Report no. RDM/WMA04/00/CLA/0620

DEPARTMENT: WATER AND SANITATION
CHIEF DIRECTORATE: WATER ECOSYSTEMS MANAGEMENT
DIRECTORATE: WATER RESOURCE CLASSIFICATION

DETERMINATION OF WATER RESOURCE CLASSES AND ASSOCIATED RESOURCE QUALITY OBJECTIVES IN THE THUKELA CATCHMENT

SUB-COMPONENTS PRIORITISATION AND INDICATORS SELECTION REPORT

FINAL

February 2021

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

DEPARTMENT OF WATER AND SANITATION

Chief Directorate: Water Ecosystems

DETERMINATION OF WATER RESOURCE CLASSES AND ASSOCIATED RESOURCE QUALITY OBJECTIVES IN THE THUKELA CATCHMENT

SUB-COMPONENTS PRIORITISATION AND INDICATORS SELECTION REPORT
WP 11255

Study Report No.

RDM/WMA04/00/CON/CLA/0620

February 2021

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Published by

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

Tel: (012) 336 7500/ +27 12 336 7500
Fax: (012) 336 6731/ +27 12 336 6731

This report is to be cited as:

Department of Water and Sanitation, South Africa. February 2021. Determination of Water Resource Classes and associated Resource Quality Objectives in the Thukela Catchment: Sub-components Prioritisation and Indicators Selection Report. Report No: RDM/WMA04/00/CON/CLA/0620

Prepared by:

Golder Associates Africa in association with AECOM, Prime Africa, Wetland Consulting Services, JMM Stassen, Zitholele Consulting, Dr Gavin Snow and Andre Joubert Communication Services

Title:	*Sub-components Prioritisation and Indicators Selection Report*
Authors:	*L Boyd, P Moodley, J Crafford, J Schroder, E van Wyk, R Stassen, G Snow, M Vosloo, A Joubert, G Marneweck*
Project Name:	*Determination of Water Resource Classes and associated Resource Quality Objectives in the Thukela Catchment: WP 11255*
DWS Report No:	*RDM/WMA04/00/CON/CLA/0620*
Status of Report:	*Final*
First Issue:	*November 2020*
Final Issue:	*February 2021*

Approved for the Professional Service Provider by:

…… *……*

Trevor Coleman *Date*

Project Director, Golder Associates

DEPARTMENT OF WATER AND SANITATION

Chief Directorate: Water Ecosystems

Approved for DWS by:

…… *……*

Mohlapa Sekoele *Date*

Project Manager: Water Resource Classification

…… *……*

Mkhevu Mnisi *Date*

Scientific Manager: Water Resource Classification

…… *……*

Lebogang Matlala *Date*

Director: Water Resource Classification

DOCUMENT INDEX

Reports as part of this project:

Bold type indicates this report.

REPORT INDEX	REPORT NUMBER	REPORT TITLE
1.0	RDM/WMA04/00/CON/CLA/0119	Inception Report
2.0	RDM/WMA04/00/CON/CLA/0120	Water Resources Information and Gap Analysis Report
3.0	RDM/WMA04/00/CON/CLA/0220	Specialist Workshops Report
4.0	RDM/WMA04/00/CON/CLA/0320	Status Quo and Integrated Unit of Analysis and Resource Units Report
5.0	RDM/WMA04/00/CON/CLA/0420	Linking the Socio-Economic and Ecological Value and Condition of the Water Resources
6.0	RDM/WMA04/00/CON/CLA/0520	Preliminary Resource Units Selection and Prioritisation Report
7.0	RDM/WMA04/00/CON/CLA/0620	**Sub-components Prioritisation and Indicators Selection Report**

TERMINOLOGY AND ABBREVIATIONS

Acronym	Description
CD: WE	Chief Directorate: Water Ecosystems
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Ecological Category
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Area
GRU	Groundwater Resources Unit
IUA	Integrated Unit of Analysis
KZN	KwaZulu-Natal
MPA	Marine Protected Area
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological Sate
RQOs	Resource Quality Objectives
RDM	Resource Directed Measures
RUs	Resource Units
WMA	Water Management Area
WRCS	Water Resource Classification System

EXECUTIVE SUMMARY

Water Resource Classification, the Reserve and Resource Quality Objectives (RQOs) are protection-based measures that make up Resource Directed Measures (RDM), the protection principles contained in Chapter 3 of the National Water Act (Act No. 36 of 1998) (NWA). Classification of significant water resources and determination of the Reserve are intended to ensure comprehensive protection of all water resources. An important consideration in the determination of RDM is that they should be technically sound, scientifically credible, practical, and affordable. Once the water resources class and the Reserve have been established, RQOs are established to give effect to determined water resources classes and the Reserve.

The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation (DWS) has initiated the classification of priority water resources and development of Resource Quality Objectives (RQOs) for the Thukela catchments.

As part of the Resource Quality Objectives (RQO) process the first step was to delineate the Integrated Units of Analysis (IUA) and define Resource Units (RUs). This was undertaken and reported on in the Status Quo and delineation of Integrated Units of Analysis Report, Number: RDM/WMA04/00/CON/CLA/0320. Fifteen IUAs have been defined for the Thukela catchments and seventy two (72) preliminary resource units (Figure E-1) were subsequently defined and prioritised and reported on in the Preliminary Resource Units Selection and Prioritisation Report, Number: RDM/WMA04/00/CON/CLA/0520. The next step of the RQO determination process is to prioritise sub-components for RQO determination and select indicators for monitoring.

The selection of components and the identification of proposed sub-components and indicators for which RQOs are set, has two key objectives; firstly to identify and prioritise sub-components including habitat, quantity, quality and biota that may be important to users or the environment; and secondly to select those sub-components and associated indicators such as flow, salinity, fish and invertebrates, for which RQOs and numerical limits should be developed.

As part of this study, RQOs for rivers, groundwater, dams, wetland resources and the Thukela estuary will be determined. While there are a wide range of sub-components and indicators for which RQOs can be set, it is not practical or necessary to set RQOs for all sub-components in a resource unit. A rationalisation process is therefore required to evaluate and prioritise the sub-components for RQO determination.

This report presents the final prioritised resource units (Figure E-2) for the water resources in the Upper Thukela, Mooi/ Sundays, Buffalo and Lower Thukela Sub-catchments of the Thukela catchment. It also details the list of sub-components prioritised and indicators selected for water resource components in the Thukela catchment. This prioritisation will form the basis for development of RQOs and numerical limits.

Resource Units 3.1, 3.2, 6.1, 6.2, 6.3, 9.1, 10.1, 10.4, 10.9, 10.11 and 10.12 have been prioritised for groundwater Resource Quality Objectives.

The resource units that have been prioritised for wetland specific sub-components are Resource Units 1.1 and marginally into 1.2, 3.1 and marginally into 3.5, 5.1 and marginally into 5.2, 6.2, 7.2, 7.3 marginally into 7.1, 8.1, 9.3, 14.7 and 14.8.

Sub-components that may be important to either the users or the environment have been prioritised. This step also requires consideration of the impacts of land-based activities on the water resource.

Sub-components for rivers and dams include:

- **Quantity**
  - Low Flows
  - High Flows
- **Quality**
  - Nutrients
  - Salts
  - Systems variables
  - Toxics
  - Pathogens
- **Habitat**
  - Instream habitat
  - Riparian habitat
- **Biota**
  - Fish
  - Aquatic and riparian plant species
  - Mammals
  - Birds
  - Amphibians and reptiles
  - Periphyton
  - Aquatic invertebrates
  - Diatoms

Sub-components related to wetlands include the evaluation and prioritisation of the sub-components focused primarily on the availability of data. For all prioritised wetlands the sub-components Quality, Quantity and Habitat were selected for RQO development. Biota was included as a sub-component where available species data was available to support RQO development.

The sub-components identified for groundwater RQOs include:

- Quantity (abstraction),
- Aquifer water level,
- Water quality, and
- Protection zones

For the estuary, the following sub-components and indicators have been considered.

- **Quantity**
  - Low Flows
  - High Flows (Floods)
- **Hydrodynamics**
  - Mouth Condition
  - Abiotic states
- **Quality**

  - Salinity
  - Dissolved inorganic nitrogen
  - Dissolved inorganic phosphate
  - Water clarity
  - Dissolved oxygen
  - Toxic substances
  - Pathogens
- **Physical Habitat**
  - Intertidal
  - Subtidal
  - Substrate type
- **Biota**
  - Microalgae
  - Macrophytes
  - Invertebrates
  - Fish
  - Birds

In terms of the various components and considerations assessed for Resource Units' delineation and prioritisation, and based on the understanding and expert knowledge of the Thukela and tributary catchments, and the results of the preliminary delineation and prioritisation, the following are relevant for the setting of RQOs:

- Overall, of the seventy five (75) RUs delineated, fifty-four (54) RUs have been prioritised,
- Six dam RUs have been delineated and prioritised,
- Groundwater priority RU areas were identified with areas of high stress index and aquifers of strategic importance identified in IUA 2, IUA 3, IUA 5, IUA 7, IUA 8, IUA 10, and IUA 11,
- Twelve wetland clusters have been prioritised in the catchment area, and
- The Estuary comprises two RUs, both prioritised.

The evaluation of the resource unit's prioritisation has been done in collaboration with catchment managers, and specialists. It will be finalised following PMC and PSC review.

RQOs for the prioritised and selected rivers, dams and groundwater RUs, wetland clusters and the estuary will then be determined for the sub-components and indicators selected.

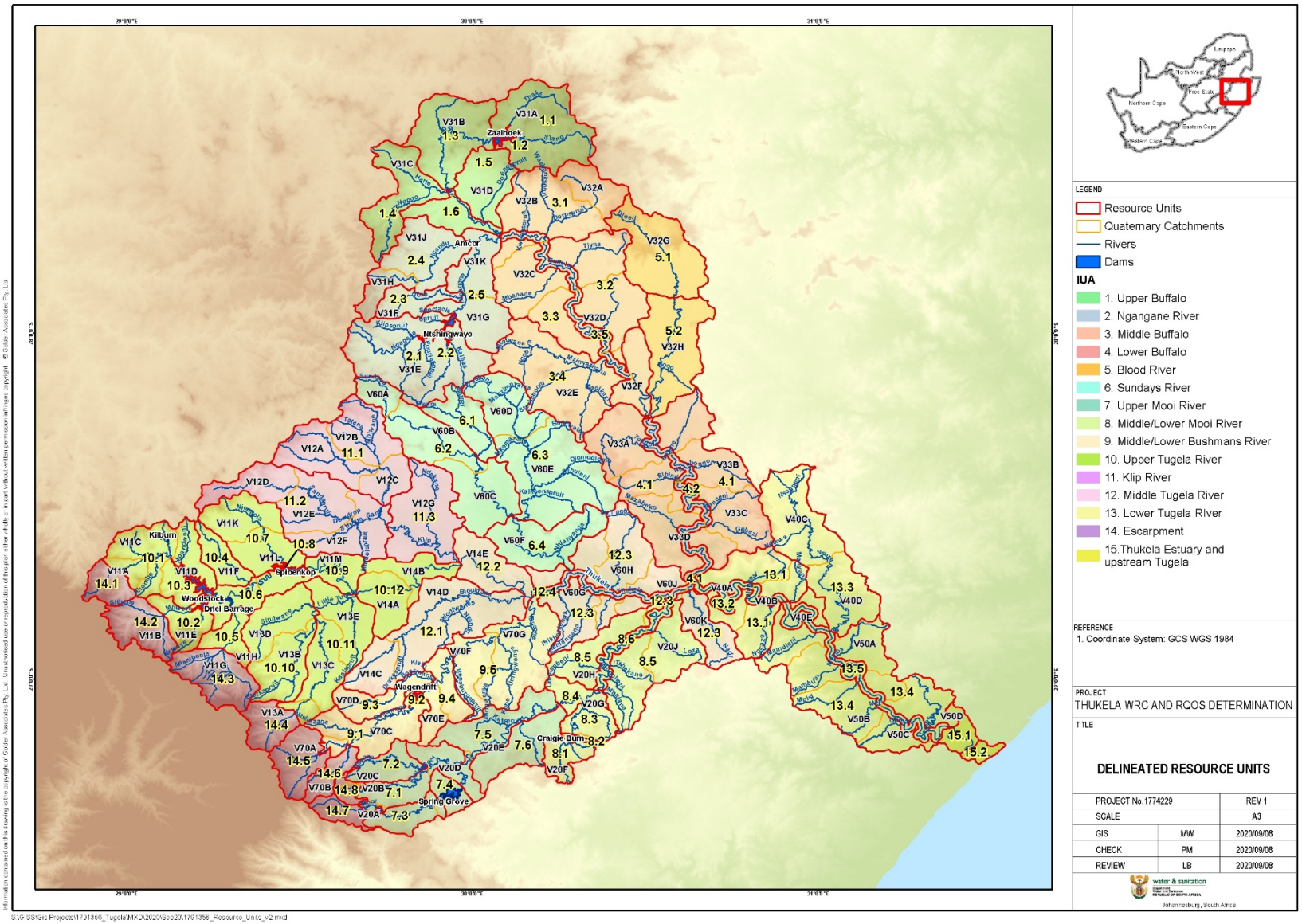

Figure E-1: Delineated Resource Units

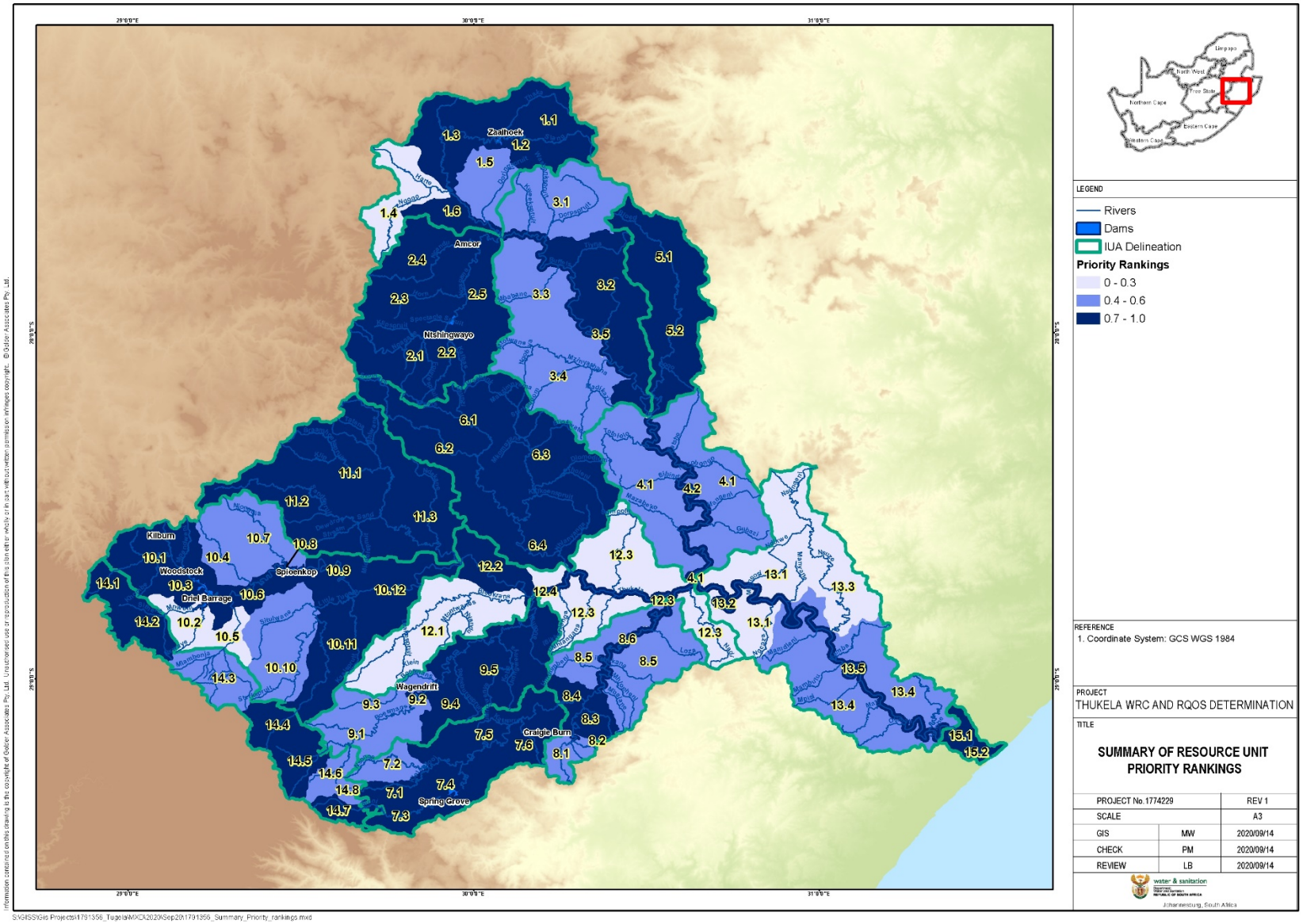

Figure E-2: Prioritisation of Resource Units (RUs rated 0.5 to 1.0 have been prioritised for RQO development)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

