Report no. RDM/WMA04/00/CLA/0520

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

REPORT TITLE: PRELIMINARY RESOURCE UNITS SELECTION AND PRIORITSATION REPORT

FINAL

February 2021

21

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

DEPARTMENT OF WATER AND SANITATION

Chief Directorate: Water Ecosystems

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PRELIMINARY RESOURCE UNITS SELECTION AND PRIORITSATION REPORT
WP 11255

Study Report No.

RDM/WMA04/00/CON/CLA/0520

February 2021

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Published by

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Private Bag X313
Pretoria, 0001
Republic of South Africa

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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: Preliminary Resource Units Selection and Prioritisation Report. Report No: RDM/WMA04/00/CON/CLA/0520

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Title:	*Preliminary Resource Units Selection and Prioritisation Report*
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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/0520*
Status of Report:	*Final*
First Issue:	*September 2020*
Final Issue:	*February 2021*

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DOCUMENT INDEX

Reports as part of this project:

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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

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

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1 INTRODUCTION

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). 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.

1.1. 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.

1.2. Purpose of this Report

The delineation and prioritisation of resource units (RU) is required to facilitate effective management within the catchments and necessitates the breakdown of a river into discrete manageable units, primarily from an ecological perspective. The resource units are generally ecologically homogenous in nature. The delineation of Integrated Units of Analysis (IUA) and prioritisation of RUs are undertaken as the initial steps of the water resource classification and Resource Quality Objectives (RQO) processes.

RQOs are then developed per RU within the context of the IUA catchment perspective. In this study for the Thukela catchment RQOs for rivers, groundwater, dams, wetland resources and the estuary will be determined. The outcomes of this study will therefore include RQOs for rivers, groundwater, wetlands, and dam resources as follows:

- Rivers on a RU scale (river RUs),
- Priority dam resources on a RU scale,
- Priority wetland resources on a RU scale,
- Groundwater resources on a groundwater RU scale which is comparable with river RUs, and
- Priority groundwater resources on a system specific scale (priority groundwater units).

This report details the process of delineating and prioritising the resource units for the water resources in the Thukela catchments. It provides the information used to delineate the RUs and details the results of the preliminary prioritised resource units.

These results will be taken through to stakeholders' consultation for finalisation of the delineation and prioritised resource units.

2 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	V11, V12, V13 and V14	7 645

Sub-catchment	Description	Tertiary drainage regions	Catchment area [(1)] (km^2)
	Bushmans River		
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
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.

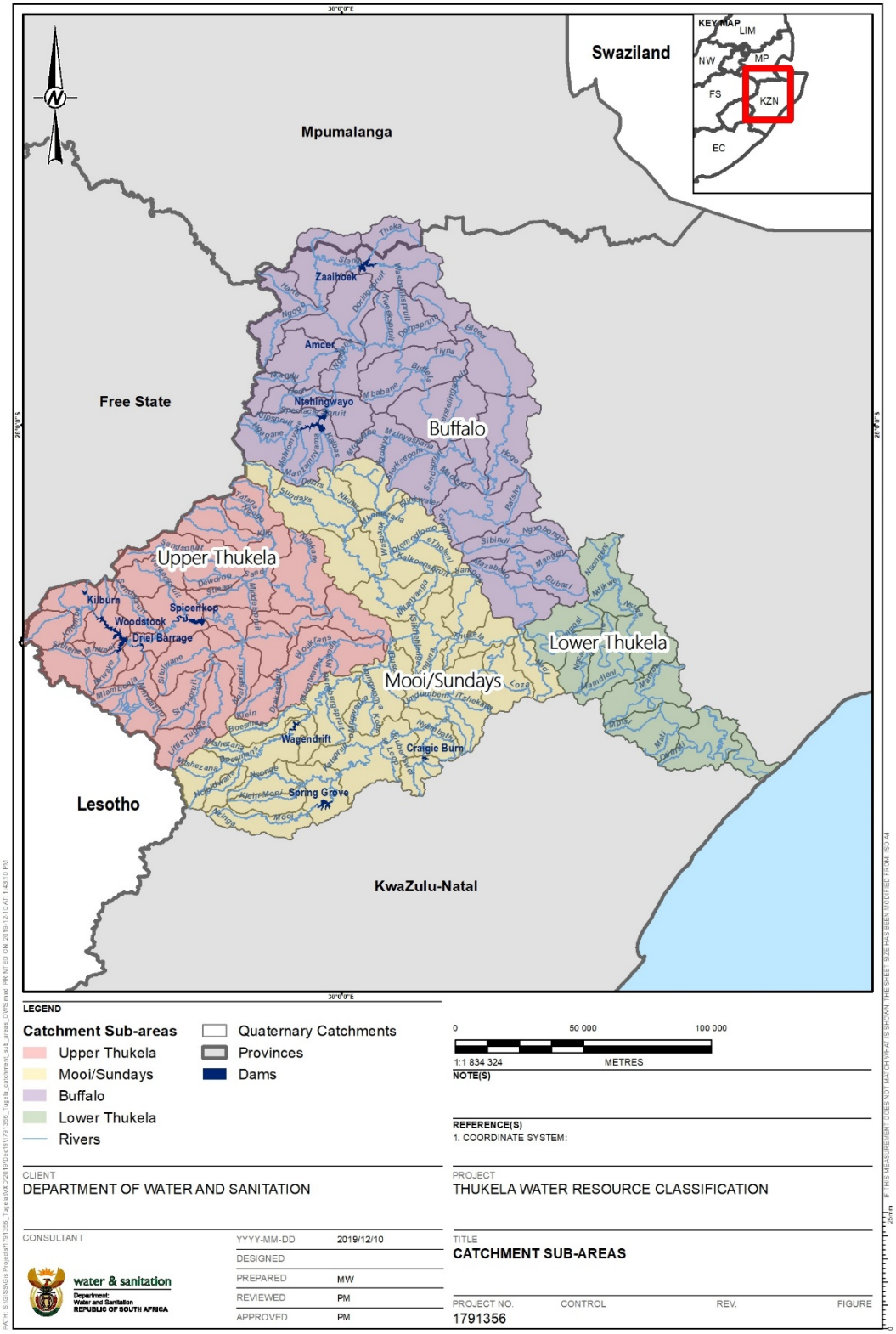

Figure 1: Thukela catchment sub-areas

3 DELINEATION OF THE 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 and approved by the Project Steering Committee members. The IUAs are set out in Table 2 and shown in Figure 4. The IUAs form 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

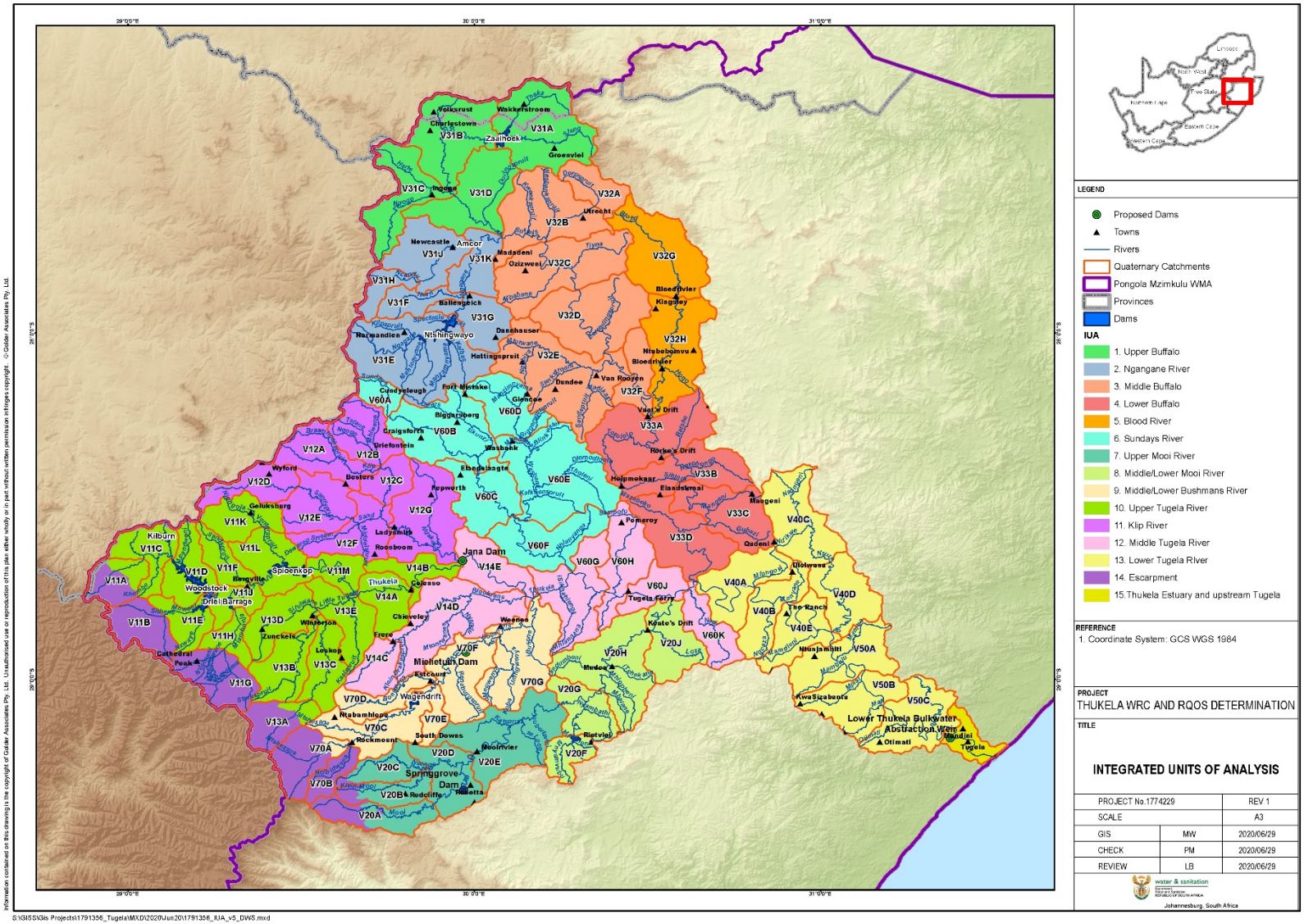

Figure 2: Integrated Units of Analysis

4 RESOURCE UNITS DELINEATION: SURFACE WATER

4.1 Approach

From an ecological perspective, rivers should be viewed as continuous longitudinal systems. Impacts that occur in upstream reaches are likely to affect downstream processes. As it would not be appropriate to set the same RQOs for the headwaters of a river as for the lowland reaches, RUs are required. The RUs are river reaches that are ecologically significantly different to warrant their own specification of the RQOs and as such the geographic boundaries of each must be clearly delineated (DWAF, 1999, Volume 3).

A RU is a section of a river that frequently has different natural flow patterns, reacts differently to stress according to their sensitivity, and requires individual specifications of the ecological requirements and RQOs appropriate for that reach, as compared to the rest of the river. The delineation of a catchment into RUs is done primarily on a biophysical basis, and where the hydrology, geomorphic characteristics (*i.e.* geomorphic zone), water quality attributes and river size remain relatively similar, a RU can be defined.

In addition, management requirements also play a role in the delineation of a RU (DWAF, 1999, Volume 3). The purpose of distinguishing a RU of management requirements is to identify a management unit within which the EWR can be implemented and managed based on one set of identified flow requirements. These management units are based on the principle of homogeneity of impacts in the demarcated RU. This may include the modification of flows in the system due to abstraction, regulation by impoundments and development along the RU and upstream from the RU which may influence the geomorphology and water quality conditions.

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

4.2 Resource Units Consideration for Delineation

Spatial data from the water resource classification component defining the IUAs and hydronodes has been reviewed and serves as the departure point for the delineation of the resource units. The EWR sites and the hydronodes have been reviewed and their relevance and rationale for inclusion has been assessed.

Each IUA has now been delineated into smaller units considering quaternary catchment boundaries. Sub-quaternary analysis and assessment also took place where required. However, the delineation based on quaternary catchment boundaries was preferred as it relates to the unit of management of the water resources in the catchment from a regulation, authorisation, and management point of view. The quaternary catchment level delineation will facilitate the implementation and application of the RQOs determined. Where present the RQOs will be linked to the EWR sites and hydronodes which will serve as the monitoring site for compliance

assessment. These reaches will be specified at the sub-quaternary level to support the monitoring programmes to be established.

The resource unit delineation has been done based on assessment of the following considerations and components:

- IUA boundaries, quaternary and sub-quaternary boundaries: This formed the basis of delineation (alignment to the water resource classification) and is of relevance from a management and implementation perspective.
- EWR sites and location of biophysical nodes (in terms of the Classification process outputs): Relevant from an ecological point of view (EWR sites) and important in meeting the classification ecological categories to be specified at the nodes. The nodes are of relevance in setting water quality and flow related resource quality objectives.
- Water resource management classes to be set: Considered to determine the level of protection required within an IUA.
- PES/EIS desktop assessment of sub-quinary reaches: To determine the reaches that require higher protection and areas that are degraded and need to be improved within an IUA.
- Ecological condition (based on the EWR and node information): Understanding of ecological condition and ensuring implementation of the Reserve.
- Protected and conservation areas: Areas that are of importance from a biodiversity and conservation point of view (different to the higher impacted areas), that would need RQOs that support the conservation status.
- Operation of the system: How the water resources in the system area regulated and managed from a system point of view. This relates more importantly to regulation of the dams, and their influence of the river surface water flow, transfers, strategic water resources, etc.
- Water quality impacts: The water quality status/condition of the resources influences the delineation of the resource units in terms of where specific RQOs would be required. Highly impacted, poor water quality areas would need RQOs and similarly areas of good water quality would require protection in line with the water resource management classes and ecological condition.
- Land use and anthropogenic activities: the activities within the IUAs, were considered – the nature, intensity, scale, type and extent of impact. This influenced the delineation of resource units in terms of the management required and the RQOs that would be required to ensure the water resources are sustainably used.
- User dependence: The reliance of users on the water resources for domestic water supply.
- Groundwater units: the priority groundwater resources and their importance to the system and users.

- Wetlands: The priority wetland areas and systems and their importance from their value, support to the ecosystem and services they provide, and to the users; and
- Expert knowledge of the catchment area and system.

The following sections provides some detail on the background information related to land cover, ecological information, water infrastructure and freshwater water ecosystem areas which also informed the delineation of resource units.

4.2.1 Land cover

Land cover and land use information for the Thukela catchments has been used to determine homogeneity of impacts and used in the decision-making regarding delineation of the RUs. The land cover of the Thukela catchments is dominated by large rural settlements and agriculture (both subsistence and intensive farming) throughout the catchment. There are also several unserviced settlements along the Lower Thukela River, and medium sized towns are dotted throughout. These are often linked to poorly performing domestic wastewater treatment works. Several closed coal mines are located in the Newcastle and Dundee areas and in the Sundays River catchments, and sand mining is occurring in the Buffalo River from the Ngagane River to the lower reaches. Industrial developments are associated with the towns of Newcastle, Ladysmith, Estcourt, Mooi River and Mandini.

It is also important to note that the Thukela catchment has large natural areas and a number of strategic water source areas that support water resource use and economic activities nationally.

4.2.2 Ecological information

As resource unit definition is to a large extent based on the ecological condition and characteristics of the water resource, it is important to understand the ecological requirements and specifications of the surface water resources in the Thukela catchments. The ecological conditions of the 15 Integrated Units of Analysis delineated for the Thukela catchment are summarised in Table 3.

The larger part of the catchment is in a good ecological condition, with the majority of river reaches in a largely natural to a moderately modified state (B and C present ecological state). A smaller portion of the river systems specifically in the vicinity of the urbanised developed areas are largely modified (D present ecological state), due to the impacts from land use and associated activities.

The uKhahlamba-Drakensberg Park is the most prominent conservation area in the catchment area. Some smaller conservation areas and historic sites are also found in the catchment. In almost all cases the Environmental Importance (EI) is rated as High and the Environmental Significance (ES) as High to Very High.

