaternary catchment, RU and socio-economic zone is preferred for ease of reference.	No	A descriptive table can be found in Appendix A and is referred to in the text (pge 19-2). Note that socio-economic zones are delineated for large catchments to provide descriptions of similar use and not relevant to IUA delineation. Quaternary catchments are not shown on the table as there are many faulty delineations which may result in the border of the IUA falling in two catchments.
		List of biophysical nodes: Please include map showing locations of biophysical and allocation nodes. Note: the biophysical and allocation river nodes for the study area should be defined according to the procedures described in DWAF (2007f).	Yes	The map has been included in Appendix A. Note that the guideline procedure of selecting biophysical nodes and allocation river nodes have been superseded by improved practices as applied to recent Classification studies. It must be noted that the guideline was written based on one pilot study for a single small river catchment which does not apply to the larger areas now being used for Classification. Also, the DWS PES/EIS information were not available at the time, however, the guidelines did say that once this information is in place, it should supersede the guidelines. Therefore one is now dealing with RUs based on SQs and nodes are linked to these. Also, note that RU determination did not form part of the Classification guidelines as it is part of the Reserve process and was also included in the RQO guidelines. These links were therefore not made in the Classification guidelines.

Ms Daisy Kotsedi, Department of Environmental Affairs - 24 February 2017				
Section 18.1	In this assessment, an estuary is defined as “a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action or salinity penetration. During floods an estuary can become a river mouth with no seawater entering the formerly estuarine area, or when there is little or no fluvial input an estuary can be isolated from the sea by a sandbar and become a lagoon or lake which may become fresh or hypersaline”.	I’ve noted that the estuary definition in section 18.1 is copied verbatim from the NBA 2011 without referencing it.	Yes	Reference added.