1.1 Background

The Chief Directorate: Water Ecosystems has initiated a study for the determination of Water Resource Classes and associated Resource Quality Objectives in the Thukela Catchment.

Water Resource Classification, the Reserve and Resource Quality Objectives (RQOs) are protection-based measures that make up Resource Directed Measures (RDM), the protection principles contained in Chapter 3 of the National Water Act (Act No. 36 of 1998) (NWA). Classification of significant water resources and determination of the Reserve are intended to ensure comprehensive protection of all water resources. An important consideration in the determination of RDM is that they should be technically sound, scientifically credible, practical, and affordable. Once the water resources class and the Reserve have been established, RQOs are established to give effect to determined water resources classes and the Reserve.

Resource quality objectives have to be determined for a significant water resource as the means to ensure a desired level of protection. The purpose of the RQOs is to provide limits or boundaries (such as biological, physical and chemical attributes) which should be met in the receiving water resource in order to ensure protection.

In determining the RQOs, it is important to recognise that different water resources will require different levels of protection. In addition to achieving the water resource class, the RQOs determined will ensure that the needs of all users and competing interests who rely on the water resources are considered.

The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation (DWS) has initiated the classification of priority water resources and development of Resource Quality Objectives (RQOs) for the Thukela catchments. With the water resources in these catchment areas being classified as part of the integrated process, RQOs will be determined as the next step of the protection framework.

In terms of the National Water Act, the RQOs are based on the water resource class and may relate to the following:

- the Reserve,
- the in-stream flow,
- the water level,
- presence and concentration of particular substances in the water,
- the characteristics and quality of the water resource,
- the in-stream and riparian habitat quality,
- characteristics and distribution of aquatic biota,
- the regulation or prohibition of in-stream or land-based activities which may affect the quantity

of water in or quality of the water resource, and

- any other characteristic of the water resource in question.

RQOs encompass four components of the resource:

- Water quantity,
- Water quality,
- Habitat integrity, and
- Biotic characteristics.

RQOs are important management objectives against which resource monitoring will be assessed. Compliance monitoring will provide an indication as to whether the water resource class is being maintained and will form important sustainability indicators for integrated water resource management.

1.2 Study Objective

The main objective of the study is to determine appropriate water resource classes and Resource Quality Objectives (RQOs) for all significant water resources in the Thukela River catchment area that would facilitate sustainable use of the water resources while maintaining ecological integrity, specifically maintain or improving the present ecological state of the water resources.

The key aims of this study are therefore to co-ordinate the implementation of the Water Resource Classification System (WRCS) published as Regulation 810 in September 2010 for determination of water resource classes and associated RQOs in the Thukela catchment. The study is linked to the preliminary Reserve determination Studies and other water resource management initiatives. Where the preliminary Reserve is available and relevant, the information will be adopted and where needed, within the ambit of this study, gaps will be filled.

The water resource classes and associated RQOs will assist the Department in ensuring that water resources within Thukela catchment are protected to achieve equitable share in a sustainable manner. In determining classes and associated RQOs, socio-economic factors and ecological goals will be considered by evaluating the magnitude of impacts in the present as well as proposed future developments. The water resource classes and associated RQOs will also assist the Department in the authorisation of future water uses, operation and management of the system and the evaluation of the magnitude of the impacts of the present and proposed developments, as well as ensure the economic, social and ecological goals are attained.

It is recognised that the successful Determination of the water resource classes and RQOs will depend on the integration of a number of disciplines in respect of water resources with the water uses and the needs of the water users present in the catchment area, through consultative processes. Specialist technical assessment and stakeholder engagement are key components to the process.

1.3 Prioritisation of Sub-components and Selection of Indicators task

As part of the Resource Quality Objectives (RQO) process the first step was to delineate the Integrated Units of Analysis (IUA) and define Resource Units (RUs). This was undertaken and reported on in the *Status Quo and delineation of Integrated Units of Analysis Report*, Number: RDM/WMA04/00/CON/CLA/0320. Fifteen IUAs have been defined for the Thukela catchments. Preliminary resource units were subsequently defined and prioritised and reported on in the *Preliminary Resource Units Selection and Prioritisation Report,* Number: RDM/WMA04/00/CON/CLA/0520. Both of these reports were submitted for review and have been finalised. The next step of the RQO determination process is to prioritise sub-components for RQO determination and select indicators for monitoring.

The selection of components and the identification of proposed sub-components and indicators for which RQOs are set, has two key objectives; firstly to identify and prioritise sub-components including habitat, quantity, quality and biota that may be important to users or the environment; and secondly to select those sub-components and associated indicators such as flow, salinity, fish and invertebrates, for which RQOs and numerical limits should be developed.

As part of this study, RQOs for rivers, groundwater, dams, wetland resources and the Thukela estuary will be determined. While there are a wide range of sub-components and indicators for which RQOs can be set, it is not practical or necessary to set RQOs for all sub-components in a resource unit. A rationalisation process is therefore required to evaluate and prioritise the sub-components for RQO determination.

1.4 Study Area

The study area is the catchment of the Thukela River, predominantly in the KwaZulu-Natal Province, except for a narrow strip in the extreme north which falls in Mpumalanga Province. It is the largest river system within the Pongola to Mtamvuma Water Management Area (WMA 4). To enable improved representation of the water resources situation in the catchment and to facilitate the applicability and better use of information for strategic management and planning purposes, the catchment was divided into four sub-areas, based on practical considerations such as size and location of sub-catchments, homogeneity of natural characteristics, location of pertinent water infrastructure such as dams, and economic development (Table 1 and Figure 1).

Table 1: Sub-catchment areas of the Thukela catchment (DWS, 2004)

Sub-catchment	Description	Tertiary drainage regions	Catchment area (1) (km^2)
Upper Thukela	The catchment of the Thukela River to just upstream of the confluence of the Bushmans River	V11, V12, V13 and V14	7 645
Mooi/Sundays	The catchment of the Mooi, Bushmans and Sundays River as well as of smaller tributaries, down to the confluence of the Buffalo River with the Thukela River.	V20, V60, V70	8 496

Sub-catchment	Description	Tertiary drainage regions	Catchment area [(1)] (km^2)
Buffalo	The catchment of the Buffalo River	V31, V32 and V33	9 803
Lower Thukela	The catchment of the Thukela River between the confluence of the Buffalo River and the Indian ocean	V40 and V50	3 102

[1]WR2012 data

The Thukela catchment drains an area of 29 040 km^2, rising on the escarpment of the Drakensberg and flowing approximately 512 km through the eastern slopes, the midlands, and discharging to the Indian Ocean. The two main drainage systems are the Upper Thukela and Buffalo rivers. This is attributed to the great Thukela Fault which runs in an east-west direction through the catchment as far as Colenso.

The topography of the Thukela River Catchment varies dramatically, ranging from steep areas to gentle slopes. The main topographic feature in the catchment is the Drakensberg Mountain Range in the west, which also demarcates the continental divide between the rivers flowing eastward to the Indian Ocean, notably the Thukela River, and the Orange/ Vaal River basin with its outflow to the Atlantic Ocean. The climate is strongly influenced by the topography and ranges from cool in the mountains to subtropical at the coast. Mean annual rainfall is in the range of 600 mm to approximately 1 500 mm, with most of the runoff originating in the vicinity of the escarpment and in the upper reaches of tributaries, where waterfalls are a significant feature.

The main river rises above Bergville. Major tributaries flowing into the Thukela River from the north include:

- The Klip River, which passes through Ladysmith,
- The Sundays River, and
- The Buffalo River, which rises above Newcastle.

Major tributaries into the Thukela River from the south include:

- The Little Thukela River,
- The Bloukrans River,
- The Bushmans River, passing through Estcourt, and
- The Mooi River.

1.5 Purpose of this Report

This report presents the final prioritised resource units for the water resources in the Upper Thukela, Mooi/ Sundays, Buffalo and Lower Thukela Sub-catchments of the Thukela catchment. It also details the list of sub-components prioritised and indicators selected for water resource components in the Thukela catchment. This prioritisation will form the basis for development of RQOs and numerical limits.

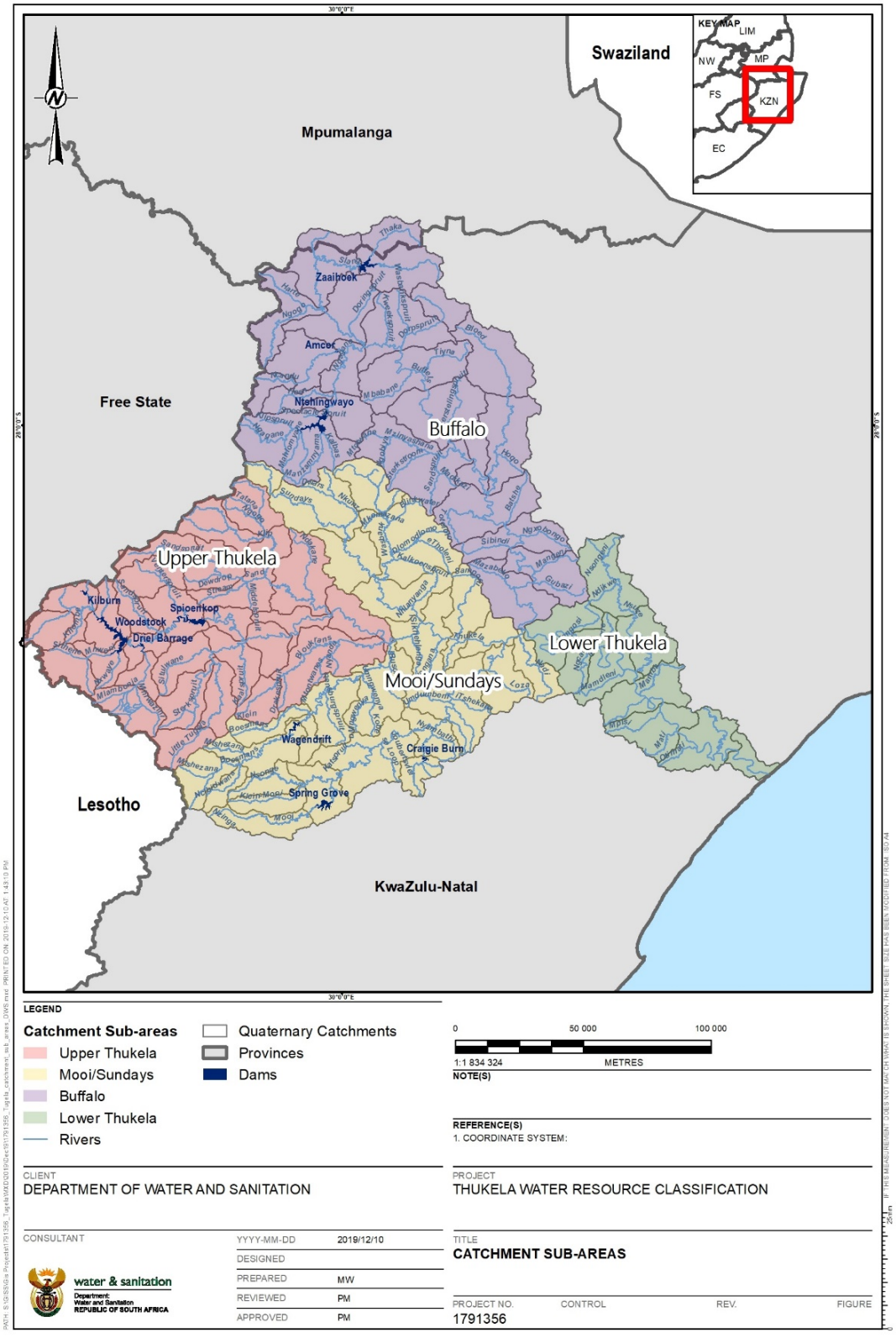

Figure 1: Thukela catchment sub-areas

2 INTEGRATED UNITS OF ANALYSIS

As part of the classification process the IUAs for the catchment were delineated and the EWR sites and river nodes were specified. These outputs from the classification process form the basis for the RQO determination process, and primarily for the RU definition. Fifteen (15) IUAs were delineated and are detailed in Study Report: RDM/WMA04/00/CON/CLA/0320. These IUAs were presented to the Project Steering Committee members and comments were received and IUAs updated accordingly. The IUAs are set out in Table 2 and shown in Figure 2. The IUAs formed the boundaries for RU delineation.