Table 3: Ecological description

IUA	Quaternary catchment	Resource Unit (Description)	PES	EI	ES	EWR site
1: Upper Buffalo River	V31A	Wetland resource unit: Wakkerstroom	B	High	Very High	
	V31A	Zaaihoek Dam	-	-	-	
	V31B	Buffalo and Slang	C	High	Very High	
	V31C	Ngogo and Harte to confluence with Buffalo	B/C	High	Very High	
	V31D	Doringspruit catchment	D	Moderate	High	
	V31C, D	Buffalo to confluence to Ngagane	B/C	High	High	
2: Ngagane River	V31E	Upper Ngagane to Ntshingwayo Dam	C	High	Very High	May13_EWR1
	V31E	Ntshingwayo Dam	-	-	-	
	V31F	Horn to confluence with Ngagane	E	Moderate	Very High	May13_EWR2
	V31H, J	Ncandu to confluence with Ngagane	D	High	Very High	
	V31G, K	Ngagane from Ntshingwayo Dam to confluence with Buffalo	C	Moderate/ High	High	May13_EWR3
3: Middle Buffalo River	V32A, B	Dorps (including Kweek and Wasbankspruit) to confluence with Buffalo	D/B	High	High/ Very High	
	V32C, D	Tiyna, Eersteling,	C/B	High	High	
	V32 C	Mbabane	D	Moderate	High	
	V32E	Mzinyashana including Sterkstroom and Sandspruit	C/B	High	High	
	V32B, C, D, E, F	Buffalo from Ngagane to Blood River confluence	B	High	High	
4: Lower Buffalo River	V33A, B, C, D	Totololo, Batse, Sibindi, Ngxobongo, Mangeni, Gubazi, Mazabeko catchments	C/D/B	High	High	
	V33A, B, C, D	Buffalo from Blood to Thukela confluence	D/C/B	Moderate/ High	High/ Very High	Thukela_EWR14
5: Blood River	V32G	Wetland RU: Blood River	C	High	Very High	
	V32H	Blood River from outlet of V32H to confluence with the Buffalo River	C	High	High	
6: Sundays River	V60B	Nkunzi to confluence with Sundays	C	High	High	
	V60A, B, C	Sundays from source to confluence with Wasbank	C	Moderate/ High	HIGH	Thukela_EWR7
	V60D, E	Wasbank to confluence with Sundays	D/B/C	Moderate/ High	High	
	V60F	Sundays from Wasbank to Thukela confluence	C	High	High	Thukela_EWR8
7: Upper Mooi River	V20B (lower portion), D	Klein - Mooi from source to Mooi confluence	C	High	High	
	V20C	Nsonge tributary catchment	C	High	High	

IUA	Quaternary catchment	Resource Unit (Description)	PES	EI	ES	EWR site
	V20A (lower portion), D (upper)	Mooi upstream of Spring Grove Dam	C	High	High	
	V20D	Spring Grove Dam	-	-	-	
	V20D (lower) and E	Downstream Spring Grove Dam to outlet of V20E	C	Moderate	High	EWR_Mooi_N3
	V20E	Joubertsvlei to confluence with Mooi	E	Moderate	Very High	
8: Middle/ Lower Mooi River	V20F	Mnyamvubu upstream Craigieburn Dam	B/C	High	Very High	
	V20F	Craigie Burn Dam	-	-	-	
	V20G	Mnyamvubu downstream dam to confluence with Mooi	B/C	High	High	
	V20G	Mooi to Mnyamvubu confluence	B	High	High	EWR site 11
	V20H, J	Mbalane, Mhlopeni, Tshekana, Tshekana, Umdumbeni, Loza catchments	C/B	High	Very High/ High	
	V20H, J	Mooi from Mnyamvubu to Thukela confluence	B/C	High	High	Thukela_EWR12
9: Middle/ Lower Bushmans River	V70A (lower portion), B, C	Mtshezana, Boesmans, Ncibidwana tributary catchments up to Wagendrift Dam	A/B/C	High	Very High/ High	
	V70C	Wagendrift Dam	-	-	-	
	V70D	Little Bushmans to confluence with Bushmans	C	High	High	
	V70E, F	Bushmans from Wagendrift Dam to confluence with Rensburgspruit	C	High	High	
	V70F, G	Bushmans from Rensburgspruit Dam to confluence with Thukela	C/B	High	High	
10: Upper Thukela River	V11A (lower portion), C, D	Thukela, Putterill, Majaneni, Khombe tributary catchments	B	High/ Moderate	Very High	
	V11E	Mweni tributary catchment	C	Moderate	Very High	
	V11D, E	Woodstoock Dam	-	-	-	
	V11F	Sandspruit tributary catchment	C	Moderate	Very High	
	V11H	Mlambonja and tributaries	C	Moderate	Very High	
	V11J, L	Thukela between Driel and Spioenkop Dam	B/C	High/ Moderate	Very High/High	
	V11K, L	Njongola, Ventersprui tributary catchments	B/C	High	High	
	V11L	Spioenkop Dam	-	-	-	Thukela_EWR1
	V11M	Spioenkop Dam to Little Thukela confluence	C	High	High	Thukela_EWR2
	V13B, D	Sterkspruit, Situlwane tributary catchment	D/C/B	High	High/ Very High	

IUA	Quaternary catchment	Resource Unit (Description)	PES	EI	ES	EWR site
	V13A (lower portion), C, E	Little Tugela from IUA14 outlet to confluence with Thukela River	C	High/ Moderate	Very High/ High	Thukela_ EWR3
	V14A, B	Tugela from Little Thukela confluence to proposed Jana Dam/ Klip confluence	B	High	High	
11: Klip River	V12D	Upper reaches of Sandspruit	C	High	High	
	V12A, B, C, E, F	Klip, Braamhoek, Tatana, Ngogo, Mhlwane, Sand, Dewdrop tributary catchments	A/B/C	High/ Moderate	Very High/ High	
	V12G	Klip from Ladysmith to confluence with Thukela	C	High	High	
12: Middle Thukela River	V14C, D	Bloukrans, Drake, Mtontwanes, Nyandu tributary catchments	A/B/C	High	High	
	V14E	Thukela From Klip confluence to Bushmans confluence	A/B	High	High	EWR Site 4A and 4B
	V60G, H, K	Sikhehlenga, Sampofu, Nadi tributary catchments	B/C	High	High	
	V60G, H, J, K	Thukela from Bushmans confluence to d/s Mooi confluence	B/D/C	High/ Moderate	High	
13: Lower Thukela River	V40A, B	Mfongosi, Ngcaza, Manyane tributary catchments	B	Very High/ High	Very High/ High	
	V40A, B	Thukela from d/s Mooi confluence to Middeldrift transfer	B/C	High	High	
	V40C, D	Nsuze from source to confluence with Thukela	C/B/A	High	Very High/ High	
	V50A, B, C	Mamba, Mambulu, Mpisi, Mati, Nembe, Mandeni tributary catchments	B/C	High	High	
	V40E, V50A, B, C	Thukela from Middeldrift to reach in V50D	B/C	High	High	Thukela_ EWR16
14: Escarpment	V11A	Upper reaches of Thukela River	B	High	Very High	
	V11B	Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River)	B	Moderate	High	
	V11G	Source to confluence of Mlambonja and Mhlwazini Rivers (Mlambonja River (upper); Mhlwazini River; Ndedema River; Ndumeni River; Thuthumi River)	A/B	High/ Moderate	Very High/ High	
	V13A	Upper reaches of Little Thukela River	Not assessed	Not Assessed	Not Assessed	
	V70A	Upper reaches of Boesmans River	A/B	High	High/ Very High	
	V70B	Ncibidwana source to outlet of V70B	B	High	High	

IUA	Quaternary catchment	Resource Unit (Description)	PES	EI	ES	EWR site
	V20A	Upper reaches of Mooi River	C	High	High	
	V20B	Upper reaches of Little Mooi River	C	High	High	
15: Thukela Estuary and upstream Thukela Reach	V50D (upper portion)	Thukela reach upstream Estuary to Mngeni transfer	C	High	High	Thukela_ EWR 17
	V50D	Estuary (8.5 km upstream)	C	High	High	Thukela_ EWR18

4.2.3 EWR sites

A number of Reserve studies have been undertaken over the last 20 years. The Thukela preliminary Reserve included 17 Ecological Water Requirement (EWR) sites, nine in the upper Thukela Catchment and tributaries and eight sites in the Lower Thukela Catchment. A number of rapid Reserve determinations were undertaken between 2002 and 2005. However, no reports were available for these studies. Rapid assessments were undertaken for the Ngagane, Horn, Ncandu and Ncone Rivers in 2013 and for the Mooi River just upstream of the existing comprehensive site Thukela_10 in V20E during 2019. An intermediate assessment was undertaken during 2017 for the lower Thukela River at Thukela_16 and two additional sites just downstream of the new abstraction weir in quaternary catchment V50D.

The sites and level of assessments are listed in Table 4 with their locations indicated in Figure 4. Additional sites that have been assessed as part of this study process (September 2020) are described in Table 5.

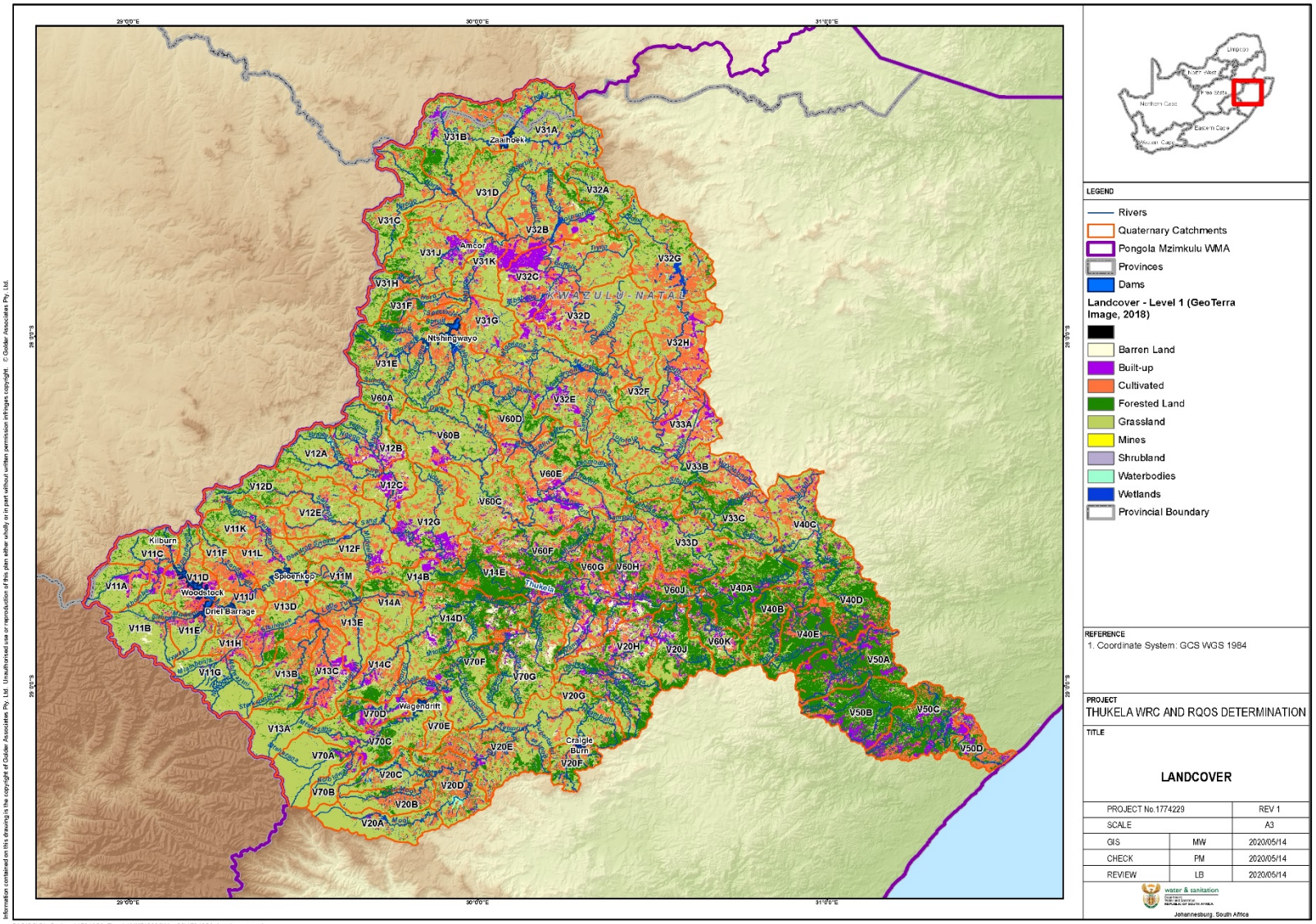

Figure 3: Land cover and land use information of the Thukela catchment

Table 4: EWR sites and Rapid assessments undertaken in the Thukela Catchment

EWR site	River	Quaternary catchment	Level	Year
Thukela_1, Bergville	Thukela	V11J	Comprehensive	2003
Thukela_2, Skietdrift	Thukela	V11M	Comprehensive	2003
Thukela_3, Klein Thukela	Little Thukela	V13E	Comprehensive	2003
Thukela_4A, Zingela	Thukela	V14E	Comprehensive	2003
Thukela_4B, Thukela Estates	Thukela	V14E	Comprehensive	2003
Thukela_10, Caravan Park	Mooi	V20E	Comprehensive	2003
Thukela_11, Mooi Falls	Mooi	V20E	Comprehensive	2003
Thukela_12, Gracelands	Mooi	V20H	Comprehensive	2003
Thukela_13, Upper Buffalo	Buffalo	V32F	Comprehensive	2003
Thukela_14, Lower Buffalo	Buffalo	V33C	Comprehensive	2003
Thukela_15, Jameson's Drift	Thukela	V40E	Comprehensive	2003
Thukela_16, Mandini	Thukela	V50C	Comprehensive; revised in 2017 with an intermediate assessment	2003/ 2017
Thukela_7, Upper Sundays	Sundays	V60C	Comprehensive	2003
Thukela_8, Lower Sundays	Sundays	V60F	Comprehensive	2003
Thukela_9, Thukela Ferry	Thukela	V60J	Comprehensive	2003
Thukela_5, Weenen NR	Boesmans	V70F	Comprehensive	2003
Thukela_6, Darkest Africa	Boesmans	V70G	Comprehensive	2003
Thu_EWR17	Thukela	V50D	Intermediate	2017
Thu_EWR18	Thukela	V50D	Intermediate	2017
V11C	Khombe	V11C	Rapid 3	2005
V11D	Mpandweni	V11D	Rapid 3	2005
EWR2, Venterspruit	Venterspruit	V11K	Rapid 3	2005
EWR3, Klipspruit	Klipspruit	V12A	Rapid	tbc
V12A	Braamhoekspruit	V12A	Rapid 3	2005
Klein Thukela	Little Thukela	V13C	Rapid 3	2002
V20A	Mooi	V20A	Rapid 3	2002
EWR4	Hlatikhulu	V20C	Rapid 3	2005
EWR_Mooi_N3	Mooi	V20D	Rapid 3	2012, 2019
V31E, May13_EWR1	Ngagane	V31E	Rapid 1	2013
V31F, May13_EWR2	Horn	V31F	Rapid 3	2013
V31H	Ncandu	V31H	Rapid 3	2005
V31K, May13_EWR3	Ngagane	V31K	Rapid 3	2013
Kno_up	Knockbrex	V31K	Rapid 2	2017
Kno_down	Knockbrex	V31K	Rapid 2	2017
Ncone	Ncone	V32H	Rapid 3	2012
EMAN2	eMandeni Stream	V50D	Rapid 3	2017

Table 5: Additional EWR sites assessed as part of this study

IUA	River	Quaternary	Biological	Rapid 3	Revisit (Biological & discharge)	Comments
1	Buffalo	V31D		x		New site – EWR 23
2	Ncandu	V31H, J		x		New site – EWR 19
3	Buffalo	V32F			x	Thukela_EWR13a on Buffalo
4	Buffalo	V33B		x		Thukela_EWR23 on Buffalo
6	Sundays	V60F		x		Thukela_EWR7a on Sundays
8	Mnyamvubu	V20G		x		New site – EWR21
	Mooi	V20H		x		Thukela_EWR12a on Mooi
	Bushmans	V70G		x		Thukela_EWR6a on Bushmans
	Thukela	V14A, B	x			New site – EWR 4C
11	Klip	V12G		x		New site – EWR 20

4.2.4 Freshwater Ecosystem Priority Areas

The Freshwater Ecosystem Priority Areas (FEPAs) identified through the National Freshwater Ecosystem Priority Areas Project of the Water Research Commission (WRC, 2011) within the Thukela catchments were considered and assessed for RU delineation. FEPAs have been identified as those areas that are important for sustaining the integrity and continued functioning of their related ecosystems. The FEPAs of importance as identified in the Thukela catchment are shown in Figure 5 (WRC, 2011). FEPAs are present in all of the sub-catchments. The following catchments have Natural Threatened Ecosystems:

- Ngagane River and upper portions of the Buffalo River (IUA 2),
- Portions of the Blood River catchment (IUA 5),
- Upper reaches of the Sundays River (IUA 6),
- Nsonge and upper reaches of the Mooi and Klein-Mooi river (IUAs 14, 7 and 8),
- Mbalane and Mnyamvubu rivers in the middle reaches of the Mooi River catchment (IUA 8),
- Nsuze catchment and lower reaches of the Thukela River (IUA 13), and
- Thukela Estuary (IUA 15).

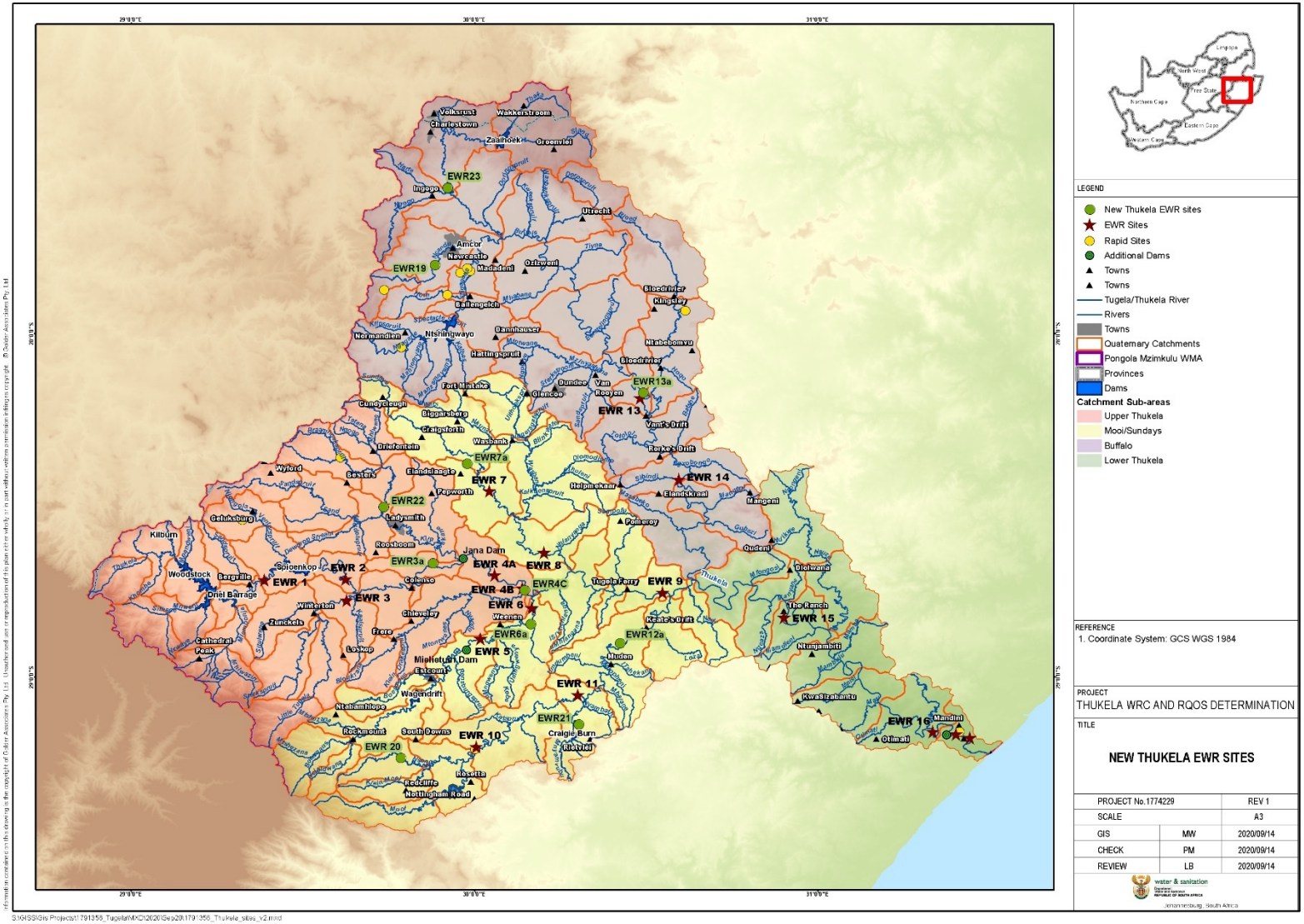

Figure 4: EWR sites in the Thukela Catchment

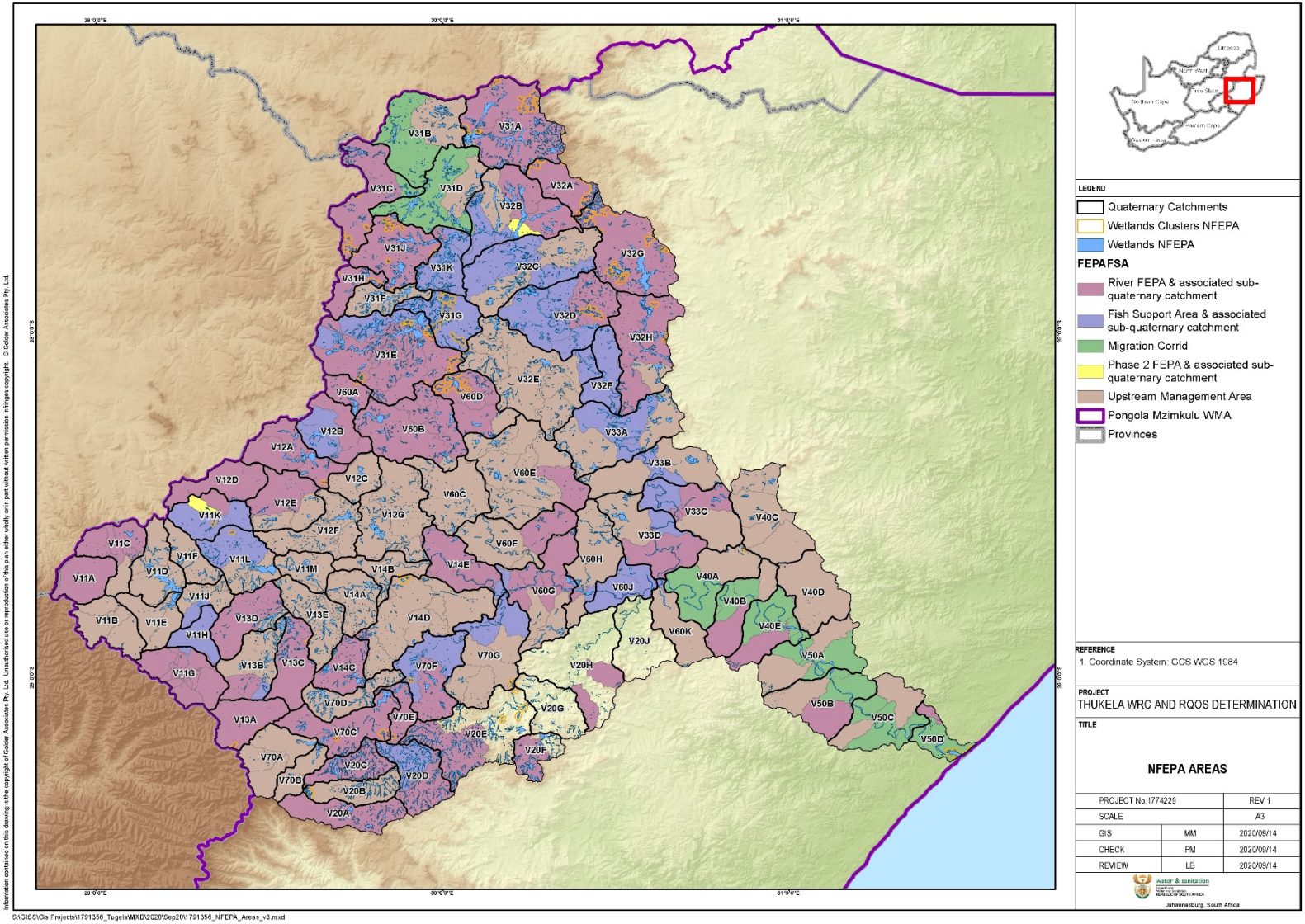

Figure 5: The FEPAs of importance and protected areas within the Thukela Catchments

4.2.5 Water Infrastructure

The resources of the Thukela River are predominantly used to support requirements for water in other parts of the country, with large transfers of water to neighbouring catchments (DWS, 2004). The river is relied upon for transfers into the Vaal System, the Mhlatuze catchment to the north-west and Mooi-Mgeni system in the south. The catchment includes eight major dams however, for the most part, the Thukela River remains largely unregulated.

Relatively large potential for further development of surface resources exists in the catchment area, and several options have been investigated in this respect. The largest and most notable of these is the Thukela Water Project which is to consist of the proposed Jana Dam on the main stem of the Thukela River, Mielietuin Dam on the Bushmans River and an extensive aqueduct system for transfer of water to the Vaal River.

Surface water has been highly developed in some parts of the catchment, where it is being fully utilised. The main storage dams (Table 6) are:

- Woodstock and Spioenkop Dams on the Thukela River,
- Windsor and Qedusizi Dams on the Klip River, in the Upper Thukela sub-area. Windsor Dam is expected to be decommissioned in the near future, whilst Qedusizi Dam expressly serves for flood control and has no active storage.
- Zaaihoek and Ntshingwayo (Chelmsford) dams in the upper tributaries of the Buffalo River.
- Wagendrift Dam on the Bushmans River, Craigieburn Dam on the Mnyamvubu, a tributary of the Mooi River, Spring Grove Dam on the Mooi River, Olifantskop Dam on the Sundays River, in the Mooi/Sundays sub-area.

No large dams have been constructed in the Lower Thukela sub-area.

Table 6: Major Dams in the Thukela

Dam name	Number	Quaternary catchment	River	Purpose	Full supply capacity (million/m^3)
Woodstock	V1R003	V11D, V11E	Thukela	Transfer to Vaal for domestic and industrial use	380.4
Driel Barrage	V1R002	V11J	Thukela	Transfer to Vaal for domestic and industrial use	8.7
Spioenkop	V1R001	V11M	Thukela	Transfer to Vaal for domestic and industrial use	279.6
Qedusize	V1R005	V12F	Klip	Flood control	194
Zaaihoek	V3R003	V31A	Slang	Transfer to Vaal for domestic and industrial use	193.0
Ntshingwayo (Chelmsford)	V3R001	V31E	Ngagane	Municipal and industrial use	198.4
Wagendrift	V7R001	V70C	Bushmans	Irrigation	58.4
Spring Grove	V2R003	V20D	Mooi	Transfer to Mgeni for domestic and industrial use	139.5

Dam name	Number	Quaternary catchment	River	Purpose	Full supply capacity (million/m^3)
Craigie Burn	V2R001	V20F	Mnyamvubu	Irrigation and future water supply to Greytown	23.4

The level of potable water supply in the catchment varies from household taps in developed areas, to standpipes in the townships, to none in remote areas. The main water resource infrastructure are the dams, which are located on the major rivers.

The majority of the towns in the catchment have their own potable water and sewage treatment works near the towns. The larger potable water treatment facilities are found at Newcastle, Esikawini township, Utrecht, Dundee, Ladysmith, Mandini, Bergville, Weenen, Estcourt, Emakwezini and Mooi River. The largest sewage plants are at Newcastle, Madadeni, Utrecht, Dundee, Ladysmith, Bergville, Estcourt, Mooi River, Colenso, Volksrust and at the prison near Volksrust and on the coast at Mandini.

4.2.6 Thukela Estuary

The Thukela Estuary (31^{o}29'56" E; 29^{o}13'24" S) is located within the Thukela catchment approximately 100 km north of Durban in the KwaZulu-Natal Province. 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 (29^{o}11'59.1"S, 31^{o}25'27.1"E) approximately 8.5 km from the estuary mouth (Government Gazette No. 42478, 2019) (Figure 5).

The estuary is classified as an open river mouth (Large Fluvially Dominated) (Whitfield, 1992; van Niekerk *et al*. 2019a) and falls within the sub-tropical biogeographical coastal region of South Africa's east coast. 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 3754 x 106 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).

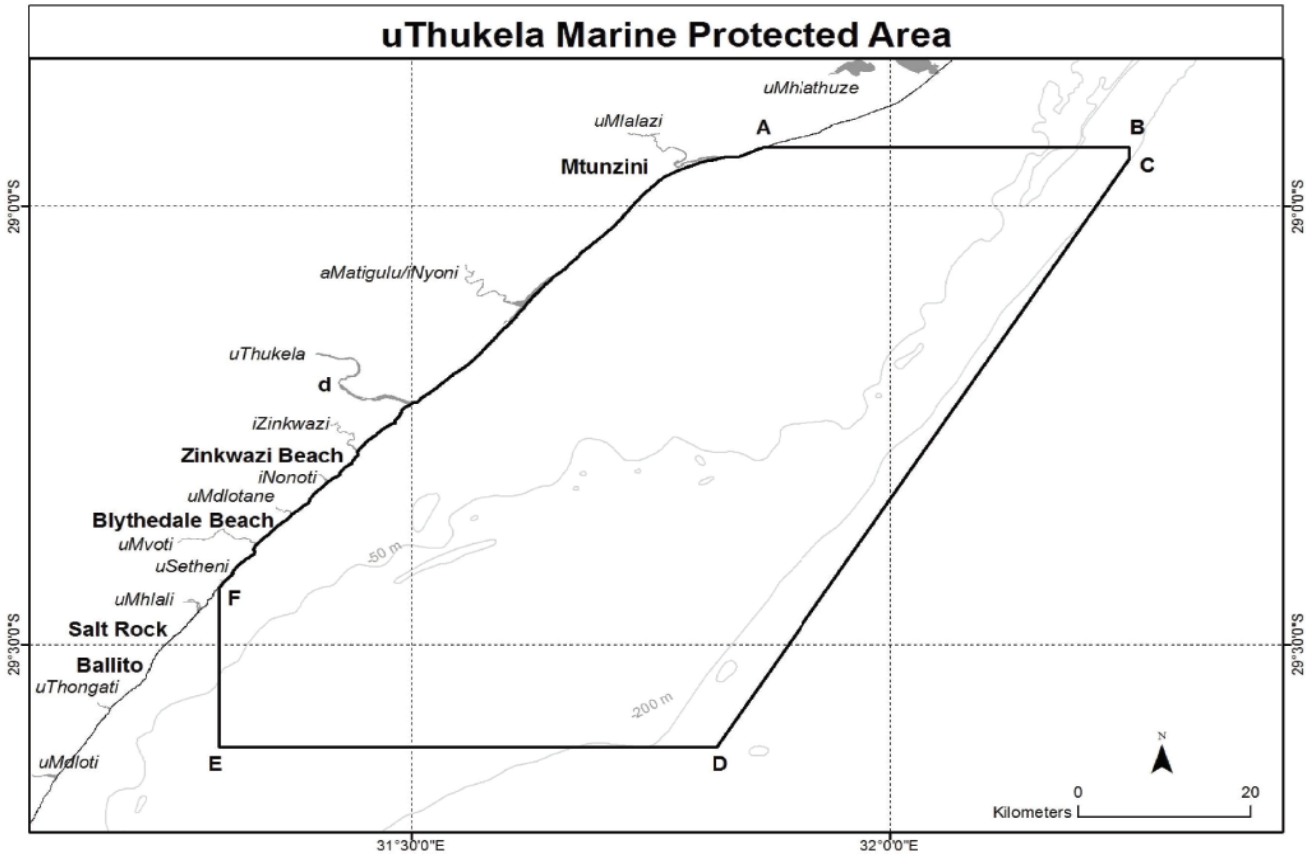

Figure 6: Boundaries of the uThukela Marine Protected Area (Government Gazette 42478, 2019)

5 RESOURCE UNIT DELINEATION RESULTS

Based on the consideration and integration of the aspects discussed above, as well as using expert knowledge including discussions with specialists and catchment water resource managers, 75 RUs have been delineated in the Thukela catchments. The RUs are shown in Figure 6 and are listed and described in Table 7.