Table 2: IUA delineation for Thukela Catchment

IUA	Delineation	Quaternary Catchment
1	Upper Buffalo	V31A; V31B; V31C and V31D
2	Ngagane River	V31E; V31F; V31G; V31H; V31J; V31K
3	Middle Buffalo	V32A; V32B; V32C; V32D; V32E; V32F;
4	Lower Buffalo	V33A; V33B; V33C; V33D
5	Blood River	V32G; V32H
6	Sundays River	V60A; V60B; V60C; V60D; V60E; V60F
7	Upper Mooi River	V20A (lower portion); V20B (lower portion); V20C; V20D; V20E
8	Middle/Lower Mooi River	V20F; V20G; V20H; V20J
9	Middle/Lower Bushmans River	V70A (lower portion) V70C; V70D; V70E; V70F; V70G
10	Upper Thukela River	V11A (lower portion), V11C; V11D; V11E; V11F; V11H; V11J; V11K; V11L; V11M; 13A (lower reaches) V13B; V13C; V13D; V13E; V14A; V14B
11	Klip River	V12A; V12B; V12C; V12D; V12E; V12F; V12G
12	Middle Thukela River	V14C; V14D; V14E; V60G; V60H; V60J; V60K
13	Lower Thukela River	V40A; V40B; V40C; V40D; V40E; V50A; V50B; V50C; V50D (upper portion)
14	Escarpment	V20A (upper reaches); V20B (upper reaches); V70A (upper reaches); V70B; V13A (upper reaches); V11G; V11B; V11A (upper reaches)
15	Thukela Estuary and upstream Thukela reach	V50D

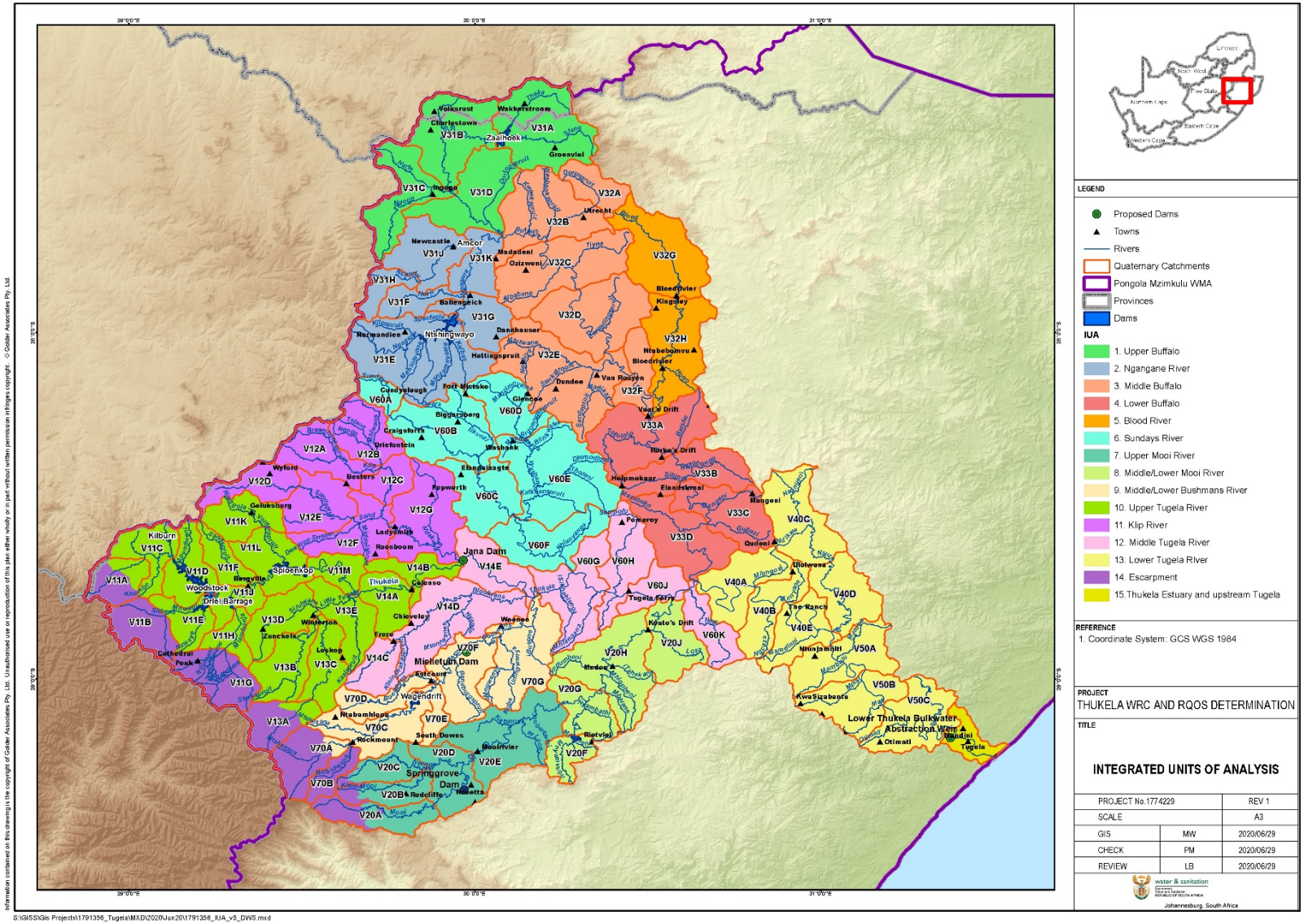

Figure 2: Integrated Units of Analysis

3 RESOURCE UNITS

Delineation and prioritisation of RUs is required as it would not be appropriate to set the same RQOs for all water resources in a catchment. The RUs are aligned to the IUA boundaries to prevent overlap between two IUAs. Based on a range of characteristics and considerations detailed in the report: *Preliminary Resource Units Selection and Prioritisation Report,* Number: RDM/WMA04/00/CON/CLA/0520, 75 RUs have been delineated in the Thukela catchments. The RUs are listed in Table 3 and are listed and described in Figure 3.

Table 3: Description of Resource Units in the Thukela catchments

IUA 1: Upper Buffalo River		
RU	***Delineation***	***Catchment/s***
1.1	Wetland resource unit: Wakkerstroom	V31A
1.2	Zaaihoek Dam	V31A
1.3	Buffalo and Slang	V31B
1.4	Ngogo and Harte to confluence with Buffalo	V31C
1.5	Doringspruit catchment	V31D
1.6	Buffalo to confluence to Ngagane	V31C, D
IUA 2: Ngagane River		
RU	***Delineation***	***Catchment/s***
2.1	Upper Ngagane to Ntshingwayo Dam	V31E
2.2	Ntshingwayo Dam	V31E
2.3	Horn to confluence with Ngagane	V31F
2.4	Ncandu to confluence with Ngagane	V31H, J
2.5	Ngagane from Ntshingwayo Dam to confluence with Buffalo	V31G, K
IUA 3: Middle Buffalo River		
RU	***Delineation***	***Catchment/s***
3.1	Dorps (including Kweek and Wasbankspruit) to confluence with Buffalo	V32A, B
3.2	Tiyna, Eersteling	V32C, D
3.3	Mbabane	V32C
3.4	Mzinyashana including Sterkstroom and Sandspruit	V32 E
3.5	Buffalo from Ngagane to Blood River confluence	V32B, C, D, E, F
IUA: 4: Lower Buffalo River		
RU	***Delineation***	***Catchment/s***
4.1	Totololo, Batshe, Sibindi, Ngxobongo, Mangeni, Gubazi, Mazabeko catchments	V33A, B, C, D
4.2	Buffalo from Blood to Thukela confluence	V33A, B, C, D
IUA 5: Blood River		
RU	***Delineation***	***Catchment/s***
5.1	Wetland RU: Blood River	V32G
5.2	Blood River from outlet of V32G to confluence with the Buffalo River	V32H
IUA 6: Sundays River		
RU	***Delineation***	***Catchment/s***
6.1	Nkunzi to confluence with Sundays	V60B
6.2	Sundays from source to confluence with Wasbank	V60A, B, C
6.3	Wasbank to confluence with Sundays	V60D, E
6.4	Sundays from Wasbank to Thukela confluence, including Nhlanyanga	V60F
IUA 7: Upper Mooi River		
RU	***Delineation***	***Catchment/s***
7.1	Klein - Mooi from source to Mooi confluence	V20B (lower portion), D
7.2	Nsonge tributary catchment	V20C

7.3	Mooi upstream of Spring Grove Dam	V20A (lower portion), D (upper)
7.4	Spring Grove Dam	V20D
7.5	Downstream Spring Grove Dam to outlet of V20E	V20D (lower) and E
7.6	Joubertsvlei to confluence with Mooi	V20E
IUA 8: Middle/ Lower Mooi River		
RU	***Delineation***	***Catchment/s***
8.1	Mnyamvubu upstream Craigieburn Dam	V20F
8.2	Craigieburn Dam	V20F
8.3	Mnyamvubu downstream dam to confluence with Mooi	V20G
8.4	Mooi to Mnyamvubu confluence	V20G
8.5	Mbalane, Mhlopeni, Tshekana, Tshekana, Umdumbeni, Loza catchments	V20H, J
8.6	Mooi from Mnyamvubu to Thukela confluence	V20H, J
IUA 9: Middle/ Lower Bushmans River		
RU	***Delineation***	***Catchment/s***
9.1	Mtshezana, Boesmans, Ncibidwana tributary catchments up to Wagendrift Dam	V70A (lower portion), B, C
9.2	Wagendrift Dam	V70C
9.3	Little Bushmans to confluence with Bushmans	V70D
9.4	Bushmans from Wagendrift Dam to confluence with Rensburgspruit downstream of Estcourt	V70E, F, G
9.5	Bushmans from Rensburgspruit Dam to confluence with Thukela	V70F, G
IUA 10: Upper Thukela River		
RU	***Delineation***	***Catchment/s***
10.1	Thukela, Putterill, Majaneni, Khombe tributary catchments	V11A (lower portion), C, D
10.2	Mweni tributary catchment	V11E
10.3	Woodstock Dam	V11D, E
10.4	Sandspruit tributary catchment	V11F
10.5	Mlambonja and tributaries	V11H
10.6	Tugela between Driel and Spioenkop Dam	V11J, L
10.7	Njongola, Venterspruit tributary catchments	V11K, L
10.8	Spioenkop Dam	V11L
10.9	Spioenkop Dam to Little Thukela confluence	V11M
10.10	Sterkspruit, Situlwane tributary catchment	V13B, D
10.11	Little Tugela from IUA14 outlet to confluence with Thukela River	V13A (lower portion), C, E
10.12	Tugela from Little Tugela confluence to proposed Jana Dam/ Klip confluence	V14A, B
IUA 11: Klip River		
RU	***Delineation***	***Catchment/s***
11.1	Sandspruit and triburtaries	V12D, E and F
11.2	Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments	V12A, B, C,
11.3	Klip from Ladysmith to confluence with Thukela	V12G
IUA 12: Middle Thukela River		
RU	***Delineation***	***Catchment/s***
12.1	Bloukrans, Drake, Mtontwanes, Nyandu tributary catchments	V14C, D
12.2	Thukela From Klip confluence to Bushmans confluence	V14E
12.3	Sikhehlenga, Sampofu, Nadi tributary catchments	V60G, H, K
12.4	Thukela from Bushmans confluence to d/s Mooi confluence	V60G, H, J, K
IUA 13: Lower Thukela River		
RU	***Delineation***	***Catchment/s***
13.1	Mfongosi, Ngcaza, Manyane tributary catchments	V40A, B
13.2	Thukela from d/s Mooi confluence to Middeldrift transfer	V40A, B

13.3	Nsuze from source to confluence with Thukela	V40C, D
13.4	Mamba, Mambulu, Mpisi, Mati, Nembe, Otimati, Mandeni tributary catchments	V50A, B, C
13.5	Thukela from Middeldrift to reach in V50D	V40E, V50A, B, C
IUA 14: Escarpment		
RU	***Delineation***	***Catchment/s***
14.1	Upper reaches of Thukela River	V11A
14.2	Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River)	V11B
14.3	Source to confluence of Mlambonja and Mhlwazini Rivers (Mlambonja River (upper); Mhlwazini River; Ndedema River; Ndumeni River; Thuthumi River)	V11G
14.4	Upper reaches of Little Thukela River	V13A
14.5	Upper reaches of Boesmans River	V70A
14.6	Ncibidwana source to outlet of V70B	V70B
14.7	Upper reaches of Mooi River	V20A
14.8	Upper reaches of Little Mooi River	V20B
IUA 15: Thukela Estuary		
RU	***Delineation***	***Catchment/s***
15.1	Thukela reach upstream Estuary to Mngeni transfer	V50D (upper portion)
15.2	Estuary (8.5 km upstream)	V50D

The rationalisation process for RU selection and prioritisation was based on the decision support tool that has been developed to guide and support the process. The 'Resource Unit Prioritisation Tool' incorporates a multi criteria decision analyses approach to assess the importance of monitoring each RU as part of management operations to identify important RUs. The criteria assessed per RU included:

- Position of RUs within an IUA,
- Importance of the RU to users,
- Threat posed to water resource quality for users,
- Threat posed to water resource quality for the environment,
- Ecological considerations,
- Practical constraints, and
- Management considerations.

Based on the priority ratings obtained through application of the RU prioritisation tool, inputs from specialists, and a workshop with local catchment water resource managers, fifty four (54) relevant RUs were selected and prioritised. These preliminary results were circulated for review in report: *Preliminary Resource Units Selection and Prioritisation Report,* Number: RDM/WMA04/00/CON/CLA/0520.