Table 7: Description of Resource Units in the Thukela catchments

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
IUA 1: Upper Buffalo River				
1.1	Wetland resource unit: Wakkerstroom	V31A		Main stem; Falls within areas defined as SWSA. Important ecosystem services, two priority wetlands being significant to rural communities, Wakkerstroom and Groenvlei FEPA wetlands (prioritized) - important for flood attenuation and sediment trapping, important for water purification; Rivers are in a B ecological category. High household, tourism, and society value. Proposed Groenvlei Agri village. Sampling points on WMS.
1.2	Zaaihoek Dam	V31A		Main stem; SWSA - transfer Scheme transferring water to the Vaal system (Majuba Power Station in Mpumalanga Province). Surplus water is released into the Vaal River to flow into Grootdraai Dam, thus increasing the capacity of the Vaal River system. Supports the town of Volksrust. Sampling points on WMS.
1.3	Buffalo and Slang	V31B		Main stem. Rivers are in a PES: C category. Some FEPA wetlands, irrigated areas. Domestic WWTW discharge in Volksrust (poor quality effluent) and Charlestown WWTW (ponds). Absence of formalised sanitation impacts to groundwater. Sampling points on WMS, however difficult to access.
1.4	Ngogo and Harte to confluence with Buffalo	V31C		SWSA in Harte River and upper reaches of the Ngogo River catchment. Harte River is in a B category PES (very natural) FEPA wetlands in upper Harte catchment; Ngogo River in a C category – agricultural activities along the river, FEPA wetlands in lower reach of Ngogo; gauging weir at outlet (V3H002). Sampling points on WMS.
1.5	Doringspruit catchment	V31D		Rivers are in a D category (quantity); extensive subsistence agriculture; FEPA wetland areas. Quality – acceptable. No sampling points currently and needs to be investigated for accessibility and land use activity.
1.6	Buffalo to confluence to Ngagane	V31C, D		Rivers in a category C; extensive irrigation; FEPA wetlands; AMCOR industrial area downstream in the RU, just upstream of confluence of Buffels with Doringspruit. Proposed Ncandu Dam. Sampling points on WMS, however difficult to access.
IUA 2: Ngagane River				
2.1	Upper Ngagane to Ntshingwayo Dam	V31E	May13_EWR1	SWSA in upper reaches of Ngagane River catchment. Upper reaches of Ngagane River and Mahlonyane River in a B category, Klipspruit, Fouriespruit and Spectaclespruit are

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
				category C. Some FEPA (prioritized) wetlands. Impacts from old mines. Sampling points on WMS.
2.2	Ntshingwayo Dam	V31E		Within the Chelmsford Nature Reserve (V3H027); The use from the dam is increasing (80ML/d to Newcastle) and there are significant plans for greater supply from the dam for domestic supply to water resource strapped areas further away. The Ntshingwayo Dam has a flood operating rule in the summer months and makes some emergency releases during drought for abstractions downstream at Tayside for Glencoe and Dundee. Sampling points on WMS.
2.3	Horn to confluence with Ngagane	V31F	May13_EWR2	Extensive agriculture with irrigation; River is in a PES: E category because of quantity concerns; impacts from old mines. Ngagane Water Treatment Works - abstraction increases – upgrading to 220ML/d – will be upgraded in 30ML/d modules for Newcastle; first module being planned now. Sampling points on WMS.
2.4	Ncandu to confluence with Ngagane	V31H, J		SWSA in upper reaches of Ncandu River catchment. River is in a Category D PES and highly impacted downstream by Newcastle urban and industrial areas; upstream agricultural areas; FEPA wetlands (prioritized). AMCOR Dam at outlet (V3R002); Domestic discharges. Both active and old mines. Sampling points on WMS.
2.5	Ngagane from Ntshingwayo Dam to confluence with Buffalo	V31G, K	May13_EWR3	Extensive agricultural activities including irrigation and subsistence (considerable erosion); Mines, industrial areas, urban areas, Chivelston Power Station in lower portion of the catchment impact quality; Rivers in a category C. Sampling points on WMS.
IUA 3: Middle Buffalo River				
3.1	Dorps (including Kweek and Wasbankspruit) to confluence with Buffalo	V32A, B		Mainstem tributary; SWSA in upper reaches of the Dorps River catchment. Town of Utrecht; Category D because of quantity, fairly natural. Old mining activities that impact water quality – decants; Sabalele Nature Reserve in the town along the Dorpspruit River; Old mines along Swartkop Farms – quality concerns; sediment issues and vegetation impacts. Sampling points on WMS.
3.2	Tiyna, Eersteling	V32C, D		Tiyna is in a category C (some natural areas but also extensive subsistence agriculture and some irrigation), Eerstelingspruit is a category B (fairly natural); FEPA wetlands scattered throughout. Impacts from abandoned and operational mines. No sampling points.

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
3.3	Mbabane	V32C		Mbabane is in a category D (quality and quantity due to extensive villages, subsistence agriculture, extensive erosion); No sampling points.
3.4	Mzinyashana including Sterkstroom and Sandspruit	V32 E		Rivers are in a category C except for the Sandspruit which is in a category B, extensive agriculture, and irrigation; urban impacts from Town of Dundee; Coal mines, small nature reserve (Dr Alden Lloyd). Sampling points on WMS, although some points are difficult to access.
3.5	Buffalo from Ngagane to Blood River confluence	V32B, C, D, E, F		River is in a category B (large natural reaches of the river and subsistence agriculture), except for the reach in V32D which is in a category C (extensive irrigation in this area). Old mines decanting along the river. Sampling points on WMS, although some points are difficult to access.
IUA: 4: Lower Buffalo River				
4.1	Totololo, Batshe, Sibindi, Ngxobongo, Mangeni, Gubazi, Mazabeko catchments	V33A, B, C, D		Batshe and Ngxobongo in category D (quantity); Totololo River is a category C; Sibindi, Mangeni, Gubazi and Mazabeko rivers are categorised as B. Areas in upper portion of the RU – extensive erosion from subsistence agriculture, lower portions are largely natural and SWSA (upper Mangeni and lower Sibindi river catchments). Some FEPA wetlands in V33A. No sampling points.
4.2	Buffalo from Blood to Thukela confluence	V33A, B, C, D	Thukela_EWR14	Areas just downstream of Blood River confluence is in a category D to C (V33A - extensive subsistence agriculture; erosion) moving to a category B to the confluence with Thukela. In these areas the river flows through largely natural areas. Some FEPA wetlands along the river. Sampling points on WMS, although difficult to access.
IUA 5: Blood River				
5.1	Wetland RU: Blood River	V32G		SWSA in Upper portions of the Blood River; extensive FEPA wetlands (prioritized); river is in a category C; large rural villages; extensive subsistence agriculture and formal irrigation; erosion. Wetland RQOs. Operational mine (once abandoned). No sampling points, accessibility unsure.
5.2	Blood River from outlet of V32G to confluence with the Buffalo River	V32H		River is in a category C; large rural villages; extensive subsistence agriculture; limited formal irrigation; extensive erosion. No sampling points and accessibility unsure.

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
IUA 6: Sundays River				
6.1	Nkunzi to confluence with Sundays	V60B		Rivers are in a category C; SWSA on upper reaches of the Dwars and Nkunzi river catchments. Some natural areas in upper parts of the Nkunzi; agricultural activities with some irrigation; few FEPA wetlands (prioritized). Abandoned mines. Acid mine drainage decant. Sampling points on WMS.
6.2	Sundays from source to confluence with Wasbank	V60A, B, C	Thukela_EWR7	River is in a category C; SWSA in upper reaches of the Sundays River catchment; large rural villages; extensive subsistence agriculture, some formal irrigation (Irrigation Board Dam); erosion. Sampling points on WMS. Some points are difficult to access. Dangerous area.
6.3	Wasbank to confluence with Sundays	V60D, E		Upper reaches of the Wasbank and Mzamyana to confluence are in a category C, and below the confluence in a category D; FEPA wetlands; natural areas and irrigation; from the confluence of Wasbank and Mzamyana to confluence with Biggersgatspruit the river flows through fairly natural areas and is in a category B. After this the land use changes to extensive villages and subsistence agriculture and the river moves into a category C. Abandoned mines that will impact on Wasbank, decant. Some monitoring in the upper reaches. Acid mine drainage, nutrients. Sampling points on WMS Accessible via private cultivated land. Difficult to access. Dangerous area.
6.4	Sundays from Wasbank to Thukela confluence, including Nhlanyanga	V60F	Thukela_EWR8	SWSA in Nhlanyanga River catchment which is in a category B and flows through a natural area with very little development. The Sundays River in the RU is in a category C with some subsistence agriculture along the banks. Sampling points on WMS Difficult to access
IUA 7: Upper Mooi River				
7.1	Klein - Mooi from source to Mooi confluence	V20B (lower portion), D		Extensive formal agriculture (intensive dairy farms) and irrigation, tourism; rivers are in a category C; extensive FEPA wetlands throughout the RU. Accessible.
7.2	Nsonge tributary catchment	V20C		Extensive formal agriculture and irrigation, plantations, tourism; SWSA; river is in a category C ecologically; water quality seems good. FEPA wetlands, upper section of the river is part of the Ezemvelo KZN Tugela North Corridor; there is also the Hlatikulu Crane Sanctuary. Might consider wetland RQOs. Accessibility unsure.

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
7.3	Mooi upstream of Spring Grove Dam	V20A (lower portion), D (upper)		Extensive formal agriculture and irrigation, tourism; rivers are in a category C; extensive FEPA wetlands throughout the RU; SWSA. Accessible.
7.4	Spring Grove Dam	V20D		SWSA; Water transfer and irrigation (Mooi/Mgeni transfer scheme to keep Midmar full and support Mgeni). Accessible.
7.5	Downstream Spring Grove Dam to outlet of V20E	V20D (lower) and E	EWR_Mooi_N3	Extensive formal agriculture and irrigation, tourism; rivers are in a category C; extensive FEPA wetlands throughout the RU; urban impacts from town of Mooi River (predominantly domestic but some industrial). Accessible.
7.6	Joubertsvlei to confluence with Mooi	V20E		Plantations and irrigation; River is in a category E (quantity). Accessibility unsure.
IUA 8: Middle/ Lower Mooi River				
8.1	Mnyamvubu upstream Craigieburn Dam	V20F		Plantations, irrigation in the upper parts of the Mnyamvubu, large farm dam (PES: C); plantations and subsistence agriculture in Mpatheni (PES: D) and Rietvleispruit (PES: C); FEPA wetlands; Accessible.
8.2	Craigieburn Dam	V20F		SWSA; water supply and irrigation; earmarked for water supply to Greytown; fully allocated. Accessible.
8.3	Mnyamvubu downstream dam to confluence with Mooi	V20G		Plantations, irrigation in the upper parts of the Nyambathi River; some subsistence agriculture along the rivers; Mnyamvubu and Nyambathi rivers are in a PES: C category upstream of the confluence of the two; PES: B category after the confluence to the Mooi River. Accessible.
8.4	Mooi to Mnyamvubu confluence	V20G	EWR site 11	Main stem; PES: C category; subsistence agriculture and limited formal agriculture. Natural areas, some FEPA/ prioritised wetlands along the river. Accessible.
8.5	Mbalane, Mhlopeni, Tshekana, Tshekana, Umdumbeni, Loza catchments	V20H, J		Extensive subsistence and formal agriculture in lower portions of the river; Mbalane PES: B; other rivers in PES: C; Accessibility unsure.
8.6	Mooi from Mnyamvubu to Thukela confluence	V20H, J	Thukela_EWR12	Main stem; Extensive villages and subsistence and formal agriculture along the river; PES: C except for a short reach in V20H where PES: B; Accessible.

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
IUA 9: Middle/ Lower Bushmans River				
9.1	Mtshezana, Boesmans, Ncibidwana tributary catchments up to Wagendrift Dam	V70A (lower portion), B, C		SWSA; Mtshezana River PES: A; protected areas; Boesmans, and Ncibidwana – PES: B to confluence after which Boesmans PES: C; large natural areas, villages, tourism. REMP site – last monitored in 2017. Accessible in parts of the river.
9.2	Wagendrift Dam	V70C		SWSA; water supply and irrigation. Proposed hydroelectricity plant. Accessible.
9.3	Little Bushmans to confluence with Bushmans	V70D		SWSA; Priority wetlands, Little Bushmans River – PES: C; plantations in upper portion of the catchment; extensive rural villages; subsistence agriculture, tourism, fairly natural in lower reaches of the river. Accessible.
9.4	Bushmans from Wagendrift Dam to confluence with Rensburgspruit downstream of Estcourt	V70E, F, G		Main stem; Town of Estcourt with associated domestic wastewater treatment works; extensive rural villages; subsistence and formal agriculture and irrigation along the river; tourism; natural areas (portion of the Weenen Nature Reserve) in lower reaches; PES: C category, except for the lower portion which are in a PES: B. Accessible.
9.5	Bushmans from Rensburgspruit Dam to confluence with Thukela	V70F, G	EWR site 5	Main stem; Town of Weenen, with associated domestic wastewater treatment works; extensive rural villages; subsistence and formal agriculture and irrigation along the river; tourism; natural areas (portion of the Weenen Nature Reserve) in lower reaches; PES: C category, except for the lower portion which are in a PES: B. Accessible.
IUA 10: Upper Thukela River				
10.1	Thukela, Putterill, Majaneni, Khombe tributary catchments	V11A (lower portion), C, D		Main stem and tributaries; SWSA; PES: B except for Majaneni – PES: D; Kilburn Dam in upper reach of the Majaneni River; extensive agriculture (formal and subsistence throughout the RU); elevated nutrients, agriculture, number of small WWTWs; nature reserve in upper areas; Accessible.
10.2	Mweni tributary catchment	V11E		SWSA; Mnweni River – extensive rural villages and subsistence agriculture along the river – PES: C; Nxwaye River; flows through very natural areas; PES: B. Tourism. No sampling points.
10.3	Woodstock Dam	V11D, E		SWSA; Key water transfers are from the Tugela-Vaal Transfer Scheme transferring water to the Sterkfontein dam and eventually to the Vaal system. Sampling points on WMS.

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
10.4	Sandspruit tributary catchment	V11F		SWSA in upper reaches of Sandspruit; extensive rural villages and subsistence agriculture along the river – PES: C; tourism; Bergville – sewage related issues. Sampling points on WMS.
10.5	Mlambonja and tributaries	V11H		SWSA; extensive rural villages and subsistence agriculture along the river – PES: C; tourism. No sampling points.
10.6	Tugela between Driel and Spioenkop Dam	V11J, L	Thukela_EWR1	SWSA – upper reaches; Spioenkop Nature Reserve in lower reaches; tourism; extensive irrigation; PES: A/B. No sampling points.
10.7	Njongola, Venterspruit tributary catchments	V11K, L		Njonjola River – PES: B; and Geluksburgspruit – PES: A; in the SWSA; tourism, very natural; below the confluence the river becomes the Venterspruit and is in a PES: C category; extensive rural villages and subsistence agriculture along the river; considerable unlawful use (dams). No sampling points.
10.8	Spioenkop Dam	V11L		Spioenkop Nature Reserve; linked to Thukela-Vaal transfer; supply to Ladysmith; tourism; prioritised wetlands. No sampling points.
10.9	Spioenkop Dam to Little Thukela confluence	V11M	Thukela_EWR2	Main stem; PES: C; irrigation along the river; priority wetlands along the river; No sampling points.
10.10	Sterkspruit, Situlwane tributary catchment	V13B, D		SWSA; Sterkspruit - PES: B (upper reaches), PES: D in lower reaches (quantity); Situlwane – PES: C. Sterkspruit - extensive tourism - Okhahlamba National Park, plantations; extensive rural villages and subsistence agricultural (considerable erosion) in middle reaches with extensive agriculture and irrigation along lower reaches of Situlwane; No sampling points.
10.11	Little Tugela from IUA14 outlet to confluence with Thukela River	V13A (lower portion), C, E	Thukela_EWR3	SWSA (upper reaches) PES: C; Town of Winterton; extensive tourism - Okhahlamba National Park, plantations; extensive agriculture and irrigation along Sterkspruit and lower reaches of Little Tugela; extensive rural villages and subsistence agricultural along Little Tugela (considerable erosion). Sampling points on WMS. Difficult to access. Will have to find alternate access.
10.12	Tugela from Little Tugela confluence to proposed Jana Dam/ Klip confluence	V14A, B		PES: B; Agriculture and irrigation along Thukela River; Town of Colenso with associated domestic wastewater treatment works; large natural areas; irrigation upstream of Colenso.

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
				Difficult to sample. Sampling points on WMS however difficult to access. Will have to find alternate access.
IUA 11: Klip River				
11.1	Sandspruit and triburtaries	V12D, E and F		SWSA in upper reaches of the Sandspruit; tourism; agriculture in lower reaches; PES: C category; extensive villages and subsistence agriculture in lower reaches. No sampling points.
11.2	Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments	V12A, B, C,	EWR 3_Klipspruit	SWSA in upper reaches of the Klip and Braamhoekspruit river catchments; Ngula pump storage scheme; Klip upstream confluence with Braamhoekspruit - PES: A; Braamhoekspruit - PES: B; Ngogo upstream confluence with Tatana, PES: B; Mhlwane and Tatana – PES: C; extensive agriculture and irrigation; extensive villages and subsistence agriculture along the Klip. Sampling points on WMS.
11.3	Klip from Ladysmith to confluence with Thukela	V12G		Main stem; Town of Ladysmith and Ezakheni with associated domestic wastewater treatment works; Ladysmith industrial areas; Ndakane River that confluences with Klip River upstream Ezakheni is a PES: B; Klip River PES: C. Some NFEPA wetlands. Sampling points on WMS, however difficult to access.
IUA 12: Middle Thukela River				
12.1	Bloukrans, Drake, Mtontwanes, Nyandu tributary catchments	V14C, D		Extensive rural villages and subsistence agriculture (erosion); Bloukrans- PES C except for a reach below confluence with Drake, Mtontwanes - PES: B and Nyandu: PES: A; large natural areas here and in lower reaches of the Bloukrans; Accessible.
12.2	Thukela From Klip confluence to Bushmans confluence	V14E	EWR Site 4A and 4B	Main stem; PES: A; natural area; tourism; Accessible.
12.3	Sikhehlenga, Sampofu, Nadi tributary catchments	V60G, H, K		Extensive rural villages and subsistence agriculture (erosion); Rivers all in PES: C category; Accessibility unsure.
12.4	Thukela from Bushmans confluence to d/s Mooi confluence	V60G, H, J, K		Main stem: SWSA in upstream catchment of the Thukela/ Mooi confluence; Town of Tugela Ferry; Extensive rural villages and subsistence agriculture (erosion); PES: C with priority wetlands along the river. Accessible.

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
IUA 13: Lower Thukela River				
13.1	Mfongosi, Ngcaza, Manyane tributary catchments	V40A, B		SWSA; all rivers in a PES: B, large natural areas; smaller villages with subsistence agriculture; Accessibility unsure.
13.2	Thukela from d/s Mooi confluence to Middeldrift transfer	V40A, B		Main stem; River is in a PES: C; smaller villages with subsistence agriculture; Middeldrift pump station; likely to be used for increased volumes for Richards Bay (continuous supply); Accessibility unsure.
13.3	Nsuze from source to confluence with Thukela	V40C, D		SWSA; PES: A/B; tea plantations; large natural areas; smaller villages with subsistence agriculture. Accessibility unsure.
13.4	Mamba, Mambulu, Mpisi, Mati, Nembe, Otimati, Mandeni tributary catchments	V50A, B, C		SWSA; Mamba, Mambulu, Otimati and Nembe rivers in PES: B category; Mpisi and Mati in PES: C category; large natural areas; smaller villages with subsistence agriculture; Accessibility unsure.
13.5	Thukela from Middeldrift to reach in V50D	V40E, V50A, B, C	Thukela_EWR16	Main stem; PES: B category; smaller villages with subsistence agriculture along the river. Accessible.
IUA 14: Escarpment				
14.1	Upper reaches of Thukela River	V11A		Main stem; SWSA; Royal Natal National Park; tourism; PES: B; Sampling points on WMS.
14.2	Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River)	V11B		SWSA; Rivers are in PES: B; tourism. No sampling points.
14.3	Source to confluence of Mlambonja and Mhlwazini Rivers (Mlambonja River (upper); Mhlwazini River; Ndedema River; Ndumeni	V11G		SWSA; Rivers in PES: A and B; Cathkin Peak Forest Reserve; Cathedral Peak State Forest along the Ndedema River; tourism. Sampling points on WMS.

RU Number	Resource Unit (Description)	Quaternary catchment	EWR site	Rationale
	River; Thuthumi River)			
14.4	Upper reaches of Little Thukela River	V13A		SWSA; Giants Castle Game Reserve; tourism; PES: C; Accessible – Central Berg Area.
14.5	Upper reaches of Boesmans River	V70A		SWSA; Giants Castle Game Reserve; PES: A/B; Accessible – Central Berg Area.
14.6	Ncibidwana source to outlet of V70B	V70B		SWSA; small villages and subsistence agriculture in lower reaches if the Ncibidwana River; PES: B; tourism. Accessible – Central Berg Area.
14.7	Upper reaches of Mooi River	V20A		Main stem; SWSA; Ukhahlamba Drakensberg World Heritage Site; tourism; PES: C category. Accessible but dangerous.
14.8	Upper reaches of Little Mooi River	V20B		SWSA; tourism; PES: C category; Accessible.
IUA 15: Thukela Estuary				
15.1	Thukela reach upstream Estuary to Mngeni transfer	V50D (upper portion)	Thukela_EWR 17	Main stem. Town of Mandeni – urban areas; PES: ecological category B; Mgeni transfer station; Industrial area; Sappi Mandeni Mill; tourism. Sampling point on WMS.
15.2	Estuary (8.5 km upstream)	V50D	Thukela_EWR 18	Main stem. Protected Area; PES: C; Harold Johnson Nature Reserve; urban areas; tourism. No sampling point, accessibility unsure.

SWSA: Strategic Water Source Area; PES: Present Ecological Status

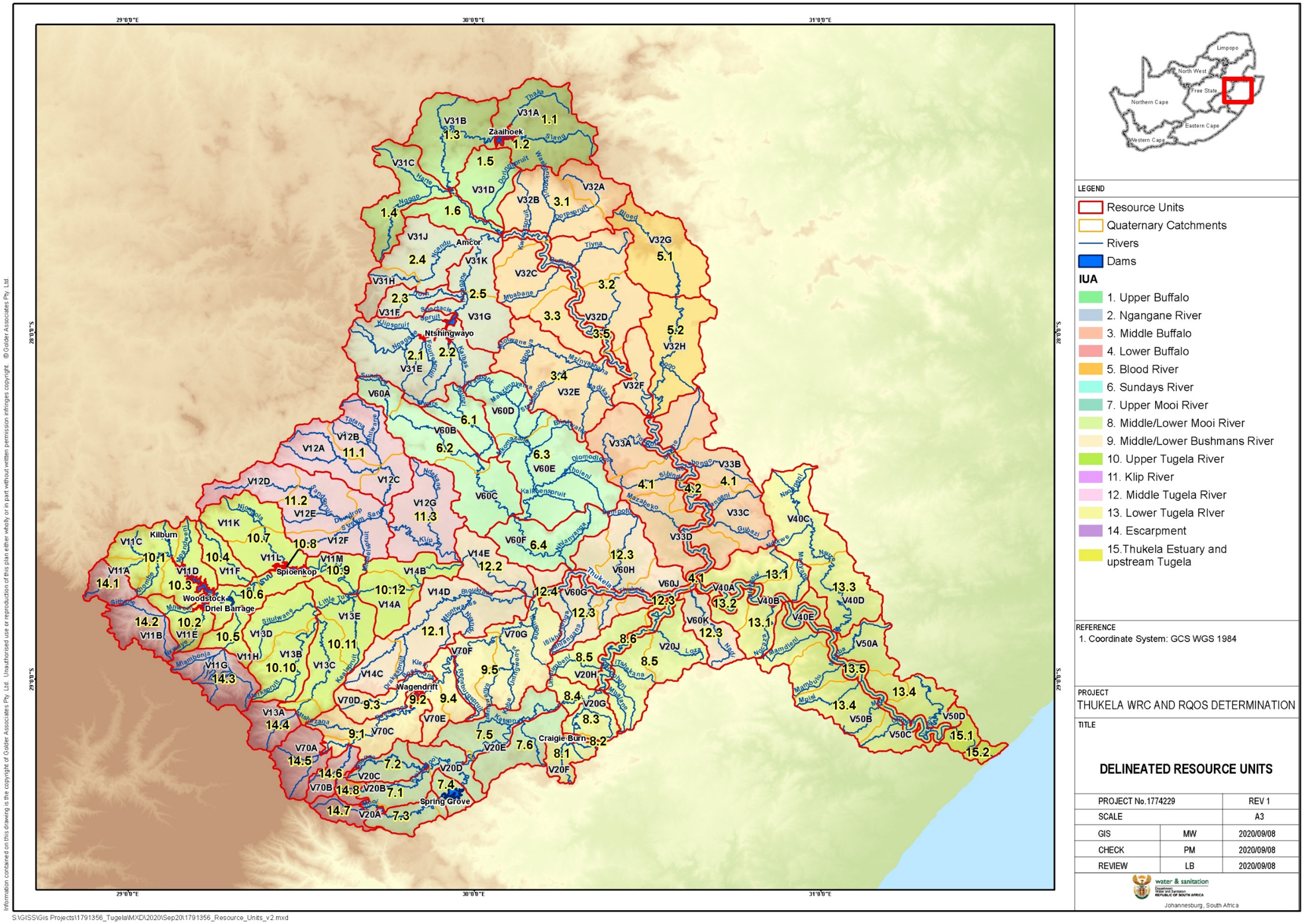

Figure 7: Delineated Resource Units

6 RESOURCE UNIT PRIORITISATION

While the RQO determination procedure proposes that RQOs be set for each resource unit, this may not always possible due the potentially large number of RUs that could be delineated for a catchment. A rationalisation process has therefore been developed as part of the RQO Determination Procedure (DWA, 2011) in order to prioritise and select the most useful RUs for RQO determination. These will then be taken through stakeholder consultation with relevant stakeholders to confirm priority.

The rationalisation process for RU selection and prioritisation is based on a 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 include:

- 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.

Standardised rankings and weightings are proposed for each of the seven criteria above used in the prioritisation process by application of the tool. The RU Prioritisation Tool comprises of a simple scoring system where a score of 0, 0.5 or 1 is assigned to the criteria to assess conformance to the guidelines supporting criterion. The rating scores then go through ranking, relative weighting and multiplication allows for the relative prioritisation of RUs to be determined, by producing a prioritisation score – the priority rating of the RU (DWA, 2011). The priority rating scores the RUs relative to each other and considers the summary scores for the criteria. This provides an integrated measure to inform the selection of RUs. However, these values may be altered if strong motivation exists and may be adjusted to suite the current context. The process also requires that a rationale is provided for the selection of priority RUs as in some cases low and moderate rated RUs may be selected over higher rated ones (DWA, 2011).

While the tool may be applied using desktop information, local knowledge and good understanding of the catchment is required to obtain optimal results.

6.1 Resource Unit Prioritisation Based on Assessment Criteria

As described above the Resource Unit Prioritisation Tool incorporates seven criteria that are scored, ranked, weighted, rated, and assessed. The criteria assessed to prioritise the RUs are described in Table 8.

Table 8: Resource Unit Prioritisation Criteria

Criterion	Description and Reasoning	Sub-criteria rated per criterion per RU (0: low, 0.5: moderate or 1: high)
Position of RU within IUA	This is the first criterion that is considered within the RU Prioritisation Tool. Resource Units on large main stem rivers at the downstream end of the IUAs are located at the edge of socio-economic zones where user requirements are likely to differ. Such Resource Units also aggregate the upstream impacts from the entire IUA and thus enable the assessment of management performance at meeting objectives (including the gazetted IUA Class) for the upstream catchment. These RU thus receive high prioritisation in the Tool. It is important to note that estuaries will always be prioritised in this way (DWA, 2011).	Resource Units located on large main stem river at the downstream end of the IUA (IUA outlet node)
Assessment of the importance of each Resource Unit to users	This is the second criterion assessed and considers both current and future use. The tool assesses a number of sub-criteria relevant to different user considerations.	Resource units which provide important cultural services to society Resource units which are important in supporting livelihoods of significant vulnerable communities Resource units which are important in meeting strategic requirements and international obligations Resource units that provide supporting and regulating services Resource units most important in supporting activities contributing to the economy (GDP & job creation) in the catchment (e.g. commercial agriculture, industrial abstractions, and bulk abstractions by water authorities)
Level of threat posed to the water resource quality for users	This assessment considers the risk of the water resources to the users. Resource units which are threatened or are likely to be threatened by current or future activities should be monitored (most likely to be impacted by high risk activities)	Level of threat posed to users
Ecological importance	This criterion is assessed to identify resource units that are important from an ecological perspective. A range of attributes relative to the water resource are considered.	Ecological Importance and Sensitivity Categories (EIS) Present Ecological State (PES) and Nested Ecological category (NEC) National Freshwater Ecosystem Priority Areas

		Priority habitats/species identified in provincial conservation plans
Threat posed to the water resource quality for the environment	This criterion is assessed to identify RUs which are threatened or are likely to be threatened by current or future activities that should be monitored due to the risk posed to the ecological elements of the water resource. This considers those RUs most likely to be impacted by high risk activities.	Level of threat posed to the ecological components of the resource unit
Management considerations	This criterion requires the assessment of RUs where management actions should be prioritised. This applies to RUs or reaches where it is necessary to monitor the effectiveness of measures implemented to improve status quo.	Resource Units with PES lower than a D category or lower than the accepted gazetted category (NEC)
Practical considerations	In addition, the above practical considerations are also considered if RQOs can be determined and monitored.	Availability of EWR site data or other monitoring data (RHP, DWA gauging weirs) located within reach Accessibility of resource units for monitoring Safety risk associated with monitoring resource unit

The Resource Unit Prioritisation Tool was applied at a desktop level considering the information presented by the specialists in the Status Quo and delineation of IUAs report (Report number: RDM/WMA04/00/CON/CLA/0320). The desktop results were presented and discussed with specialists and catchment water resource managers to obtain their input on the rating of the resource units. Based on their local knowledge and understanding of the study area the desktop prioritisation scores were revised, and the RUs selected and prioritised. These results were workshopped with the relevant catchment managers responsible for the area. The results of the prioritisation rating process are included in Appendix A and presented in Figure 6 and Figure 7. The overall prioritisation rating score per RU for the Thukela catchments are listed below in Table 9. The resource units rated as high and in cases where the moderate rating was at 0.7, have been prioritised for RQO development.