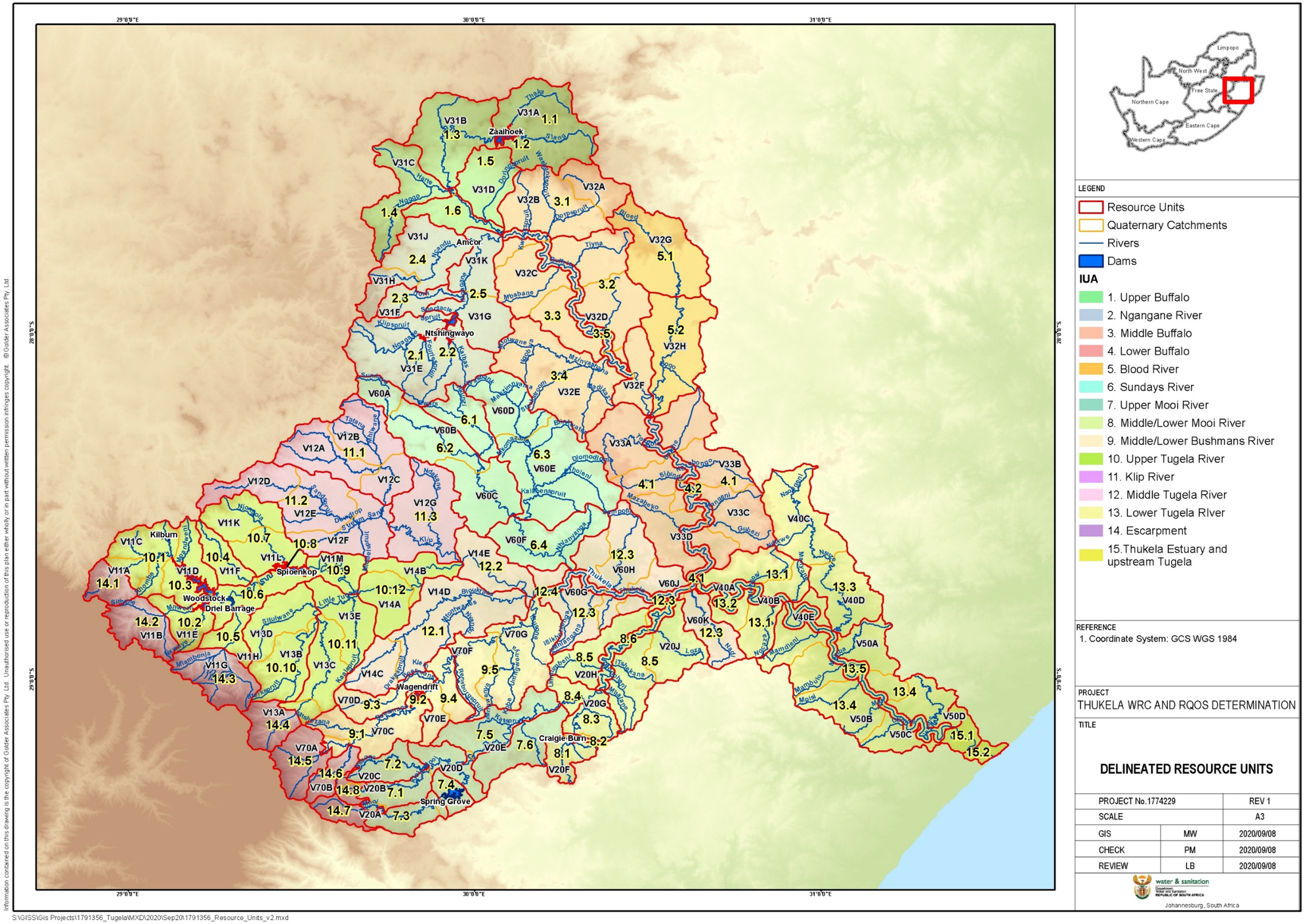

Figure 3: Delineated Resource Units

Table 4 sets out the overall results of the prioritisation rating process and are described in more detail in the *Preliminary Resource Units Selection and Prioritisation Report,* Number: RDM/WMA04/00/CON/CLA/0520. The overall prioritisation rating score per RU for the Thukela catchments are listed in Table 4 and illustrated in Figure 4. The resource units rated as high and in cases where the moderate rating was at 0.7, have been prioritised for RQO development (Figure 5).

Table 4: RU Delineation Priority based on rating score

RU Number	Resource Unit (Description)	Catchment/s
IUA 1: Upper Buffalo River		
1.1	Wetland resource unit: Wakkerstroom	V31A
1.2	Zaaihoek Dam	V31A
1.3	Buffalo and Slang	V31B
1.6	Buffalo to confluence to Ngagane	V31C, D
IUA 2: Ngagane River		
2.1	Upper Ngagane to Ntshingwayo Dam	V31E
2.2	Ntshingwayo Dam	V31E
2.3	Horn to confluence with Ngagane	V31F
2.4	Ncandu to confluence with Ngagane	V31H, J
2.5	Ngagane from Ntshingwayo Dam to confluence with Buffalo	V31G, K
IUA 3: Middle Buffalo River		
3.2	Tiyna, Eersteling	V32C, D
3.5	Buffalo from Ngagane to Blood River confluence	V32B, C, D, E, F
IUA: 4: Lower Buffalo River		
4.2	Buffalo from Blood to Thukela confluence	V33A, B, C, D
IUA 5: Blood River		
5.1	Wetland RU: Blood River	V32G
5.2	Blood River from outlet of V32G to confluence with the Buffalo River	V32H
IUA 6: Sundays River		
6.1	Nkunzi to confluence with Sundays	V60B
6.2	Sundays from source to confluence with Wasbank	V60A, B, C
6.3	Wasbank to confluence with Sundays	V60D, E
6.4	Sundays from Wasbank to Thukela confluence, including Nhlanyanga	V60F
IUA 7: Upper Mooi River		
7.1	Klein - Mooi from source to Mooi confluence	V20B (lower portion), D
7.3	Mooi upstream of Spring Grove Dam	V20A (lower portion), V20D (upper)

RU Number	Resource Unit (Description)	Catchment/s
7.4	Spring Grove Dam	V20D
7.5	Downstream Spring Grove Dam to outlet of V20E	V20D (lower) and V20E
7.6	Joubertsvlei to confluence with Mooi	V20E
IUA 8: Middle/ Lower Mooi River		
8.3	Mnyamvubu downstream dam to confluence with Mooi	V20G
8.4	Mooi to Mnyamvubu confluence	V20G
8.6	Mooi from Mnyamvubu to Thukela confluence	V20H, J
IUA 9: Middle/ Lower Bushmans River		
9.2	Wagendrift Dam	V70C
9.3	Little Bushmans to confluence with Bushmans	V70D
9.4	Bushmans from Wagendrift Dam to confluence with Rensburgspruit downstream of Estcourt	V70E, F, G
9.5	Bushmans from Rensburgspruit Dam to confluence with Thukela	V70F, G
IUA 10: Upper Thukela River		
10.1	Thukela, Putterill, Majaneni, Khombe tributary catchments	V11A (lower portion), C, D
10.3	Woodstock Dam	V11D, E
10.4	Sandspruit tributary catchment	V11F
10.6	Tugela between Driel and Spioenkop Dam	V11J, L
10.8	Spioenkop Dam	V11L
10.9	Spioenkop Dam to Little Thukela confluence	V11M
10.10	Sterkspruit, Situlwane tributary catchment	V13B, D
10.11	Little Tugela from IUA14 outlet to confluence with Thukela River	V13A (lower portion), C, E
10.12	Tugela from Little Tugela confluence to proposed Jana Dam/ Klip confluence	V14A, B
IUA 11: Klip River		
11.1	Sandspruit and tributaries	V12D, E and F
11.2	Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments	V12A, B, C,
11.3	Klip from Ladysmith to confluence with Thukela	V12G
IUA 12: Middle Thukela River		
12.2	Thukela From Klip confluence to Bushmans confluence	V14E
12.4	Thukela from Bushmans confluence to d/s Mooi confluence	V60G, H, J, K
IUA 13: Lower Thukela River		
13.2	Thukela from d/s Mooi confluence to Middeldrift transfer	V40A, B
13.5	Thukela from Middeldrift to reach in V50D	V40E, V50A, B, C
IUA 14: Escarpment		

RU Number	Resource Unit (Description)	Catchment/s
14.1	Upper reaches of Thukela River	V11A
14.2	Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River)	V11B
14.4	Upper reaches of Little Thukela River	V13A
14.5	Upper reaches of Boesmans River	V70A
14.7	Upper reaches of Mooi River	V20A
IUA 15: Thukela Estuary and upstream Thukela reach		
15.1	Thukela reach upstream Estuary to Mngeni transfer	V50D (upper portion)
15.2	Estuary (8.5 km upstream)	V50D

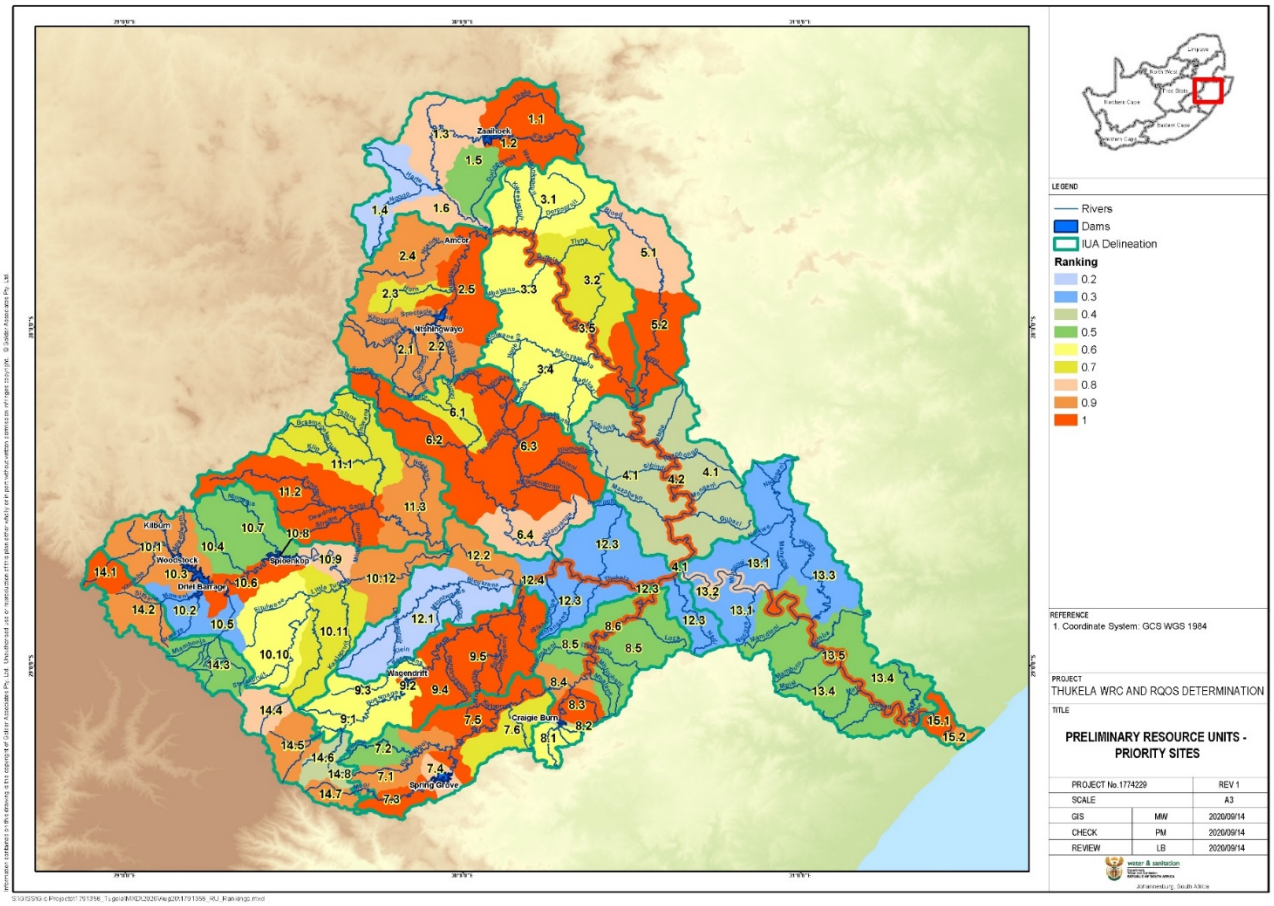

Figure 4: Prioritisation ratings of RUs based on the application of the RU Prioritisation Tool

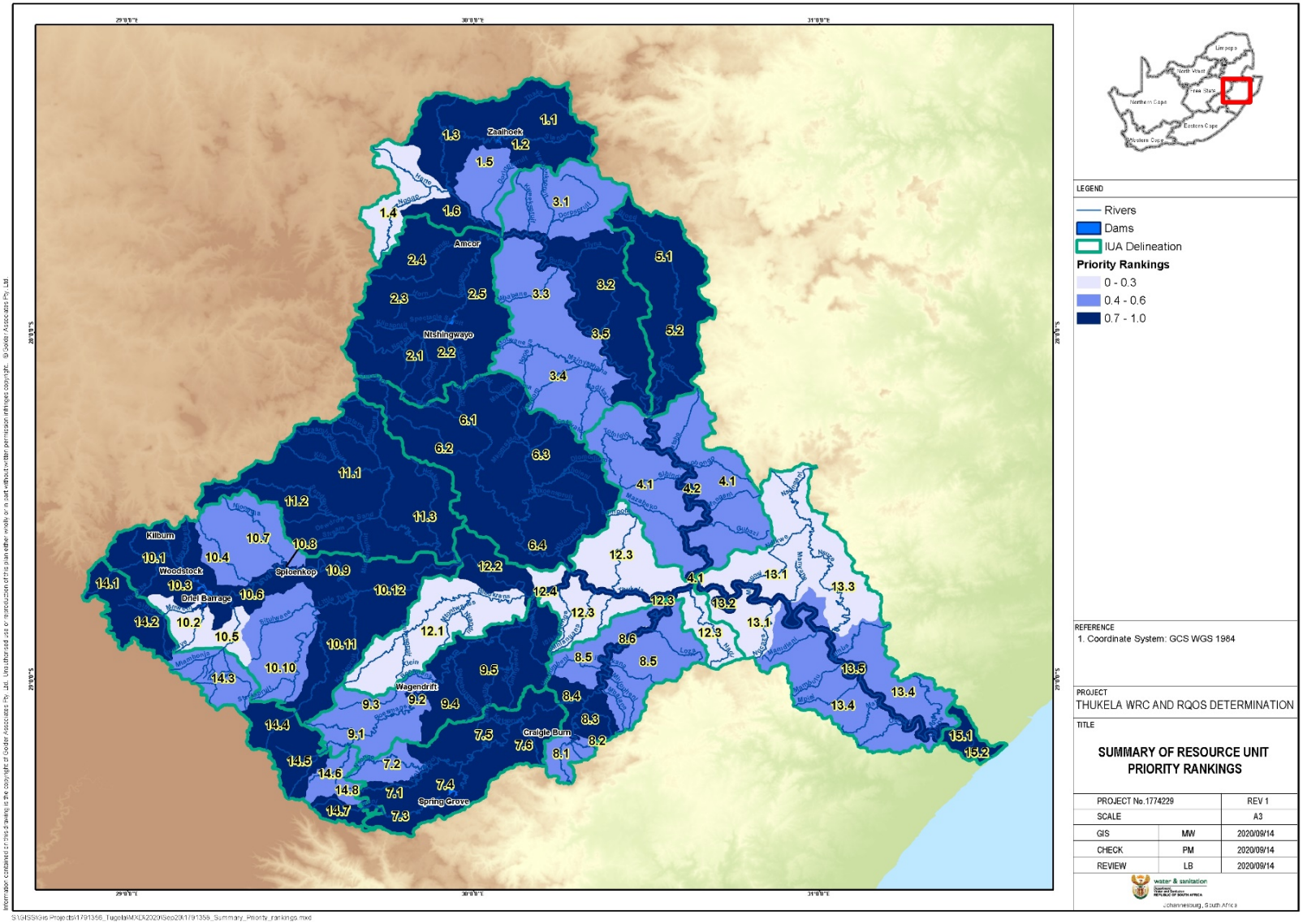

Figure 5: Summary of the Prioritisation ratings of RUs (Dark blue being of higher priority in terms of setting RQOs)

4 PRIORITY GROUNDWATER AREAS

In terms of hydrogeology, sedimentary rocks of the Karoo Supergroup occur throughout the Thukela catchment and were deposited on basement rock formations represented by competent formations of the (i) the oldest rocks in South Africa, Barberton Sequence (mostly granites) and (ii) Namaqua-Natal (Metamorphic) Province Group (various degrees of shear-zoned meta-arenaceous rocks (quartzite, gneiss, migmatite and granulite).

The Karoo Supergroup is represented from the base by the basal diamictite/ tillite, through to the upper Karoo Formations – mainly argillaceous rocks (shales, claystones, mudstone and siltstone) and arenaceous rocks (sandstone, feldsphatic sandstone and arkose) to the younger overlying extrusive volcanic rocks (basalt and andesite) of the Drakensberg Group forming the southwestern boundary highlands of the catchment. On the coastal plains, for example at the Thukela Mouth area, undifferentiated (younger) coastal and inland deposits consisting of amongst others, unconsolidated to semi-consolidated sand, calcrete, aeolianite and conglomerate, occur.

Isolated occurrences of young (quaternary) fluvial deposits (*viz.* river-alluvium primary aquifers) along major river channels are present throughout the catchment along the middle sections of the Thukela, Sundays, and Buffalo rivers and along the coastline in estuary aquifer systems.

Pre-Karoo formations have been altered significantly by shearing and associated metamorphism formed over various geological periods, thus representing isolated fractured aquifer zones. The Thukela Fault, a low gradient shear-fault system dates form the Pre-Karoo Era, but probably has been reactivated during Post-Karoo times. The central section of the Thukela River intersects this feature for several hundred kilometres (roughly from quaternary catchment V13D eastwards to quaternary catchment V40B).

The Karoo Supergroup sedimentary deposits are intruded by the younger Karoo Dolerite Suite during the initial stages of the Gondwana Land Break-Up (Jurassic Period, 190 to 135 Ma) in the form of massive dolerite sills/oblique dyke intrusions. These features play a significant role in the physical characteristics of the hydrogeological occurrences/ regimes in the catchment. Groundwater exploration focussing on the water bearing properties of dolerite dyke/sill intrusion, representing “so-called” contact-zone aquifers, indicates that these features have indeed higher yields and could be>5 L/s – although they are regarded a “local aquifer” systems, *i.e*. <50 km^2 with limited long-term sustainability if not replenished annually by rainfall recharge.

River-alluvium aquifers are present along certain sections of the main river systems in the catchment. These are unique aquifer types found in river valleys and consist mainly of un/semi-consolidated eroded/transported rock formations (boulders, gravel, sand, silt and clay). For a certain distance from the river channel, it is regarded as being hydraulically connected with the surface water resource. A “stream deflection” factor is applied as indicator and, as with the impact on wetlands, used as a resource quality objective to limit this interaction where groundwater is abstracted from these aquifer systems. The groundwater resource units are illustrated in Figure 6.

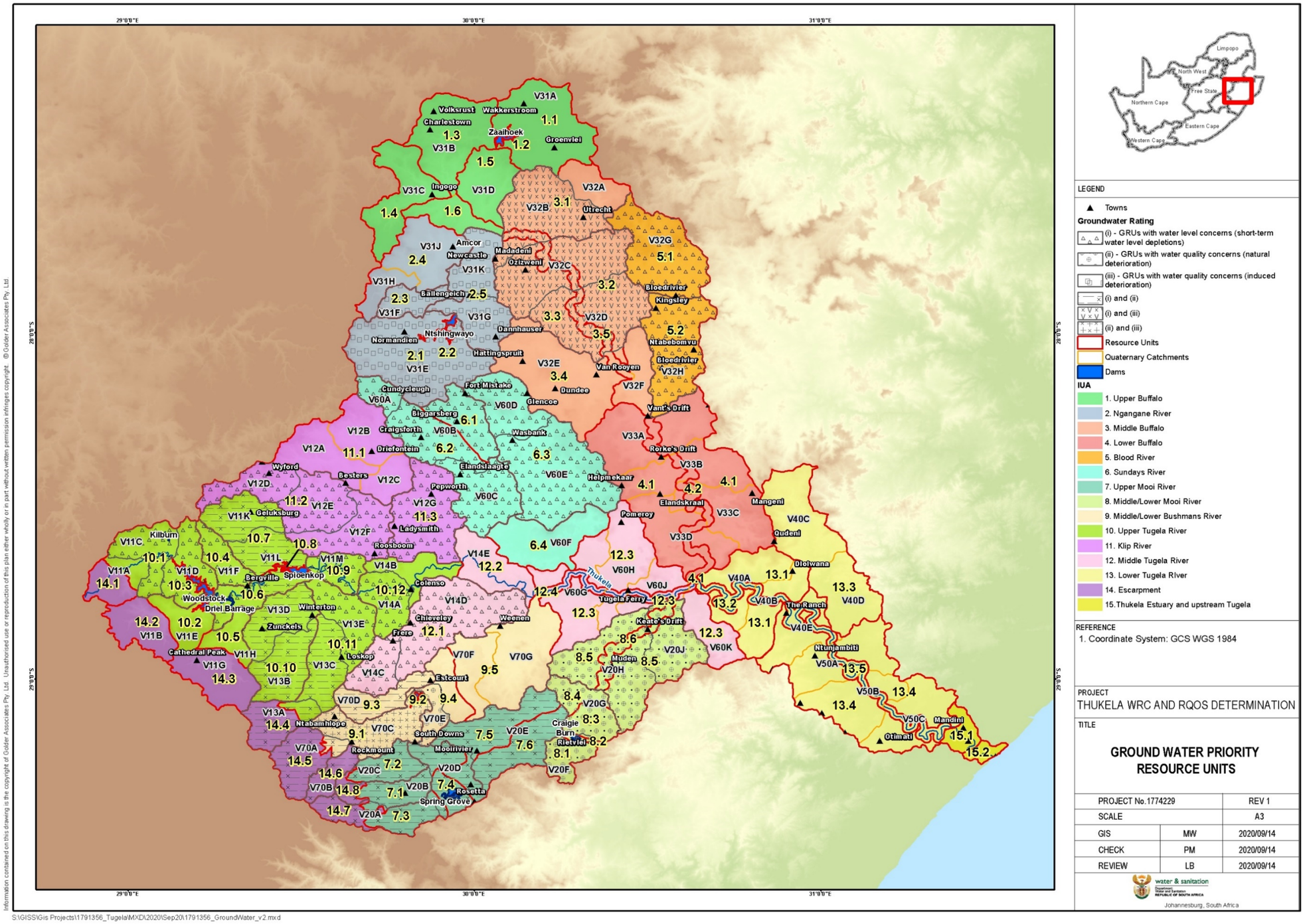

Figure 6: Groundwater Resource Units

The most critical aspects of these resources units are (i) the status of ground water use and (ii) risks to pollution of shallow aquifer system as in most cases, especially towards the Escarpment Area (IUA 14), the local water table is above 5 m below ground surface.

Five areas in the Thukela Catchment have been marked as reporting high rated impact conditions that will require clearly defined resource quality objectives for medium and long-term groundwater management protocols.

Table 5 describes the priority groundwater areas for which RQOs will be set.

Table 5: Priority Groundwater Areas in the Thukela Catchments for RQO Determination

SELECTED GROUNDWATER PRIORITY UNITS			
IUA 3	RUs 3.1 and 3.2	Dorps (including Kweek and Wasbankspruit) to confluence with Buffalo and Tiyna, Eersteling	V32B to V32D
IUA 6	RU 6.1, 6.2 and 6.3	Nkunzi to confluence with Sundays; Sundays from source to confluence with Wasbank; Wasbank to confluence with Sundays	V60A, V60B, V60C, V60D and V60E
IUA 9	RU 9.1	Mtshezana, Boesmans, Ncibidwana tributary catchments up to Wagendrift Dam	V70C
IUA 10	RU 10.1, 10.4,	Thukela, Putterill, Majaneni, Khombe tributary catchments, Sandspruit tributary catchment and Thukela between Driel and Spioenkop Dam	V11C, V11D, V11F and V11J
	RU 10.9, 10.11 and 10.12	Spioenkop Dam to proposed Jana Dam/ Klip confluence; Little Tugela from IUA14 outlet to confluence with Thukela River and Tugela from Little Tugela confluence	V11M, V13E and V14A

5 PRIORITY WETLANDS

The Thukela catchment includes a number of protected wetland systems and areas illustrated in Figure 7. Table 6 sets out the proposed priority wetlands based on National Wetland Map 5 data and will be refined based on site visit data. In all cases the wetlands have been identified as Freshwater Ecological Protection Areas (FEPAs).

Table 6: Proposed Priority Wetlands

IUA	RU	Wetland	Type	NWM5 Wetland Vegetation Group and Threat Status
1	1.1	Groenvlei	**Unchannelled Valley Bottom (51.5 %)** Seep (45.5%) Floodplain (3.0%)	Mesic Highveld Grassland Bioregion. Mesic Highveld Grassland (Valley Bottom) - CR Mesic Highveld Grassland (Seep) - CR Mesic Highveld Grassland (Floodplain) - CR
	1.1 and marginally into 1.2	Wakkerstroom	**Channelled Valley Bottom (39.0 %)** Floodplain (27.5 %) Seep (23.5 %) Unchannelled Valley Bottom (9.5 %) Depression	Mesic Highveld Grassland Bioregion. Mesic Highveld Grassland (Valley Bottom) - CR Mesic Highveld Grassland (Floodplain) - CR Mesic Highveld Grassland (Seep) - CR Mesic Highveld Grassland (Depression) - LC
3	3.1 and	Boschoffsvlei	**Channelled Valley Bottom (70.5 %)** Seep (20.5 %)	Mesic Highveld Grassland Bioregion and extends into Sub-Escarpment Grassland Bioregion.

IUA	RU	Wetland	Type	NWM5 Wetland Vegetation Group and Threat Status
	marginally into 3.5		Unchannelled Valley Bottom (6.5 %) Depression	Mesic Highveld Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Depression) - EN
5	5.1 and marginally into 5.2	Blood River Vlei	**Channelled Valley Bottom (96.0 %)** Unchannelled Valley Bottom (2.5 %) Seep (1.0 %) Depression	Mostly Mesic Highveld Grassland Bioregion, extends marginally into Sub-Escarpment Grassland Bioregion. Mesic Highveld Grassland (Valley Bottom) - CR Mesic Highveld Grassland (Seep) - CR Mesic Highveld Grassland (Depression) - LC Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Depression) - EN
	5.1 & 3.1	Upper Bloed	**Seep (76.0 %)** Channelled Valley Bottom (23.5 %) Depression (0.5 %)	Mesic Highveld Grassland Bioregion. Mesic Highveld Grassland (Valley Bottom) - CR Mesic Highveld Grassland (Seep) - CR Mesic Highveld Grassland (Depression) - LC
6	6.2	Boschbergvlei	**Depression (90.0 %)** Seep (9.5 %) Channelled Valley Bottom (0.5 %) Unchannelled Valley Bottom	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Depression) - EN
7	7.2	Hlatikulu	**Channelled Valley Bottom (88.5 %)** Unchannelled Valley Bottom (4.5 %) Seep (4.5 %) Floodplain (2.5 %)	Sub-Escarpment Grassland Bioregion and Drakensberg Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Floodplain) - CR Drakensberg Grassland (Valley Bottom) - EN
7 & 14	14.7 & 7.3 and marginally into 7.1	Stillerust	**Floodplain (53.5 %)** Channelled Valley Bottom (25.5 %) Seep (18.0 %)	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Floodplain) - CR
8	8.1	Scawby, Dartmoor, Melmoth	**Unchannelled Valley Bottom (74.0 %)** Channelled Valley Bottom (25.0 %) Seep (0.5 %) Floodplain (0.5 %)	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Floodplain) - CR
9	9.3	Ntabamhlope	**Channelled Valley Bottom (55.0 %)** Seep (38.0 %) Unchannelled Valley Bottom (6.5 %) Floodplain (0.5 %)	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Floodplain) - CR
14	14.8	Highmoor	**Channelled Valley Bottom (65.5%)** Seep (35.5%)	Drakensberg Grassland Bioregion Drakensberg Grassland (Seep) - LC Drakensberg Grassland (Valley Bottom) - EN

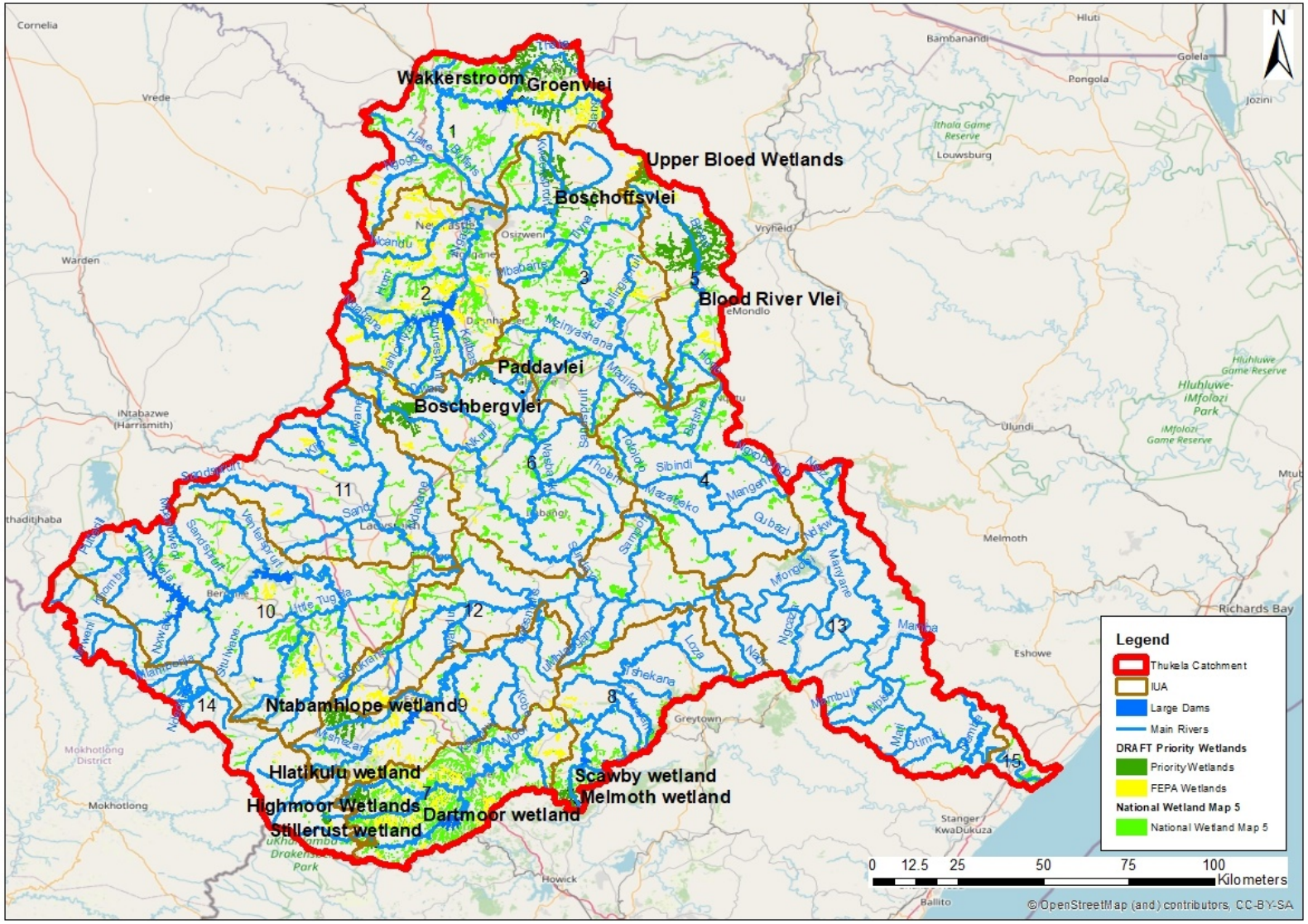

Figure 7: Map showing the distribution of RUs with prioritised wetlands

6 ESTUARY

The Thukela estuary is classified as an open river mouth (Large Fluvially Dominated) (Whitfield, 1992; van Niekerk *et al*. 2019a) and forms the downstream extent of the Thukela River in IUA 15. The estuary falls within the recently declared uThukela Marine Protected Area (MPA) that includes the adjacent marine and coastal zones outside the estuary mouth and up to a point approximately 8.5 km from the estuary mouth (Government Gazette No. 42478, 2019).