Table 9: RU Delineation Priority based on rating score

RU Number	Resource Unit (Description)	Quaternary catchment	Overall prioritisation rating (based on above criteria)
IUA 1: Upper Buffalo River			
1.1	Wetland resource unit: Wakkerstroom	V31A	High
1.2	Zaaihoek Dam	V31A	Moderate
1.3	Buffalo and Slang	V31B	High
1.4	Ngogo and Harte to confluence with Buffalo	V31C	Low
1.5	Doringspruit catchment	V31D	Moderate

RU Number	Resource Unit (Description)	Quaternary catchment	Overall prioritisation rating (based on above criteria)
1.6	Buffalo to confluence to Ngagane	V31C, D	High
IUA 2: Ngagane River			
2.1	Upper Ngagane to Ntshingwayo Dam	V31E	High
2.2	Ntshingwayo Dam	V31E	Moderate
2.3	Horn to confluence with Ngagane	V31F	Moderate
2.4	Ncandu to confluence with Ngagane	V31H, J	High
2.5	Ngagane from Ntshingwayo Dam to confluence with Buffalo	V31G, K	High
IUA 3: Middle Buffalo River			
3.1	Dorps (including Kweek and Wasbankspruit) to confluence with Buffalo	V32A, B	Moderate
3.2	Tiyna, Eersteling	V32C, D	Moderate
3.3	Mbabane	V32C	Moderate
3.4	Mzinyashana including Sterkstroom and Sandspruit	V32 E	Moderate
3.5	Buffalo from Ngagane to Blood River confluence	V32B, C, D, E, F	High
IUA: 4: Lower Buffalo River			
4.1	Totololo, Batshe, Sibindi, Ngxobongo, Mangeni, Gubazi, Mazabeko catchments	V33A, B, C, D	Low
4.2	Buffalo from Blood to Thukela confluence	V33A, B, C, D	High
IUA 5: Blood River			
5.1	Wetland RU: Blood River	V32G	High
5.2	Blood River from outlet of V32G to confluence with the Buffalo River	V32H	High
IUA 6: Sundays River			
6.1	Nkunzi to confluence with Sundays	V60B	Moderate
6.2	Sundays from source to confluence with Wasbank	V60A, B, C	High
6.3	Wasbank to confluence with Sundays	V60D, E	High
6.4	Sundays from Wasbank to Thukela confluence, including Nhlanyanga	V60F	High
IUA 7: Upper Mooi River			

RU Number	Resource Unit (Description)	Quaternary catchment	Overall prioritisation rating (based on above criteria)
7.1	Klein - Mooi from source to Mooi confluence	V20B (lower portion), D	High
7.2	Nsonge tributary catchment	V20C	Moderate
7.3	Mooi upstream of Spring Grove Dam	V20A (lower portion), V20D (upper)	High
7.4	Spring Grove Dam	V20D	Moderate
7.5	Downstream Spring Grove Dam to outlet of V20E	V20D (lower) and V20E	High
7.6	Joubertsvlei to confluence with Mooi	V20E	Moderate
IUA 8: Middle/ Lower Mooi River			
8.1	Mnyamvubu upstream Craigieburn Dam	V20F	Moderate
8.2	Craigieburn Dam	V20F	Low
8.3	Mnyamvubu downstream dam to confluence with Mooi	V20G	High
8.4	Mooi to Mnyamvubu confluence	V20G	High
8.5	Mbalane, Mhlopeni, Tshekana, Tshekana, Umdumbeni, Loza catchments	V20H, J	Moderate
8.6	Mooi from Mnyamvubu to Thukela confluence	V20H, J	High
IUA 9: Middle/ Lower Bushmans River			
9.1	Mtshezana, Boesmans, Ncibidwana tributary catchments up to Wagendrift Dam	V70A (lower portion), B, C	Moderate
9.2	Wagendrift Dam	V70C	Moderate
9.3	Little Bushmans to confluence with Bushmans	V70D	Moderate
9.4	Bushmans from Wagendrift Dam to confluence with Rensburgspruit downstream of Estcourt	V70E, F, G	High
9.5	Bushmans from Rensburgspruit Dam to confluence with Thukela	V70F, G	High
IUA 10: Upper Thukela River			
10.1	Thukela, Putterill, Majaneni, Khombe tributary catchments	V11A (lower portion), C, D	High
10.2	Mweni tributary catchment	V11E	Low
10.3	Woodstock Dam	V11D, E	High
10.4	Sandspruit tributary catchment	V11F	High

RU Number	Resource Unit (Description)	Quaternary catchment	Overall prioritisation rating (based on above criteria)
10.5	Mlambonja and tributaries	V11H	Low
10.6	Tugela between Driel and Spioenkop Dam	V11J, L	High
10.7	Njongola, Venterspruit tributary catchments	V11K, L	Moderate
10.8	Spioenkop Dam	V11L	High
10.9	Spioenkop Dam to Little Thukela confluence	V11M	High
10.10	Sterkspruit, Situlwane tributary catchment	V13B, D	Moderate
10.11	Little Tugela from IUA14 outlet to confluence with Thukela River	V13A (lower portion), C, E	Moderate
10.12	Tugela from Little Tugela confluence to proposed Jana Dam/ Klip confluence	V14A, B	High
IUA 11: Klip River			
11.1	Sandspruit and triburtaries	V12D, E and F	Moderate
11.2	Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments	V12A, B, C,	High
11.3	Klip from Ladysmith to confluence with Thukela	V12G	High
IUA 12: Middle Thukela River			
12.1	Bloukrans, Drake, Mtontwanes, Nyandu tributary catchments	V14C, D	Low
12.2	Thukela From Klip confluence to Bushmans confluence	V14E	High
12.3	Sikhehlenga, Sampofu, Nadi tributary catchments	V60G, H, K	Low
12.4	Thukela from Bushmans confluence to d/s Mooi confluence	V60G, H, J, K	High
IUA 13: Lower Thukela River			
13.1	Mfongosi, Ngcaza, Manyane tributary catchments	V40A, B	Low
13.2	Thukela from d/s Mooi confluence to Middeldrift transfer	V40A, B	High
13.3	Nsuze from source to confluence with Thukela	V40C, D	Low
13.4	Mamba, Mambulu, Mpisi, Mati, Nembe, Otimati, Mandeni tributary catchments	V50A, B, C	Moderate
13.5	Thukela from Middeldrift to reach in V50D	V40E, V50A, B, C	High

RU Number	Resource Unit (Description)	Quaternary catchment	Overall prioritisation rating (based on above criteria)
IUA 14: Escarpment			
14.1	Upper reaches of Thukela River	V11A	High
14.2	Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River)	V11B	High
14.3	Source to confluence of Mlambonja and Mhlwazini Rivers (Mlambonja River (upper); Mhlwazini River; Ndedema River; Ndumeni River; Thuthumi River)	V11G	Moderate
14.4	Upper reaches of Little Thukela River	V13A	High
14.5	Upper reaches of Boesmans River	V70A	High
14.6	Ncibidwana source to outlet of V70B	V70B	Low
14.7	Upper reaches of Mooi River	V20A	High
14.8	Upper reaches of Little Mooi River	V20B	Low
IUA 15: Thukela Estuary and upstream Thukela reach			
15.1	Thukela reach upstream Estuary to Mngeni transfer	V50D (upper portion)	High
15.2	Estuary (8.5 km upstream)	V50D	High

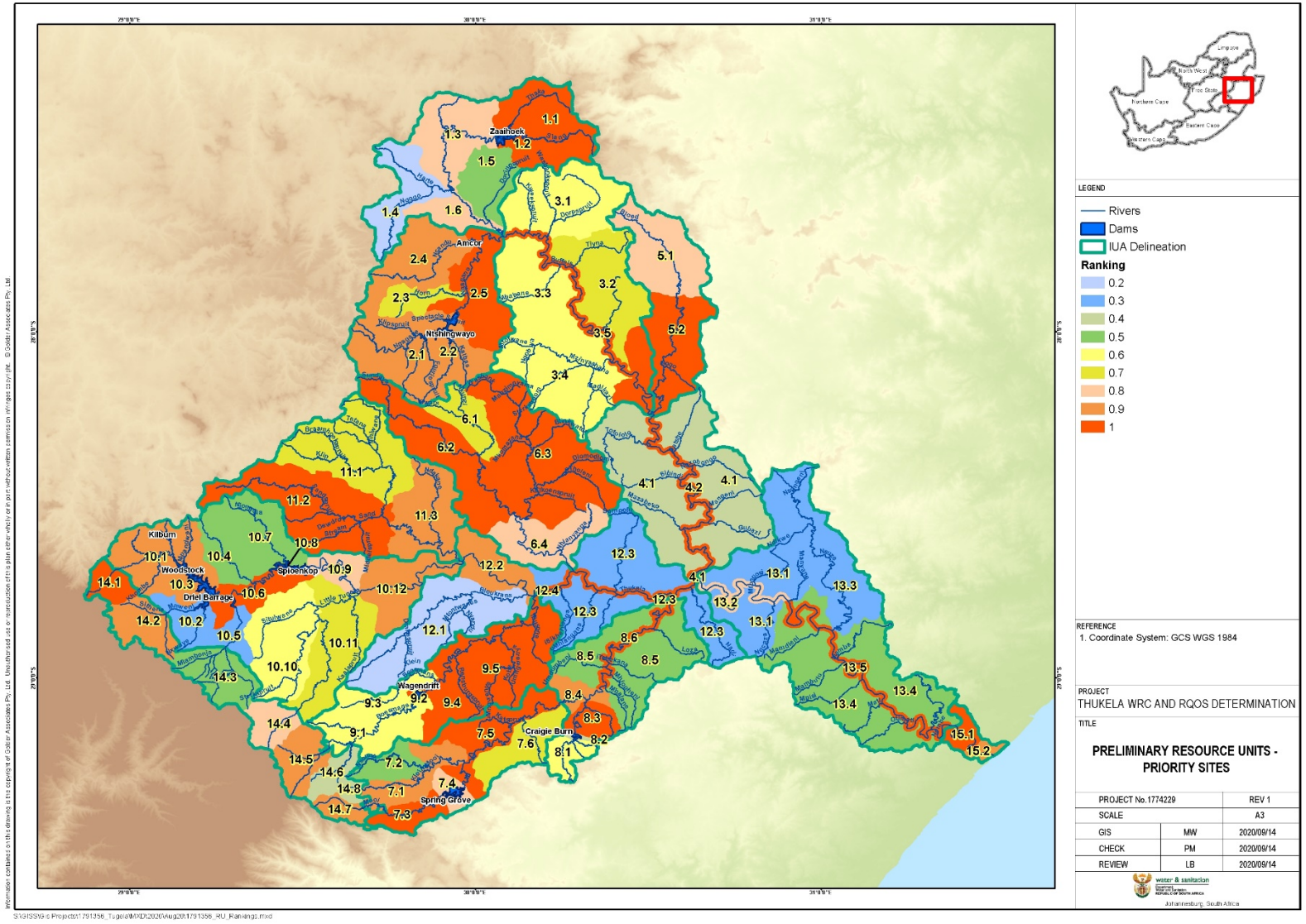

Figure 8: Prioritisation ratings of RUs based on the application of the RU Prioritisation Tool

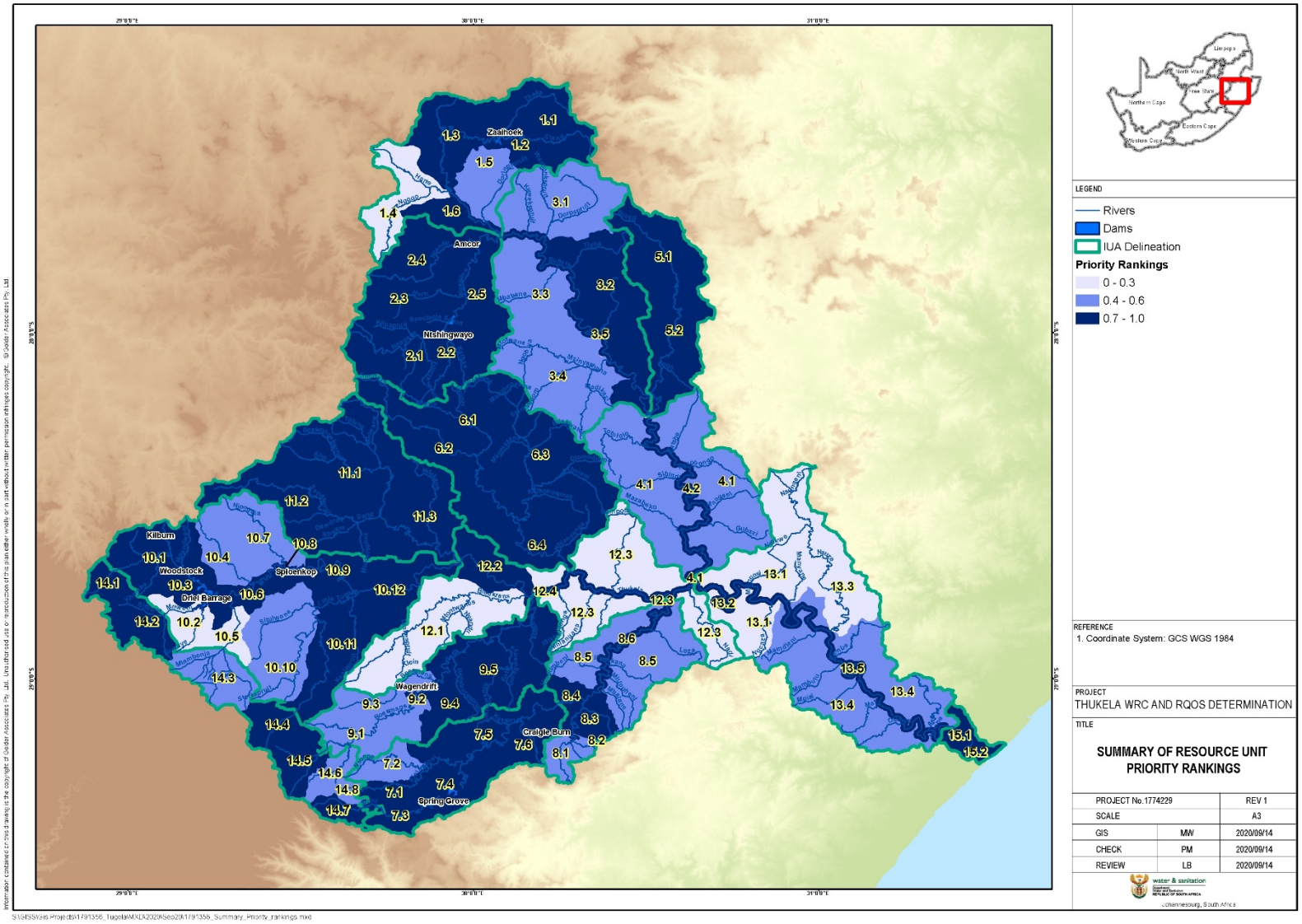

Figure 9: Summary of the Prioritisation ratings of RUs (Dark blue being of higher priority in terms of setting RQOs)

7 GROUNDWATER RESOURCE UNITS

7.1 Introduction

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 from 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” system, *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, i.e. 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.

Groundwater yields in the catchment vary significantly between the different aquifer classifications:

- Fractured Aquifer yield ranges: Moderate to High – (0.1-0.5 to 2.0 L/s),
- Fractured and Intergranular Aquifer yield ranges: Moderate to High – (0.1-0.5 to 2.0 L/s),
- River-alluvium Aquifer yield ranges: Low to High (<2.0 L/s), and
- Dolerite contact-zone Aquifer yield ranges: Significant (>5 L/s).

Due to the variable rainfall and recharge in the Thukela catchment, groundwater recharge and potential varies significantly.

The groundwater exploitation potential in the catchment can be classified as moderate with resources mostly suitable for development of small reticulation schemes i.e., local domestic use. There are, however, [and specifically in IUA 10, Upper Thukela River] rural groundwater supply schemes that should be managed focussing on long-term sustainability.

Groundwater potential based on recharge and use (i.e., reserve requirements and allocable yield) indicate that groundwater resources in certain UIAs are underutilised, i.e., less than 25% of groundwater potential is presently used. There are, however, some QCs where the groundwater use is significantly high, for example, less than 3 Mm^3/a is available for allocation as use – these QCs are considered for the development of "stressed-type" resource quality objectives based on the current groundwater allocations and stress factor status.

7.2 Approach

A comprehensive study of the groundwater Reserve for the Thukela Catchment was conducted in 2009 and most of the baseline groundwater characteristics evaluated in that study are still applicable to the current groundwater occurrences and characteristics. Due to the prolonging drought conditions in southern Africa since 2009, it was necessary to consider aquifer storage conditions, *i.e.*, considering the status of aquifer saturation levels.

In respect of groundwater, the study area was originally divided into four sub-catchments: Upper Thukela, Buffalo, Mooi/Sundays and Lower Thukela catchments and each area was then sub-divided into smaller, and in most cases quaternary catchments based on the following criteria:

- Geology,
- Climate,
- Topography and geomorphology,
- Recharge,
- Groundwater levels and flow directions,
- Groundwater quality,
- Groundwater use (and stress), and
- Groundwater-dependent ecosystems.

In total, 23 groundwater resource units were delineated, numbered RU A to RU Y. The characteristics of each GRU included the following attributes (much related to associated hydrological conditions of the resource units of which the groundwater recharge was probably the most important attribute of them all):

- Terrain conditions – mountainous area, and quaternary catchments),
- Recharge estimations based on
  - Terrain lithology (geological members, i.e. arenites, shale, mudrock or dolerite capping), and
  - The National Groundwater Maps (WRC, 1995).
- Detail geology.

Aquifer Stress Index factors were regarded as important attribute for identification of specific groundwater resource units, secondly, potential impacts of the groundwater quality due to mining/industrial/agricultural activities were also considered.

7.3 Resource Unit Delineation Results

The groundwater resource units (RU A to RU Y, dated 2009) were based on the quaternary catchment boundaries and, therefore, do not fit e.g., the 2020 demarcations of the IUAs. It has, therefore, been decided to adjust the original groundwater RUs to coincide with the surface water IUAs. It was only a small fraction of the total QCs that were "regrouped" to fit the 2020 demarcations of the IUAs. As a result, the total water resource classification and resource quality objectives are now based on the same set of IUAs and there is no need to have specific references when discussing, for example, the interaction between surface and groundwater resources as if they are listed in different IUA groups.