In terms of the National Biodiversity Assessment (NBA) 2018, the Thukela Estuary has been allocated an Ecosystem Threat Status of Endangered while the Ecosystem Protection Level of the estuary is poorly protected (van Niekerk *et al*. 2019a). It was estimated that the Thukela River has the second highest mean annual runoff of 3 754 x 10^6 m^3/a; 9.9% of South Africa's total runoff after the Orange/ Gariep River (van Niekerk and Turpie, 2012).

The recently completed National Biodiversity Assessment 2018 highlighted that the Thukela estuary is functioning under a High Cumulative Pressure Level. Key pressures identified include very high fishing pressure and the presence of alien fish in the system. Pollution and habitat loss were also identified as exerting a high pressure on the Thukela estuary system (van Niekerk *et al*. 2019b).

In this respect the RUs delineated for the estuary have both been prioritised for determination of RQOs.

Table 7: Estuary Resource Units prioritised for RQO determination

Resource Unit	Description	Quaternary catchment	EWR site
15.1	Thukela reach upstream Estuary to Mngeni transfer	V50D (upper portion)	Thukela_EWR 17
15.2	Estuary (8.5 km upstream)	V50D	Thukela_EWR 18

7 APPROACH TO THE PRIORITISATION OF SUB-COMPONENTS AND SELECTION OF INDICATORS

Now that the RUs have been prioritised, the next step of the RQO determination process is to prioritise sub-components for RQO determination and select indicators for monitoring. This step of the RQO procedure allows for a process of rationalisation in order to determine which RQOs should be formulated for water resources within the prioritised resource units of the Thukela catchment. In other words, sub-components that may be important to either the users or the environment are prioritised. This step also requires consideration of the impacts of land based activities on the water resource.

Sub-components include:

- Quantity
  - Low Flows
  - High Flows
- Quality
  - Nutrients
  - Salts
  - Systems variables
  - Toxics
  - Pathogens
- Habitat
  - Instream habitat
  - Riparian habitat

- Biota
    - Fish
    - Aquatic and riparian plant species
    - Mammals
    - Birds
    - Amphibians and reptiles
    - Periphyton
    - Aquatic invertebrates
    - Diatoms

The five water resource components addressed for the Thukela catchments include rivers, dams, groundwater, wetlands, and estuary components.

7.1 River and Dam Component

The process of evaluation for sub-component prioritisation and indicator selection is based on a decision support tool that was developed to guide the process. The 'Resource Unit Evaluation Tool' incorporates a decision analyses approach to assess impacting activities, user requirements and protection of the resource.

The four aspects that were assessed/evaluated per RU include:

- Identification and assessment of the impact of current and anticipated future use on water resource components,
- Identification of requirements of important user groups,
- Selection of sub-components for RQO determination, and
- Establishment of the desired direction of change for selected sub-components.

7.1.1 Resource Evaluation Tool

As described above the Resource Evaluation Tool incorporates four aspects that are assessed, to arrive at the prioritised sub-components. The aspects are described in Table 6 below.

Table 8: Aspects and sub-steps evaluated in Resource Evaluation Tool (DWA, 2011)

Aspect	Sub-step	Consideration/Evaluation
Identify and assess the impact of current and anticipated future use on water resource components: The first aspect in prioritising sub-components for RQO determination involves building an understanding of current impacts and future pressures on the RU using available data and specialist knowledge.	**Assess the importance of activities in driving resource change**	Consideration is given to current users (existing and authorised water use) and anticipated future use (within next 5 years) within and upstream of the RU being evaluated. Those activities which were considered to have a considerable impact are rated as very important users irrespective of their contribution to the economy. The economic contribution of activities was then assessed in terms of their contribution to GDP, the number of jobs that they provide and whether they are a strategic water user.
	Determine the anticipated level of impact on each sub-component	Each of the listed activities (*e.g.* irrigated agriculture, urban areas, rehabilitation, *etc*.) has the potential to impact the components and sub-components of the water resource in a variety of different ways. The purpose of this sub-step is to identify those sub-components which are threatened as a result of high levels of impact as such sub-components should be prioritised over those sub-components which are experiencing a low level of impact. The assessment was based on the scale, location, and

Aspect	Sub-step	Consideration/Evaluation
		intensity of the current and future activities in the Resource Unit and/or catchment.
	Determine the cumulative level of impact on each sub-component	The purpose of this step was to identify the cumulative effect of all of the impacting activities on each sub-component. Cumulative effects are commonly understood as the impacts which combine from different activities and which result in significant changes, which is larger than the individual impacts.
	Determine the anticipated consequences of the impacting activities on each sub-component	Once an understanding of key impacts driving current and future impacts to the RU was assessed, this was used to help inform an assessment of the anticipated consequences of impacting activities on water resource quality. This is expressed as a projected trajectory of change for each sub-component
Identify requirements of important user groups: The second aspect in prioritising sub-components for RQO determination entails identifying which groups are using the resource, classifying the importance of these groups, and determining which sub-components are important to them.	**Identify important user groups within the 'protection of the water resource' and 'water resource dependent activity' user group types**	The purpose of this sub-step is to identify water users that need to be considered when setting RQOs. The relative importance of user groups was therefore assessed.
	Rate the importance of sub-components for the 'protection of the water resource' and 'water resource dependent activities	The purpose this sub-step is to determine which sub-components are important and / or of concern to different user groups. This was determined identifying the importance of sub-components for users who were identified as important or very important. This helps to highlight sub-components of primary concern to different user groups, thus reflecting aspects of the water resource that they feel need to be closely monitored.
	Summarise the aspirations of each important user group	Opportunity is provided to summarise relevant aspirations of conservation agencies and users dependent on the water resource. In the case of conservation agencies and users dependent on the water resource, stakeholders highlighted specific components or attributes of the water resource which are of concern to them.
	Review Present State information	In this step the Present State information reviewed for each sub-component. This is used to inform the desired direction of change for users. The current trajectory of change for each component was also estimated. This is informed by the assessment of impacting activities but may be over-written based on more reliable information.
	Propose the desired direction and magnitude of change for each sub-component for important user-groups	For 'water resource dependent activities' and organisations responsible for protecting the natural environment, an assessment of the desired direction of change was undertaken to provide an indication of whether stakeholders would like a particular sub-component of the water resource to be improved or whether some level of degradation may be acceptable. Both the importance ratings for each of the sub-

Aspect	Sub-step	Consideration/Evaluation
		components and present state / fitness for use information was used to guide this assessment.
Selection of sub-components for RQO determination: The purpose of this sub-step is to select key sub-components for RQO determination and identify appropriate indicators to monitor them. This sub-step was undertaken using the 'Indicator Selection' worksheet in the Resource Unit Evaluation Tool.	**Review the Ecosystem and User Prioritisation ratings**	Two prioritisation ratings, one for the ecosystem and the other for users, are then determined. These prioritisation ratings are based on how important a sub-component is from an ecological or user perspective and whether this sub-component is threatened by anthropogenic activities occurring in the catchment. This step highlights those sub-components which are both important from an ecological and/or user perspective and which are threatened by anthropogenic activities. Such sub-components are logical choices for RQO determination.
	Select sub-components and associated indicators for RQO determination	Sub-components with high scores should be selected first. A rationale for selecting each sub-component was provided. Based on the rationale for sub-component selection, the selection of a sub-component as a 'UserSpec', 'EcoSpec' and/or 'Integrated measure' has been documented. Once the sub-components were selected, suitable indicators for each were identified. This was informed by the Ecosystem and User Prioritisation requirement and the rationale for selecting the indicator is also documented.

The evaluation of sub-components and selection of indicators was done applying the aspects and sub-steps of Resource Unit Evaluation Tool in the Thukela catchments using desktop, as well as field visit insights, local knowledge, and detailed understanding of the catchment. The overall priorities obtained through this process was used to guide the selection of sub-components for RQO determination. Once the sub-components were selected, suitable indicators for monitoring were then identified. The rankings of the evaluation provided an indication of the priority sub-components. Based on this, and expert judgement and knowledge, the priority sub-components were selected for the 53 prioritised Resource Units (rivers and dams) in the the Thukela catchments.

Review of the preliminary sub-component prioritisation and proposed indicators will be undertaken via a discussion document sent to all PMC members on the 10th November 2020, discussions with the DWS Provincial Office, and by the PSC members at the PSC meeting to be held on the 26th November 2020 and in comments received afterwards, in order to obtain agreement of the final sub-components and indicators for which RQOs should be determined.

7.2 Wetlands

Wetlands in the study area provide a range of services including flood attenuation, stream flow regulation, sediment trapping, erosion control and water quality enhancement services. Maintenance and enhancement of wetland functioning is therefore required to ensure that these key ecosystem services necessary to meet societal and environmental requirements are not undermined or lost at a catchment scale. Prioritisation of sub-components is based on no net loss' principles, conservation plans, wetland types (inferred functionality) and species

targets; as well as being related to ecological specifications (protection, management, mitigation, and monitoring).

The Wetland Evaluation Tool was used to a limited extent to prioritise sub-components. Rather the evaluation and prioritisation of the sub-components focused primarily on the availability of data. For all prioritised wetlands the sub-components Quality, Quantity and Habitat were selected for RQO development. Biota was included as a sub-component where available species data was available to support RQO development.

7.3 Groundwater

Step 4 of the RQO Process, "Prioritise Sub-Components for RQO Determination and Select Indicators for Monitoring", has not yet been developed for the groundwater component of the water resource. The following components will be assessed in identifying measurable sub-components and indicators for groundwater:

- Hydrogeological characteristics,
- Local aquifer conditions, such as interaction with wetlands and surface water sources, to specify distances between these areas and potential groundwater abstraction points (*i.e*. borehole/ well fields),
- Borehole yield classes were used to select high and low yielding aquifer systems within the demarcated groundwater units,
- Areas where high groundwater use occurs have been noted using the National Groundwater Resources Assessment Phase II information. These values were incorporated to define the potential balance between groundwater recharge and use (based on the stress factor) to obtain future groundwater level trends. The idea is to define an annual groundwater level recession value which can be used as a defined parameter for an aquifer's RQO status in terms of yield sustainability, and
- Groundwater quality.

The sub-components identified for groundwater RQOs include:

- Quantity (abstraction),
- Aquifer water level,
- Water quality, and
- Protection zones

When considering indicators only those hydrogeological indicators that can be observed and evaluated are being considered. These include:

- Water Level - depth to groundwater level,
- Time series water level monitoring (monthly),
- Abstraction - abstraction rate (Volume; Q), and
- Continuous flow measurement, where relevant.

In terms of aquifer water quality, the following are considered:

- Reference groundwater quality character and status (macro, micro, trace elements),
- Presence of suspended substances and other potential pollution already part of the natural/induced transport flow regime,
- Hydro-chemical trends and spatial coverage, and
- Natural deterioration for geological reasons.

Protection zones:

- Radius of influence

7.4 Estuary

For the estuary, the following sub-components and indicators have been considered.

- **Quantity**
  - Low Flows
  - High Flows (Floods)
- **Hydrodynamics**
  - Mouth Condition
  - Abiotic states
- **Quality**
  - Salinity
  - Dissolved inorganic nitrogen
  - Dissolved inorganic phosphate
  - Water clarity
  - Dissolved oxygen
  - Toxic substances
  - Pathogens
- **Physical Habitat**
  - Intertidal
  - Subtidal
  - Substrate type
- **Biota**
  - Microalgae
  - Macrophytes
  - Invertebrates
  - Fish
  - Birds

8 PRIORITISATION OUTCOMES

8.1 Rivers and Dams

The subcomponents prioritised and the proposed indicators for rivers and dams in each resource unit prioritised, are set out in Tables 9 – 23.

Table 9: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 1: Upper Buffalo

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
1.1 Wetland resource unit: Wakkerstroom	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B Potential Groenvlei Agri-village within the wetland areas leading to return flows and agricultural pollution. Unmanaged grazing leading to erosion. Sewage works within wetland areas discharging poor quality effluent.	Quantity, Quality, Habitat, Biota	Wetlands protection to support birdlife and assist with flood protection.
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Phosphates, Nitrate			
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI), Vegetation Response Assessment Index (VEGRAI).			
	Aquatic riparian plant species		✓		Indicator of ecological integrity.	Index of wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								

	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
1.2 Zaaihoek Dam	Low flows			✓	Dam levels will give an indication of volumes available for transfer and downstream release to meet EWR	Operating rules	Transfer to Vaal system for Majuba Power Stations and Grootdraai Dam. Reduced movement of sediment to downstream areas. Alters downstream habitat and biota. Barrier to fish migration. Unmanaged livestock causing erosion around the dam. Litter from hikers and fishermen.	Quantity, Quality, Biota	Water supply
	High flows (floods)								
	Nutrients			✓	These variables govern eutrophication in water resources, and the measurement thereof will indicate trophic status	Nitrate, Orthophosphate, Chlorophyl-a			
	Salts			✓					
	Pathogens								
	System Variables			✓	Indicator of water clarity and a measure of overall concentration of fine suspended particles (light scattering). pH is an indicator of system variability.	pH, turbidity			
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage	FRAI, Indicator species			
	Dam Habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Riparian habitat								
	Aquatic riparian plant species								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
	Mammals								
	Birds		✓		Ecological integrity	Indicator species			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates								
	Diatoms								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
1.3 Buffalo and Slang	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Irrigation, Unmanaged grazing, Poor quality discharges from Volksrust and Charlestown WWTW. Urban areas	Quantity, Quality, Habitat, Biota	Volume and quality, human health, environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Fitness for use for users.	Total Dissolved Solids			
	Pathogens	✓			Fitness for use for users.	*Escherichia coli*			
	System Variables			✓	Indicator of System variability	pH			
	Toxics		✓		Ecological importance	Ammonia			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required

1.6 Buffalo to confluence with Ngagane	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Extensive irrigation, Newcastle Industrial area: AMCOR at outlet of RU Abandoned mines, decants	Quantity, Quality, Habitat, Biota	Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids; sulphate, chloride			
	Pathogens								
	System Variables			✓	These variables will give a fitness for use for users.	pH, EC, Alkalinity			
	Toxics			✓	These variables will give a fitness for use for users.	Metals			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 10: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 2: Ngagane

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
2.1 Upper Ngagane to Ntshingwayo Dam	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B and PES C Extensive irrigation upstream of Ntshingwayo Dam Unmanaged livestock grazing Abandoned mines, decants Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Good indicator of change in the system	Total Dissolved Solids			
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change	pH			
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								

	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
2.2 Ntshingwayo Dam	Low flows			✓	Dam levels will give an indication of volumes available for transfer and downstream release to meet EWR	Operating rules	Some irrigation on eastern banks of Ntshingwayo Dam Unmanaged livestock grazing Tourism Abstraction for water supply to Newcastle	Quantity, Quality, Biota	Water supply
	High flows (floods)								
	Nutrients			✓	These variables govern eutrophication in water resources, and the measurement thereof will indicate trophic status	Nitrate, Orthophosphate, Chlorophyl-a			
	Salts			✓	Good indicator of overall inorganic water chemistry and Indicator of salinisation of water bodies (simple to measure)	Electrical conductivity			
	Pathogens								
	System Variables			✓	Indicator of water clarity and a measure of overall concentration of fine suspended particles (light scattering). pH is an indicator of system variability.	pH, turbidity			
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage	FRAI, Indicator species			
	Dam Habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Riparian habitat								
	Aquatic riparian plant species								

	Mammals								
	Birds		✓		Ecological integrity, specifically for the wetland areas	Indicator species			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates								
	Diatoms								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
2.3 Horn to confluence with Ngagane	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES E Extensive irrigation Afforestation Unmanaged livestock grazing Coal mines, decants Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids; sulphate, chloride			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics	✓			These variables will give a fitness for use for users.	Metals, pesticides, ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
2.4 Ncandu to confluence with Ngagane	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES D Extensive irrigation, agriculture Unmanaged livestock grazing	Quantity, Quality, Habitat, Biota	Water supply, Volume and quality, human
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids; sulphate, chloride	Coal mines, decants Industry Urban (Newcastle)		and environ-mental health
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics	✓			These variables will give a fitness for use for users.	Metals, pesticides, hydrocarbons			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM)			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
2.5 Ngagane from Ntshingwayo Dam to confluence with Buffalo	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Agriculture; Unmanaged livestock grazing Coal mine decants Industry; Chivelston Power Station Urban (Madadeni)	Quantity, Quality, Habitat, Biota	Human and environ-mental health
	High flows (floods)								
	Nutrients								
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics	✓			These variables will give a fitness for use for users.	Metals, pesticides, hydrocarbons			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream								
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 11: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 3: Middle Buffalo River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
3.2 Tiyna, Eersteling	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C/ PES B (Eerstelings) Extensive subsistence agriculture (Unmanaged livestock grazing and considerable erosion) Irrigation Abandoned mines, decants Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Good indicator of change in the system	Total Dissolved Solids, sulphate			
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change	pH, turbidity			
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			

	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
3.5 Buffalo from Ngagane to Blood River confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B Subsistence agriculture and extensive unmanaged livestock grazing Abandoned mines decanting along the river Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Good indicator of change in the system	Total Dissolved Solids			
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change	pH			

	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 12: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 4: Lower Buffalo River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
4.2 Buffalo from Blood to Thukela confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C to a D at the outlet Extensive subsistence agriculture; erosion from unmanaged livestock grazing	Quantity, Quality, Habitat, Biota	Volume and quality, human and
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			

	Salts	✓			Good indicator of change in the system	Total Dissolved Solids	Tourism		environ-mental health
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change; clarity	pH, turbidity			
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 13: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 5: Blood River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
5.1 Wetland RU: Blood River	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Unmanaged grazing leading to erosion. Large rural villages Domestic WWTW (oxidation ponds) Extensive subsistence agriculture Extensive livestock production Formal irrigation Tourism	Quantity, Quality, Habitat, Biota	Wetlands protection to support birdlife and assist with flood protection; human and ecological health.
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Phosphates, Nitrate			
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids			
	Pathogens								
	System Variables								
	Toxics			✓	Need to assess the impacts from pesticide/ herbicides in cultivation and veterinary products use in extensive livestock production.	Organic indicators			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI), Vegetation Response Assessment Index (VEGRAI).			
	Aquatic riparian plant species		✓		Indicator of ecological integrity.	Index of wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								

	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
5.2 Blood River from outlet of V32G to confluence with the Buffalo River	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Large rural villages Domestic WWTW (oxidation ponds) Extensive unmanaged livestock grazing Subsistence agriculture Limited formal irrigation Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Good indicator of change in the system	Total Dissolved Solids			
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change	pH			
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								

	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 14: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 6: Sundays River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
6.1 Nkunzi to confluence with Sundays	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Agricultural activities with some irrigation Unmanaged livestock grazing Abandoned mines, decants Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Good indicator of change in the system	Total Dissolved Solids			
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change; clarity	pH, turbidity			
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			

	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
6.2 Sundays from source to confluence with Wasbank	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Large rural villages Domestic WWTW (oxidation ponds) Extensive subsistence agriculture Unmanaged livestock grazing Some formal irrigation (Irrigation Board Dam)	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens	✓			Indicators of faecal contamination from large rural areas	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, turbidity			
	Toxics								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
6.3 Wasbank to confluence with Sundays	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C moving to a D and then to a category B Extensive rural villages in lower parts of the RU with subsistence agriculture Domestic WWTW (oxidation ponds) Unmanaged livestock grazing Abandoned mines, decants	Quantity, Quality, Habitat, Biota	Water supply, Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			These variables will give a fitness for use for users	Total Dissolved Solids; sulphate, chloride			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			Early warning of changes	pH, Electrical Conductivity			
	Toxics			✓	Indicator of mine pollution through decants	Metals			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM)			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
6.4 Sundays from Wasbank to Thukela confluence, including Nhlanyanga	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B and PES C (Sundays) Small rural villages Subsistence agriculture Unmanaged livestock grazing	Quantity, Quality, Habitat, Biota	Human and environ-mental health
	High flows (floods)								
	Nutrients								
	Salts								
	Pathogens								
	System Variables	✓			Early warning to detect changes	pH, Electrical Conductivity, clarity			
	Toxics								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM)			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 15: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 7: Upper Mooi River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required

7.1 Klein - Mooi from source to Mooi confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Extensive irrigation Extensive formal agriculture with intensive feedlots (dairy) Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Good indicator of change in the system	Total Dissolved Solids			
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change	pH			
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
7.3 Mooi upstream of Spring Grove Dam	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Extensive irrigation Extensive formal agriculture Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Good indicator of change in the system	Total Dissolved Solids			
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change	pH			
	Toxics			✓	Important of assess the impacts of pesticide application and formal ariculture	Pesticides, herbicides, ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
7.4 Spring Grove Dam	Low flows			✓	Dam levels will give an indication of volumes available for transfer and downstream release to meet EWR	Operating rules	Water transfer (Mooi/ Mgeni transfer scheme to keep Midmar full and support Mgeni) Formal Irrigation	Quantity, Quality, Biota	Water supply
	High flows (floods)								
	Nutrients			✓	These variables govern eutrophication in water resources, and the measurement thereof will indicate trophic status	Nitrate, Orthophosphate, Chlorophyl-a			
	Salts			✓	Good indicator of overall inorganic water chemistry and Indicator of salinisation of water bodies (simple to measure)	Electrical conductivity			
	Pathogens								
	System Variables			✓	Indicator of water clarity and a measure of overall concentration of fine suspended particles (light scattering). pH is an indicator of system variability.	pH, turbidity			
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			

	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage	FRAI, Indicator species			
	Dam Habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds		✓		Ecological integrity, specifically for the wetland areas	Indicator species			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates								
	Diatoms								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
7.5 Downstream Spring Grove Dam to outlet of V20E	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Extensive formal agriculture and irrigation Afforestation Urban - Town of Mooi River Poor quality discharge from WWTW	Quantity, Quality, Habitat, Biota	Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides	Tourism		
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
7.6 Joubertsvlei to confluence with Mooi	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES E Afforestation Extensive irrigation Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and environ-mental health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			These variables will give a fitness for use for users and be an early warning for changes	Total Dissolved Solids			
	Pathogens								
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 16: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 8: Middle/ Lower Mooi River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
8.3 Mnyamvubu downstream dam to confluence with Mooi	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C (PES B in lower reaches) Afforestation in upper reaches Tourism	Quantity, Quality, Habitat, Biota	Ecological health
	High flows (floods)								
	Nutrients								
	Salts								
	Pathogens								
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			

	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
8.4 Mooi to Mnyamvubu confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Villages with subsistence agriculture Unmanaged livestock grazing Limited irrigation in upper portion	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens								
	System Variables								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
8.6 Mooi from Mnyamvubu to Thukela confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C (except for a short reach in V20H where PES: B) Extensive villages and subsistence agriculture Extensive irrigation Extensive formal agriculture) Tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			Good indicator of change in the system	Total Dissolved Solids			
	Pathogens								
	System Variables			✓	Indication of the stability of the water to change	pH			
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of instream ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 17: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 9: Middle/ Lower Bushmans River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
9.2 Wagendrift Dam	Low flows			✓	Dam levels will give an indication of volumes available for transfer and downstream release to meet EWR	Operating rules	Water supply Irrigation Proposed hydroelectricity plant	Quantity, Quality, Habitat, Biota	Water supply,
	High flows (floods)								
	Nutrients			✓	These variables govern eutrophication in water resources, and the measurement thereof will indicate trophic status	Nitrate, Orthophosphate, Chlorophyl-a			
	Salts								
	Pathogens								
	System Variables								
	Toxics								

	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage	FRAI, Indicator species			
	Dam Habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds		✓		Ecological integrity, specifically for the wetland areas	Indicator species			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates								
	Diatoms								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
9.3 Little Bushmans to confluence with Bushmans	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Afforestation in upper reaches Extensive rural villages and subsistence agriculture WWTW (oxidation ponds) Tourism	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			

	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
9.4 Bushmans from Wagendrift Dam to confluence with	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C (lower portion in a PES B) Villages with subsistence agriculture	Quantity, Quality, Habitat, Biota	Volume and quality, human and
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Salts						Urban – Town of Estcourt Discharge of poor quality effluent from WWTW Unmanaged livestock grazing Formal agriculture and irrigation		ecological health
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics			✓	Important of assess the impacts of pesticide application, as well as ammonia from WWTW	Pesticides, herbicides, ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
9.5 Bushmans from Rensburgspruit Dam to confluence with Thukela	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C (lower portion in a PES B) Extensive villages with subsistence agriculture Unmanaged livestock grazing Urban – Town of Weenen Discharge of poor quality effluent from WWTW Formal agriculture and irrigation	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics			✓	Important of assess the impacts of pesticide application, as well as ammonia from WWTW	Pesticides, herbicides, ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 18: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 10: Upper Thukela River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
10.1 Thukela, Putterill, Majaneni, Khombe tributary catchments	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B (except for Majaneni – PES: D) Kilburn Dam Extensive rural villages and subsistence agriculture Several small WWTW (oxidation ponds) Tourism	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics			✓	Important of assess the impacts of pesticide application and ammonia from WWTW	Pesticides, herbicides, ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication	FRAI			

					of the response of the constituent species of the assemblage.				
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
10.3 Woodstock Dam	Low flows			✓	Dam levels will give an indication of volumes available for transfer and downstream release to meet EWR	Operating rules	Thukela-Vaal Transfer Scheme transferring water to the Sterkfontein dam and eventually to the Vaal system Irrigation	Quantity, Quality, Habitat, Biota	Water supply
	High flows (floods)								
	Nutrients			✓	These variables govern eutrophication in water resources, and the measurement thereof will indicate trophic status	Nitrate, Orthophosphate, Chlorophyl-a			
	Salts								
	Pathogens								
	System Variables								

	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage	FRAI, Indicator species			
	Dam Habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds		✓		Ecological integrity, specifically for the wetland areas	Indicator species			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates								
	Diatoms								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
10.4 Sandspruit tributary catchment	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Afforestation in upper reaches Extensive rural villages and subsistence agriculture Small town of Bergville	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			

	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity	Bergville WWTW discharges (poor quality) Tourism		
	Toxics			✓	Important of assess the impacts of pesticide application; ammonia from WWTW	Pesticides, herbicides, ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
10.6 Thukela between Driel and Spioenkop	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES A/B	Quantity, Quality, Habitat, Biota	Volume and quality,
	High flows (floods)								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate	Extensive formal agriculture and irrigation		human and ecological health
	Salts								
	Pathogens								
	System Variables								
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
10.8 Spioenkop Dam	Low flows			✓	Dam levels will give an indication of volumes available for transfer and downstream release to meet EWR	Operating rules	Linked to Thukela-Vaal transfer Supply to Ladysmith Tourism Prioritised wetlands	Quantity, Quality, Habitat, Biota	Water supply
	High flows (floods)								
	Nutrients			✓	These variables govern eutrophication in water resources, and the measurement thereof will indicate trophic status	Nitrate, Orthophosphate, Chlorophyl-a			
	Salts								
	Pathogens								
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage	FRAI, Indicator species			
	Dam Habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Riparian habitat								
	Aquatic riparian plant species								
	Mammals								
	Birds		✓		Ecological integrity, specifically for the wetland areas	Indicator species			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates								

	Diatoms								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
10.9 Spioenkop Dam to Little Thukela confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Villages with subsistence agriculture Unmanaged livestock grazing Formal agriculture and irrigation	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens								
	System Variables								
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
10.10 Sterkspruit, Situlwane tributary catchment	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B (upper reaches), PES: D in lower reaches (quantity) Villages with subsistence agriculture Unmanaged livestock grazing Formal agriculture and irrigation Extensive tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens								
	System Variables								
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
10.11 Little Tugela from IUA14 outlet to confluence with Thukela River	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Town of Winterton Discharges from WWTW Villages with subsistence agriculture Unmanaged livestock grazing Plantations Formal agriculture and irrigation Extensive tourism	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens								
	System Variables								
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species		✓		Important to assess status of wetland aquatic and riparian plant species	Wetland vegetation			
	Mammals								
	Birds		✓		The suitability of this catchment area of river and wetlands for aquatic bird populations must be maintained.	Indicator bird species and population.			
	Amphibians/Reptiles								
	Periphyton								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
10.12 Thukela from Little Tugela confluence to proposed Jana Dam/ Klip confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B Villages with subsistence agriculture Town of Colenso Discharge from WWTW Unmanaged livestock grazing Formal agriculture and irrigation	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens								
	System Variables								
	Toxics			✓	Important of assess the impacts of pesticide application	Pesticides, herbicides			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 19: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 11: Klip River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
11.1 Sandspruit and tributaries	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								