This "regrouping" of the original GRUs to fit into the 2020 IUAs required a reassessment of the 2009 classification and Reserve listing. Since the regrouping process resulted simply in included or excluded adjacent quaternary catchments into a new demarcation for a specific groundwater and surface water IUA, these changes are not critical as the criteria originally used for the groundwater RUs are based on some degree of interpolation between larger spatial units – for example, groundwater recharge is not specifically set for individual quaternary catchments, but merely much larger regions.

The process followed to conduct the groundwater RU prioritisation were based on the following criteria:

- RUs where aquifer sustainability due to recharge and saturation levels (*viz*. water level trends) are a concern due to over abstraction and/or insignificant replenishment may occur,
- RUs where groundwater quality is a concern due to natural elevated dissolved ionic concentrations – mainly sodium-chloride and fluoride which is the result of the paleo-environmental conditions during sedimentation in the Karoo Basin, and
- RUs where groundwater quality is a concern due to induced deterioration as the result of production/storage of concentrated waste material (*i.e.,* mining/ industrial/ agricultural/ sewage processes).

The relevant quaternary catchments are illustrated in Figure 9 and they are grouped into the latest surface water resource unit configurations.

7.4 Resource Units Consideration for Prioritisation

Table 10 describes groundwater characteristics and strategic aquifer importance per groundwater resource units.

The most critical aspect of these resources units is (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 (*viz*. IUA 14), the local water table is above 5 m below ground surface.

The selected RUs resource classifications are all a class C (marginal) and above with a few "natural (Ideal)[1] to good", however, several "hotspots" where the total dissolve solids (TDS) are above 2 400 mg TDS/L – representing a "Poor" water quality class.

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 – they are as follow:

- RUs V32B to V32D (IUA 3),
- RUs V60A, V60B, V60C, V60D and V60E (IUA 6),
- RUs V11M, V13E and V14A (IUA 10),
- RU V70C (IUA 9), and
- RUs, V11C, V11D, V11F and V11J.

The remaining groundwater RUs should be regarded as "moderate" at this point in time, however, it is probably an appropriate opportunity to define clear resource quality objectives that can be implemented as request for groundwater exploitation and other future water uses are developing.

[1] Water Research Commission, *et al*, 1998: Quality of Domestic Water Supplies (Volume 1 – Assessment Guide), 2nd Edition.

Table 10: Description of the Groundwater Resource Units in the Thukela Catchments

IUA	Groundwater Resource Unit (QC)	Specific concern	Groundwater Quality characteristics	Groundwater Quantity characteristics	Strategic Aquifer Importance
IUA 2: Ngagane River	V31E, V31F, V31G and V31K.	Induced aquifer water quality issues (mining).	Water quality: - Classification = C/D (marginal to poor at hotspot s (mines))	Area with moderate annual rainfall events and depths - 2-4% annual recharge - Stress Index: 44%	Moderate groundwater use: - Major wetland area in QC V31E - "Isolated" mining areas potential water quality deterioration.
IUA 3: Middle Buffalo	V32B, V32C, V32D, V32E and V32F.	Aquifer storage potential and induced aquifer water quality (mining).	Groundwater quality deterioration due to decanting [redundant] coal mines into surface water drainages. Classification = D (poor)	Area with moderate annual rainfall events and depths - 2-4% annual recharge - Stress Index >65%	Aquifer systems are over-utilized: - Specifics of monitoring network and programmes to be assessed/ implemented. - Vulnerable aquifer system to be investigated (viz. River-Alluvium) Mapping of so-called “hotspots” to be considered.
IUA 5: Blood River	V32G and V32H.	Aquifer storage potential (water level depletions).	Water quality: Classification = C (marginal)	Area with moderate annual rainfall events and cyclic water level trends - 2-4% annual recharge - Stress Index >65%	Indications of high groundwater use: - Major wetland area in QC V32G - Forestry areas present in this IUA.
IUA 6: Sundays River	V60A, V60B, V60C, V60D and V60E.	Hotspots related to (i) high abstractions and (ii) mining/industrial pollution.	Classification = B (Good).	Area with moderate annual rainfall events and cyclic water level trends - 4% annual recharge, - Stress Factor is >65%.	Potential coal mining in the RU. Karoo dolerite intrusions occurs which could support local water supply developments.

IUA	Groundwater Resource Unit (QC)	Specific concern	Groundwater Quality characteristics	Groundwater Quantity characteristics	Strategic Aquifer Importance
IUA 7: Upper Mooi River	V20C, V20D and V20E.	Aquifer storage potential (water level depletions) and natural water quality condition (elevated fluoride).	Natural salinity (Na-Cl) and elevated fluoride. Classification = B/C (good to marginal);	Area with high annual rainfall events and depths - 8% annual recharge. - Stress factor 44%	Area with good rainfall recharge and aquifer stress factor still moderate (i.e. use allocations possible), but water quality needs to be observed if used extensively for domestic consumption.
IUA 8: Middle/Lower Mooi River	V20F, V20G, V20H and V20J.	Natural water quality condition (elevated fluoride).	Impact from geology less prominent - water quality typical Ecca Group with slightly elevated natural salinity. Classification = C (marginal)	Area with high annual rainfall events and depths - 4% annual recharge. - Stress factor <35%	Aquifer stress factor moderate (+) (i.e. use allocations possible), but water quality needs to be observed is used extensively for domestic consumption. Note: Potential coal mining in the RU.
IUA 10: Upper Thukela	V13A, V13B, V13C, V13D V11K and V11L.	Aquifer storage potential (water level depletions) and natural water quality condition.	Groundwater quality has a natural salinity signature due to the argillaceous nature of the rock formations - sodium (Na), chloride (Cl) and in some cases fluoride (F). Classification = C (marginal)	IUA falls close to the Drakensburg Escarpment with high rainfall depths thus aquifer replenishment is on a regular annual interval - ~5-7% annual recharge; - Stress factor: <43%	Karoo aquifers in the Uthukela District Municipal area is a concern ITO over-utilization: Impacts due to afforestation assessed. Wetland (several) water source to be confirmed (Gw?): - specifically, QC V11L Water quality deterioration due the population expansion (specifically nitrate concentrations).

IUA	Groundwater Resource Unit (QC)	Specific concern	Groundwater Quality characteristics	Groundwater Quantity characteristics	Strategic Aquifer Importance
	V11M, V13E V14A; V14C and V14D.	Aquifer storage potential (water level depletions).	Classification = A/B (natural/good), a few hotspot areas present around populated areas.	High rainfall depths thus aquifer replenishment is on a regular annual interval - ~5-8% annual recharge; - Stress factor: >70% in V11M, V13E and V14A♦. - Stress factor: <50% in V14C and V14D	Over-utilization at local scale foreseen for high stress factor area♦. Trends for nitrate concentration need to be observed timely (quarterly).
	V11F; V11J;; V11C and V11D	Shallow water table conditions (pollution risks), and Aquifer storage potential (water level depletions).	Classification = A/B (natural/good)	High rainfall region - ~5-8% annual recharge. Groundwater stress factor just below 65%	Over-utilization at local scale foreseen for high stress factor areas. Potential development of local water resources for domestic water supplies.
IUA 11: Klip River	V12D, V12E, V12 F; and V12G	Aquifer storage potential (water level depletions) due to groundwater use (requires verification of use).	Water quality: - Classification C (marginal)	Area with high annual rainfall events and depths - ~6% annual recharge - Stress Index >65%	High dependence for groundwater base flow. Moderate to high groundwater use: - "Isolated" industrial/ mining areas potential water quality deterioration.
IUA 14: Escarpment and IUA 7: Upper Mooi River	V20A, V20B, V20C, V20D and V20E	Potential risk in natural water quality condition.	Natural salinity (Na-Cl) and elevated fluoride. Classification = A/B (natural/good).	Area with high annual rainfall events and depths - 8% annual recharge - Stress Factor 44%	Protection of local aquifer systems: - Hotspots sites in QC V70C. Shallow groundwater table is a risk in these IUAs at waste sites and cemeteries.
IUA 14: Escarpment and IUA 9: Middle/ Lower Bushmans River	V70A, V70B, V70C, V70D and V70E	Potential risk in natural water quality condition – specific ally QC V20C.		Area with high annual rainfall events and depths - 8% annual recharge - Stress Factor 55%	

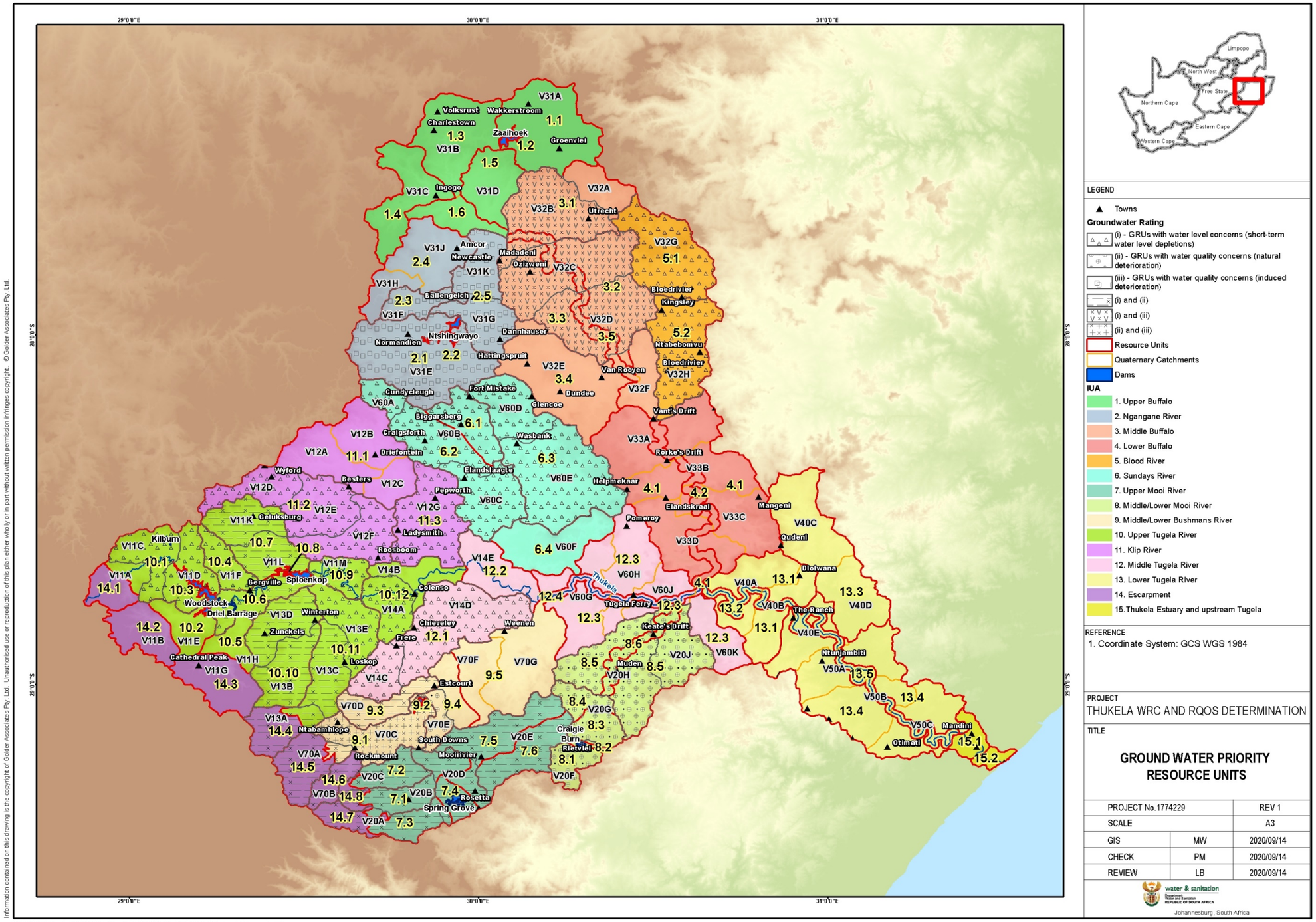

Figure 10: Groundwater Resource Units

8 WETLANDS

The Thukela catchment includes a number of protected wetland systems and areas. A very well-known priority wetland is the Wakkerstroom Vlei, particularly for birding. The wetlands and sponges in the upper and middle Drakensberg are at present not under major threat of destruction due to their remoteness and the fact that they are within a protected area. These resources need to be preserved as far as possible due to their critical role in supplying baseflows to all the rivers. Also included in the Thukela catchment is part of the Natal Drakensberg Park Ramsar Site[2] which includes mountain catchments with wetlands associated with wilderness areas, nature reserves, and state forests. This area forms the border between South Africa and the Kingdom of Lesotho and is an important mountain catchment area in South Africa due to its high yield and very good water quality, supplying rural, agricultural, urban, and industrial users downstream, including transfers to the Vaal system. A number of systems, including valley bottom and floodplain systems, also occur along the headwaters and main stems of some of the river systems draining the broader Thukela catchment.

Table 11 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).

[2] www.Ramsar.org – Annotated List of Wetlands of International Importance – South Africa

Table 11: Proposed Priority Wetlands

IUA	RU	Wetland	Type	PES	NWM5 Wetland Vegetation Group and Threat Status	Located within a Threatened Ecosystem	Unique Features
1: Upper Buffalo River	1.1	Groenvlei	**Unchannelled Valley Bottom (51.5 %)** Seep (45.5%) Floodplain (3.0%)	A/B - 5.5 % **C - 62.5 %** D/E/F - 32.0 %	Mesic Highveld Grassland Bioregion. Mesic Highveld Grassland (Valley Bottom) - CR Mesic Highveld Grassland (Seep) - CR Mesic Highveld Grassland (Floodplain) - CR	Marginally within Wakkerstroom/ Luneburg Grasslands (EN)	
	(	Wakker-stroom	**Channelled Valley Bottom (39.0 %)** Floodplain (27.5 %) Seep (23.5 %) Unchannelled Valley Bottom (9.5 %) Depression	A/B - 11.5 % C - 14 % **D/E/F - 74.5 %**	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	Wakkerstroom/ Luneburg Grasslands (EN)	Peatland. Working for Wetlands rehabilitation structures. Wattled, Blue and Southern Grey Crowned Cranes. White-winged Flufftail.
3: Middle Buffalo River	3.1 and marginally into 3.5	Boschoffs-vlei	Channelled Valley Bottom (70.5 %) Seep (20.5 %) Unchannelled Valley Bottom (6.5 %) Depression	A/B - 2.0 % C - 3.0 % D/E/F - 95.0 %	Mesic Highveld Grassland Bioregion and extends into Sub-Escarpment Grassland Bioregion. Mesic Highveld Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment	Eastern Temperate Freshwater Wetlands (VU)	Only large endorheic depressions recorded in catchment, slightly saline. Blue and Grey Crowned Cranes known to utilise wetland.

IUA	RU	Wetland	Type	PES	NWM5 Wetland Vegetation Group and Threat Status	Located within a Threatened Ecosystem	Unique Features
					Grassland (Depression) - EN		
5: Blood River	5.1 and marginally into 5.2	Blood River Vlei	**Channelled Valley Bottom (96.0 %)** Unchannelled Valley Bottom (2.5 %) Seep (1.0 %) Depression	C - 1.5 % **D/E/F - 98.5 %**	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	Extends marginally into eMondlo Sandy Moist Grassland (VU) & Paulpietersberg Moist Grassland (VU)	High diversity of habitat types. Blue and Grey Crowned Cranes observed. Working for Wetlands rehabilitation structures.
	5.1 & 3.1	Upper Bloed	**Seep (76.0 %)** Channelled Valley Bottom (23.5 %) Depression (0.5 %)	A/B - 19.5 % C - 4.5 % **D/E/F - 76.0 %**	Mesic Highveld Grassland Bioregion. Mesic Highveld Grassland (Valley Bottom) - CR Mesic Highveld Grassland (Seep) - CR Mesic Highveld Grassland (Depression) - LC	Eastern Temperate Freshwater Wetlands (VU)	
6: Sunday River	6.2	Boschbergvlei	**Depression (90.0 %)** Seep (9.5 %) Channelled Valley Bottom (0.5 %) Unchannelled Valley Bottom	A/B - 0.5 % **C - 90.5 %** D/E/F - 9.0 %	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR	Nkunzi/ Sundays River Grasslands (VU)	Working for Wetlands rehabilitation structures.