	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate	Extensive rural villages and subsistence agriculture Tourism		
	Salts								
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	**Sub-component**	**User specification**	**Ecological specification**	**Integrated Measure**	**Rationale**	**Indicator**	**Key impacts identified**	**Sub-component prioritised**	**Protection required**

11.2 Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES A/ B/ C Ingula pump storage Extensive rural villages and subsistence agriculture Tourism	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens								
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
11.3 Klip from Ladysmith to confluence with Thukela	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B to C Town of Ladysmith and Ezakheni Domestic wastewater treatment works Ladysmith industrial areas	Quantity, Quality, Habitat, Biota	Volume and quality, human and ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts	✓			These variables will give a fitness for use for users.	Total Dissolved Solids			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics			✓	Important of assess the impacts of WWTW and industries	Metals. ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Subcomponent prioritised	Protection required
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 20: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 12: Middle Thukela River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
12.2 Thukela From Klip confluence to Bushmans confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES A Very natural area Tourism	Quantity, Habitat, Biota	Ecological health
	High flows (floods)								
	Nutrients								
	Salts								
	Pathogens								
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			

	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
12.4 Thukela from Bushmans confluence to d/s Mooi confluence	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Town of Tugela Ferry Domestic WWTW Extensive rural villages and subsistence agriculture Unmanaged livestock grazing	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics	✓			Important to assess urban impacts where poor sanitation in place	Ammonia			

	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 21: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 13: Lower Thukela River

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
13.2 Thukela from d/s Mooi confluence to Middeldrift transfer	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Smaller villages with subsistence agriculture Unmanaged livestock	Quantity, Habitat, Biota	Water supply, Human and Ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts								

	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*	Middeldrift pump station; likely to be used for increased volumes for Richards Bay (continuous supply)		
	System Variables	✓			These variables will give a fitness for use for users.	pH, Electrical Conductivity			
	Toxics	✓			Important to assess urban impacts where poor sanitation in place	Ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
13.5 Thukela from Middeldrift to	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								

	Nutrients						Smaller rural villages and subsistence agriculture Unmanaged livestock grazing		
	Salts								
	Pathogens								
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Table 22: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 14: Escarpment

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
14.1 Upper reaches of Thukela River	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B Tourism	Quantity, Habitat, Biota	Ecological health
	High flows (floods)								
	Nutrients								
	Salts								
	Pathogens								
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the	Macroinvertebrate Response Assessment Index (MIRAI)			

					response of the constituent species of the assemblage				
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
14.2 Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River)	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B Tourism	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients								
	Salts								
	Pathogens								
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								

	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
14.4 Upper reaches of Little Thukela River	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B Tourism	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients								
	Salts								
	Pathogens								
	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			

	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
14.5 Upper reaches of Boesmans River	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES A/B Tourism	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients								
	Salts								
	Pathogens								
	System Variables								
	Toxics								

	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

Resource Unit	**Sub-component**	**User specification**	**Ecological specification**	**Integrated Measure**	**Rationale**	**Indicator**	**Key impacts identified**	**Sub-component prioritised**	**Protection required**
14.7 Upper reaches of Mooi River	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Tourism	Quantity, Quality, Habitat, Biota	Human health; Ecological health
	High flows (floods)								
	Nutrients								
	Salts								
	Pathogens								

	System Variables								
	Toxics								
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the response of the constituent species of the assemblage	Macroinvertebrate Response Assessment Index (MIRAI)			
	Diatoms			✓	Integrated indicator of pollution	SPI			

8.2 Groundwater

Selection of subcomponents for groundwater resource units was based on the measurable parameters including Quantity (Abstraction), Aquifer Water Level, Water Quality and Protection Zones (related to a localised borehole as a means of protecting the basic human needs and the ecological Reserve). A summary of the sub-components selected per groundwater resource unit and IUA is presented in Tables 9 - 12.

Table 23: Sub-components prioritisation for groundwater in IUA 3: Middle Buffalo River

IUA	Groundwater Resource Unit (QC)	RU	Sub-component	Indicator/ Measure
IUA 3: Middle Buffalo River	V32B, V32C, V32D, V32E and V32F	3.1 and 3.2	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Specification of discharges to downstream users
				Water balance estimations based on Stress Index (factor): limitation of SI value (65%)
			Quality	Nutrients - Nitrate
				Salts - Electrical Conductivity
			Protection Zone	Radius of influence (r)
				Distance from wetland (L)
				Ground stability (drawdown limit, L)

Table 24: Sub-components prioritisation for groundwater in IUA 6: Sundays River

IUA	Groundwater Resource Unit (QC)	RU	Sub-component	Indicator/ Measure
IUA 6: Sundays River	V60A, V60B, V60C, V60D and V60E	6.1, 6.2 and 6.3	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Specification of discharges to downstream users
				Water balance estimations based on Stress Index (factor): limitation of SI value (65%)
			Quality	Nutrients - Nitrate
				Salts - Electrical Conductivity
			Protection Zone	Radius of influence (r)
				Distance from wetland (L)
				Ground stability (drawdown limit, L)

Table 25: Sub-components prioritisation for groundwater in IUA 9: Middle/ Lower Busmans River

IUA	Groundwater Resource Unit (QC)	RU	Sub-component	Indicator/ Measure
IUA 9: Middle/ Lower Bushmans River	V70C	9.1	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Specification of discharges to downstream users

IUA	Groundwater Resource Unit (QC)	RU	Sub-component	Indicator/ Measure
				Water balance estimations based on Stress Index (factor): limitation of SI value (65%)
			Quality	Nutrients - Nitrate
				Salts - Electrical Conductivity
			Protection Zone	Radius of influence (r)
				Distance from wetland (L)
				Ground stability (drawdown limit, L)

Table 26: Sub-components prioritisation for groundwater in IUA 10: Upper Thukela River

IUA	Groundwater Resource Unit (QC)	RU	Sub-component	Indicator/ Measure
IUA 10: Upper Thukela River	V11C, V11D, V11F and V11J	10.1 and 10.4	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Specification of discharges to downstream users
				Water balance estimations based on Stress Index (factor): limitation of SI value (43%)
			Quality	Nutrients - Nitrate
				Salts - Electrical Conductivity
			Protection Zone	Radius of influence (r)
				Distance from wetland (L)
				Ground stability (drawdown limit, L)
	V11M, V13E and V14A	10.9, 10.11 and 10.12	**Quantity**	Water Level - Depth to groundwater level from ground elevation. Time series water level monitoring (Monthly) vs abstractions and rainfall input
				Abstraction - Volume (Q) Time series of abstraction vs rainfall
				Specification of discharges to downstream users
				Water balance estimations based on Stress Index (factor): limitation of SI value (50%)
			Quality	Nutrients - Nitrate
				Salts - Electrical Conductivity
			Protection Zone	Radius of influence (r)
				Distance from wetland (L)
				Ground stability (drawdown limit, L)

8.3 Estuary

The sub-components and indicators for the two (2) estuary resource units are described in Tables 13 and 14 below.

Table 27: Sub-component Prioritisation for Integrated Unit of Analysis – IUA 15: Thukela Estuary

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
15.1 Thukela reach upstream Estuary to Mngeni transfer	Low flows			✓	A flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES B Urban Town of Mandeni areas Wastewater Treatment Works Umgeni transfer station Mandeni industrial area Sappi Mandeni Mill Tourism	Quantity, Habitat, Biota	Water supply, Human and Ecological health
	High flows (floods)								
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	Ortho-phosphate, Nitrate			
	Salts			✓	Assess impact from the mill and industrial area	Total Dissolved Solids			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	System Variables	✓			To assess potential impacts from the urban, industrial areas	pH, Electrical Conductivity, clarity,			
	Toxics	✓			Important to assess urban impacts where poor sanitation in place	Ammonia			
	Fish		✓		Provides an assessment index of the reference fish assemblage and the indication of the response of the constituent species of the assemblage.	FRAI			
	Instream		✓		Indicator of ecological integrity.	Index of Habitat Integrity (IHI) Rapid Habitat Assessment Method (RHAM).			
	Riparian habitat		✓		Indicator of riparian habitat	IHI/ VEGRAI			
	Aquatic riparian plant species								
	Mammals								
	Birds								
	Amphibians/Reptiles								
	Periphyton								
	Aquatic invertebrates		✓		The MIRAI is an assessment index of the reference invertebrate's assemblage and the	Macroinvertebrate Response Assessment Index (MIRAI)			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
					response of the constituent species of the assemblage				
	Diatoms			✓	Integrated indicator of pollution	SPI			
15.2 Estuary	Low flows			✓	Important that flows are met to maintain the open mouth of the estuary - a flow measurement in the river will provide an indication if the required maintenance flows are being met.	Base flows	PES C Urban areas Domestic wastewater treatment works Cultivation with irrigation Tourism	Quantity, Hydro-dynamics Quality, Physical habitat, Biota	Human health; Ecological health
	High flows (floods)			✓	Necessary to scour the estuary of accumulated sediments and organic matter, which are then transported to the coastal zone (Tugela Banks) and support crustacean and linefish fisheries.	Sediment composition			
	Mouth condition			✓	Needs to be open to maintain river, estuary and KwaZulu-Natal Bight interlinkages.	Mouth condition – Open			
	Abiotic states			✓	The four abiotic states are primarily related to river flow; 1) closed (0-2 m^3/s), 2) occasionally closed (2-5 m^3/s), 3) open with saline intrusion (5-30 m^3/s) and 4) river-dominated (>30 m^3/s).	River discharge			
	Salinity			✓	Vertical and longitudinal salinity gradients penetrate up to 6 km from the mouth supporting a range of biodiversity that is dependent on species-specific salinity tolerances. This gradient is not likely to be present when the mouth has closed for a prolonged period or when the estuary is river dominated.	Salinity			
	Dissolved inorganic nitrogen			✓	Important to assess trophic status.	Total Oxidised Nitrogen (Nitrate + nitrite; TON) plus ammonium = Dissolved Inorganic Nitrogen (DIN)			
	Dissolved inorganic phosphates			✓		Orthophosphate; Dissolved Inorganic Phosphorus (DIP)			
	Nutrients			✓	These variables are indicators of nutrient enrichment of water resources (N:P ratios).	DIN + DIP			
	Water Clarity			✓	An indication of erosion and the state of land management in the river catchment.	Total Suspended Solids (TSS), Secchi depth, and/ or Turbidimeter			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
					Turbidity typically increases with river discharge.				
	Dissolved Oxygen			✓	An indication of poor water circulation and elevated organic matter (with associated bacterial oxygen demand).	Dissolved oxygen (mg/L)			
	Toxic substances	✓		✓	Important to assess urban impacts where poor sanitation is in place, impacts from irrigation	Pesticides, Ammonia			
	Pathogens	✓			Indicators of faecal contamination from WWTW	*Escherichia coli*			
	Intertidal habitat			✓	Habitat for intertidal species of microalgae, macrophytes, macroinvertebrates and feeding/ roosting birds	Area of tidally exposed sediments			
	Subtidal habitat			✓	Habitat for subtidal species of microalgae, macrophytes, macroinvertebrates and fish. Essential nursery habitat.	Area of permanently inundated sediments			
	Substrate type			✓	Substrate type is spatially and temporally dynamic in estuaries, providing habitat diversity. Reduced river flow favours the accumulation of fine sediments and organic matter, which can become consolidated in the absence of strong flows and floods. Consolidated sediment is more persistent in a system.	- Sediment particle size Ash-free dry weight			
	Microalgae		✓		Phytoplankton and benthic microalgal biomasses and community compositions are a function of river flow and nutrient concentration.	- Biomass using chlorophyll *a* as an index Community structure using phytoplankton groups and benthic diatoms			
	Macrophytes		✓		The distribution of plant communities is sensitive to changes in salinity and nutrient concentrations. Additional pressures include harvesting, grazing, loss of land within the estuarine functional zone and competition with invasive alien species.	Community structure using botanical survey and mapping (including alien invasive species).			

Resource Unit	Sub-component	User specification	Ecological specification	Integrated Measure	Rationale	Indicator	Key impacts identified	Sub-component prioritised	Protection required
	Invertebrates		✓		Macrobenthos communities are influenced by salinity gradients, shelter from wave action, fluctuations in temperature and dissolved oxygen, nature of the substratum, and input of detritus. Estuaries support a variety of marine, estuarine and freshwater holo- and meroplanktonic zooplankton, dominance of which depends on estuarine characteristics (including abiotic states). Macrocrustacea use estuaries for shelter and nursery grounds. River flow and water quality threaten this use and the link between fresh and marine environments.	Community structure; Macrobenthos: Eckman sediment grab sampling and sieving. Zooplankton: Night collection using Bongo nets. Macrocrustacea: Beam trawls and prawn traps.			
	Fish		✓		Estuaries can act as nursery areas for estuary-dependent fish, habitat for stenohaline marine and euryhaline freshwater fish, and conduits for Anguillid eel larvae. Mouth condition, river flow and food availability (e.g. detritus and invertebrates) affect community structure.	- Fish Recruitment Index (FRI) - Community structure (seine net collection)			
	Birds		✓		Three major groups of estuarine dependent birds; summer (incl. palaearctic migrants) and winter fauna that use the estuary for feeding, and birds that use the estuary to roost and mostly feed offshore. Changes in habitat, food availability and human disturbance affect community composition and species abundance.	Winter and summer bird counts			

9 SUMMARY AND CONCLUSION

In terms of the various components and considerations assessed for Resource Units' delineation and prioritisation, and based on the understanding and expert knowledge of the Thukela and tributary catchments, and the results of the preliminary delineation and prioritisation, the following are relevant for the setting of RQOs:

- Overall, of the seventy five (75) RUs delineated, fifty-four (54) RUs have been prioritised,
- Six dam RUs have been delineated and prioritised,
- Groundwater priority RU areas were identified with areas of high stress index and aquifers of strategic importance identified in IUA 2, IUA 3, IUA 5, IUA 7, IUA 8, IUA 10, and IUA 11,
- Twelve wetland clusters have been prioritised in the catchment area, and
- The Estuary comprises two RUs, both prioritised.

The evaluation of the resource unit's prioritisation has been done in collaboration with catchment managers, and specialists. It will be finalised following PMC and PSC review.

RQOs for the prioritised and selected rivers, dams and groundwater RUs, wetland clusters and the estuary will then be determined for the sub-components and indicators selected.

10 REFERENCES

Department of Water and Sanitation (2020) Status Quo and delineation of Integrated Units of Analysis Report, Number: RDM/WMA04/00/CON/CLA/0320

Department of Water and Sanitation (2020a) Preliminary Resource Units Selection and Prioritisation Report, Number: RDM/WMA04/00/CON/CLA/0520

National Water Act (Act No. 36 of 1998) (NWA)

APPENDIX A: Electronic spreadsheets