IUA	RU	Wetland	Type	PES	NWM5 Wetland Vegetation Group and Threat Status	Located within a Threatened Ecosystem	Unique Features
					Sub-Escarpment Grassland (Depression) - EN		
	6.3	Paddavlei	**Seep (57.0 %)** Channelled Valley Bottom (40.0 %) Unchannelled Valley Bottom (3.0 %)	A/B - 3.0 % C - 3.0 % **D/E/F - 94.0 %**	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR	Not applicable	Working for Wetlands rehabilitation structures.
7: Upper Mooi River (and portion of 14: Escarpment)	14.7 & 7.3 and marginally into 7.1	Stillerust	**Floodplain (53.5 %)** Channelled Valley Bottom (25.5 %) Seep (18.0 %)	A/B - 13.5 % C - 3.5 % **D/E/F - 83.0 %**	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Floodplain) - CR	Drakensberg Foothill Wattled Crane Habitat (VU)	Ukhahlamba Drakensberg Park.
	7.2	Hlatikulu	**Channelled Valley Bottom (88.5 %)** Unchannelled Valley Bottom (4.5 %) Seep (4.5 %) Floodplain (2.5 %)	A/B - 8.0 % C - 1.0 % **D/E/F - 91.0 %**	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	Drakensberg Foothill Wattled Crane Habitat (VU)	Working for Wetlands rehabilitation structures.
8: Middle/ Lower Mooi River	8.1	Scawby, Dartmoor, Melmoth	**Unchannelled Valley Bottom (74.0 %)** Channelled Valley Bottom (25.0 %) Seep (0.5 %) Floodplain (0.5 %)	A/B - 15.0 % C - 15.5 % **D/E/F - 69.5 %**	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Floodplain) - CR	Mount Gilboa Plateau (VU)	

IUA	RU	Wetland	Type	PES	NWM5 Wetland Vegetation Group and Threat Status	Located within a Threatened Ecosystem	Unique Features
9: Middle/ Lower Bushman's River	9.3	Ntabamhlope	**Channelled Valley Bottom (55.0 %)** Seep (38.0 %) Unchannelled Valley Bottom (6.5 %) Floodplain (0.5 %)	A/B - 7.0 % C - 2.5 % **D/E/F - 90.5 %**	Sub-Escarpment Grassland Bioregion Sub-Escarpment Grassland (Valley Bottom) - CR Sub-Escarpment Grassland (Seep) - CR Sub-Escarpment Grassland (Floodplain) - CR	Not applicable	Working for Wetlands rehabilitation structures.
14: Escarpment	14.8	Highmoor	**Channelled Valley Bottom (65.5%)** Seep (35.5%)	A/B - 3.5 % C - 10.5 % **D/E/F - 85.5 %**	Drakensberg Grassland Bioregion Drakensberg Grassland (Seep) - LC Drakensberg Grassland (Valley Bottom) - EN	Eastern Temperate Freshwater Wetlands (VU)	Ukhahlamba Drankensberg Park.

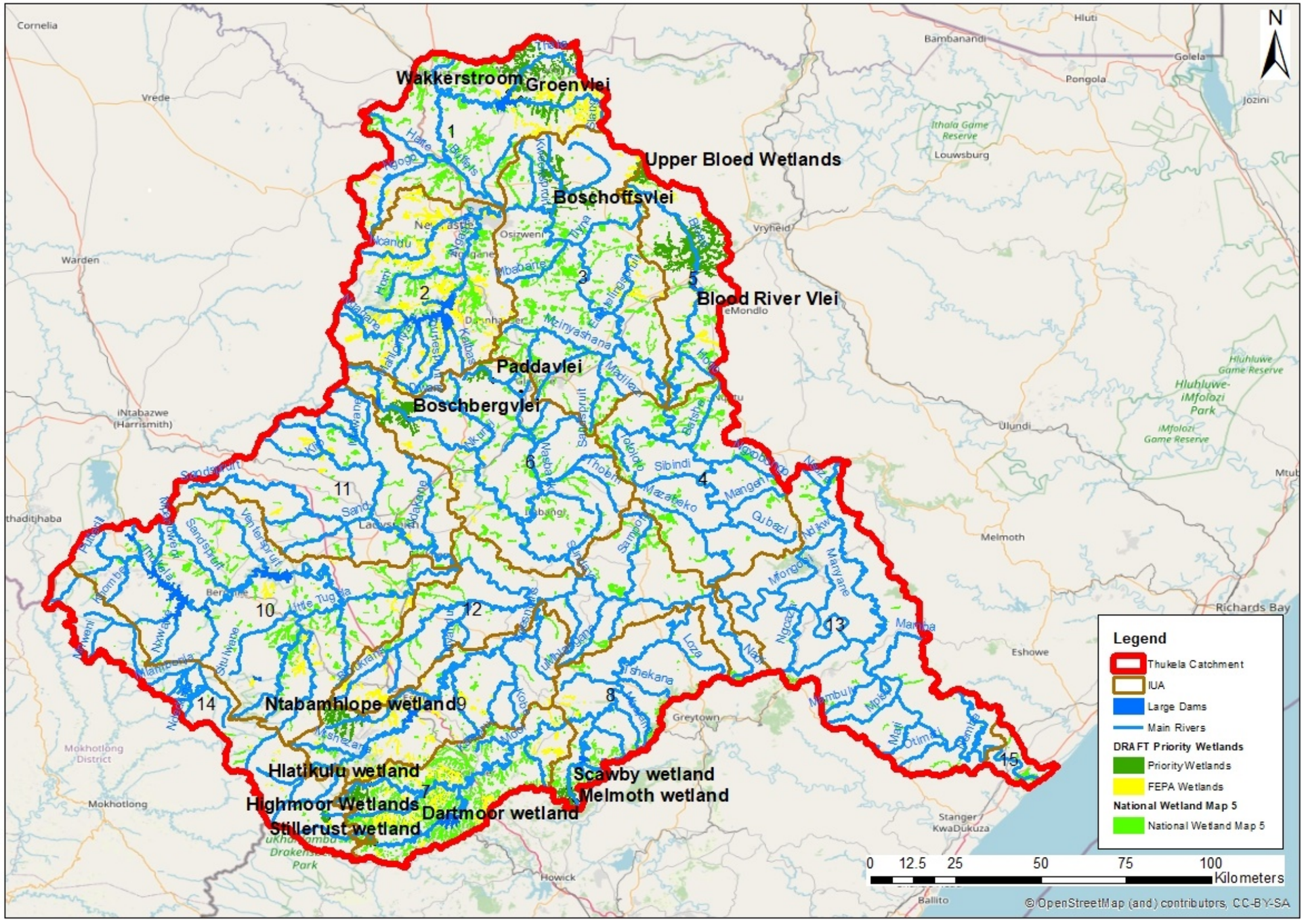

Figure 11: Map showing the distribution of NFEPA wetlands in respect of the RU delineation

9 SUMMARY AND CONCLUSION

In terms of the various components and considerations assessed for resource unit's delineation and prioritisation, and based on the understanding and expert knowledge of the Thukela and tributary catchments, the results of the preliminary delineation and prioritisation process are as follows:

- Seventy-five surface water resource RUs (rivers and wetlands) were delineated,
- Fifty-two RUs have been prioritised,
- Seven dam RUs were 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 wetlands/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 PSC review.

RQOs for the prioritised and selected rivers, dams and groundwater RUs, wetlands/wetland clusters and the estuary will then be determined for the sub-components and indicators that are still to be selected (to follow in Steps 4 and 5 of the RQO process).

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APPENDIX A: Summary of Resource Units Prioritisation Tool Ranking and Criteria Rating Maps

Table A.1: Summary of Resource Units prioritisation rating

Resource Unit	Position of resource unit within IUA	Importance for users (Current & anticipated future use)					Threat posed to users	Ecological Importance				Threat faced by ecological component of the RU	Management Considerations	Practical Considerations			Priority Rating
	Position of RU	Culture services to society	Supporting livelihoods	Strategic requirements	Supporting and regulating services	Contribution to the economy	Threat posed to users	High Ecological importance and Sensitivity	EC or PES of A/B	Freshwater Ecosystem Priority Areas	Priority conservation plans	Threat posed to ecology	PES lower than a D or lower than MC	Availability of data	Accessibility	Safety risk	
IUA 1																	
1_1	1	1	1	0.5	0.5	0.5	0.5	1	0.5	1	1	0.5	0	0.5	1	1	**1.0**
1_2	1	1	1	1	0.5	1	0	0	0	0	0.5	0	0	0.5	1	1	**0.7**
1_3	1	0.5	0.5	0	0.5	0.5	0.5	1	0	0.5	1	0.5	0	0	0.5	0.5	**0.8**
1_4	0	0.5	0.5	0	0.5	0	0	1	0.5	0.5	1	0	0	0	0.5	0.5	**0.2**
1_5	0	0.5	0.5	0	0	0	0	0.5	0	0	0	1	1	0	1	1	**0.5**
1_6	1	0.5	1	0	1	0.5	0.5	0.5	0	0	0	0.5	0	0.5	1	1	**0.8**
IUA 2																	
2_1	1	0.5	0.5	0	0.5	0.5	0.5	1	0.5	0.5	1	0.5	0	1	1	1	**0.9**
2_2	1	0.5	0.5	0	0	0.5	0	0	0	1	1	0.5	0	0.5	1	1	**0.7**
2_3	0	0.5	0.5	0	0	0.5	0	1	0	1	0	1	1	1	1	1	**0.7**
2_4	0	0.5	0.5	0	0	1	1	1	0	1	1	1	1	0.5	1	1	**0.9**
2_5	1	0.5	0.5	0	0	1	1	0.5	0	0.5	0	1	0	1	1	0.5	**1.0**

Resource Unit	Position of resource unit within IUA	Importance for users (Current & anticipated future use)					Threat posed to users	Ecological Importance				Threat faced by ecological component of the RU	Management Considerations	Practical Considerations			Priority Rating
	Position of RU	Culture services to society	Supporting livelihoods	Strategic requirements	Supporting and regulating services	Contribution to the economy	Threat posed to users	High Ecological importance and Sensitivity	EC or PES of A/B	Freshwater Ecosystem Priority Areas	Priority conservation plans	Threat posed to ecology	PES lower than a D or lower than MC	Availability of data	Accessibility	Safety risk	
IUA 3																	
3_1	0	1	0.5	0	0.5	0	0.5	1	0	1	0.5	0.5	1	0	1	0.5	**0.6**
3_2	1	0.5	0.5	0	0	0	0.5	0.5	0.5	0.5	0	0.5	0	0	0.5	0.5	**0.7**
3_3	0	0.5	0.5	0	0	0.5	1	0.5	0.5	0.5	0	1	0	0	1	0.5	**0.6**
3_4	0	0.5	0.5	0	1	0.5	1	0.5	0.5	0.5	0	0.5	0	1	1	1	**0.6**
3_5	1	0.5	0.5	0	1	0.5	1	0.5	0.5	0.5	0	1	0	1	1	1	**1.0**
IUA 4																	
4_1	0	1	1	0	0	0	0.5	0.5	0	0.5	0	0.5	0	0	0.5	0.5	**0.4**
4_2	1	1	1	0	0	0	0.5	0.5	0.5	0.5	0	0.5	0	1	1	1	**1.0**
IUA 5																	
5_1	1	0.5	0.5	0	1	0	0	1	0	1	1	0.5	0	0	1	0.5	**0.8**
5_2	1	1	1	0	0	0.5	0.5	0.5	0	1	0.5	1	0	0	1	0.5	**1.0**
IUA 6																	
6_1	0	0.5	0.5	0	0	0	1	0.5	0	1	1	1	0	0	1	0.5	**0.7**

Resource Unit	Position of resource unit within IUA	Importance for users (Current & anticipated future use)					Threat posed to users	Ecological Importance				Threat faced by ecological component of the RU	Management Considerations	Practical Considerations			Priority Rating
	Position of RU	Culture services to society	Supporting livelihoods	Strategic requirements	Supporting and regulating services	Contribution to the economy	Threat posed to users	High Ecological importance and Sensitivity	EC or PES of A/B	Freshwater Ecosystem Priority Areas	Priority conservation plans	Threat posed to ecology	PES lower than a D or lower than MC	Availability of data	Accessibility	Safety risk	
6_2	1	0.5	1	0	0.5	0.5	0.5	0.5	0	1	1	0.5	0	1	0.5	0.5	**1.0**
6_3	1	1	1	0	0	0.5	1	0.5	0	0	0	1	0	0	0.5	0.5	**1.0**
6_4	1	1	1	0.5	0.5	0	0	0.5	0	0	0	0.5	0	1	1	0.5	**0.8**
IUA 7																	
7_1	1	0.5	0.5	0	1	1	1	0.5	0	0.5	1	1	0	0	1	0.5	**0.9**
7_2	0	0.5	0.5	0	1	0.5	0.5	0.5	0	1	1	1	0	0	0.5	0.5	**0.5**
7_3	1	0.5	0.5	1	1	1	1	0.5	0	1	1	0.5	0	0	1	0.5	**0.9**
7_4	1	0.5	0.5	1	0	1	1	0	0	0	0.5	0	0	0.5	1	0	**0.7**
7_5	1	0.5	0.5	0	0	1	1	0.5	0	1	1	1	0	1	1	1	**1.0**
7_6	0	0.5	0.5	0	0	0.5	1	1	0	0	1	1	1	0	1	1	**0.7**
IUA 8																	
8_1	0	0.5	0.5	0	0.5	0.5	0.5	1	0	1	1	1	0	0	0	1	**0.6**
8_2	0	0.5	0.5	0	0	0.5	1	0	0	0	0	0	0	0.5	1	1	**0.4**
8_3	1	0.5	0.5	0	0.5	0.5	0.5	0.5	0	1	1	1	0	0	0.5	1	**1.0**
8_4	1	1	0.5	0	0	0	0.5	0.5	0	0	1	0.5	0	1	0.5	1	**0.9**

Resource Unit	Position of resource unit within IUA	Importance for users (Current & anticipated future use)					Threat posed to users	Ecological Importance				Threat faced by ecological component of the RU	Management Considerations	Practical Considerations			Priority Rating
	Position of RU	Culture services to society	Supporting livelihoods	Strategic requirements	Supporting and regulating services	Contribution to the economy	Threat posed to users	High Ecological importance and Sensitivity	EC or PES of A/B	Freshwater Ecosystem Priority Areas	Priority conservation plans	Threat posed to ecology	PES lower than a D or lower than MC	Availability of data	Accessibility	Safety risk	
8_5	0	0.5	1	0	0	0	0.5	0.5	0.5	1	1	0.5	0	0	0.5	0.5	**0.5**
8_6	1	1	1	0	0	0.5	1	0.5	0	0	0	1	0	0	0.5	0.5	**1.0**
IUA 9																	
9_1	1	1	1	0	1	0.5	0	0.5	0.5	1	1	0	0	0	0.5	1	**0.6**
9_2	1	0.5	0	0	0	0.5	0.5	0	0	1	0.5	0	0	0.5	1	1	**0.7**
9_3	0	0.5	1	0	0	1	1	0.5	0	0.5	0.5	1	0	0.5	1	0.5	**0.7**
9_4	1	0.5	0.5	0	0	0.5	1	0.5	0	0.5	0.5	1	0	1	1	0.5	**1.0**
9_5	1	0.5	0.5	0	0	0.5	1	0.5	0	0.5	0.5	1	0	1	1	0.5	**1.0**
IUA 10																	
10_1	1	0.5	1	0	0.5	0.5	0.5	1	0.5	1	1	0.5	0	0	1	1	**0.9**
10_2	0	0.5	0.5	0	0.5	0.5	0.5	1	0	0	0	0.5	0	0	0.5	0.5	**0.3**
10_3	1	0.5	0.5	1	0	1	1	0	0	0	0	0	0	0.5	1	1	**0.8**
10_4	1	0.5	0.5	0.5	0	0.5	1	1	0	0	0	1	0	0.5	1	0.5	**0.9**
10_5	0	0.5	0.5	0	0.5	0.5	0	1	0	0.5	0	0.5	0	0.5	0.5	1	**0.3**
10_6	1	0.5	0.5	1	0	1	1	0.5	0	0	0	1	0	1	1	1	**1.0**

Resource Unit	Position of resource unit within IUA	Importance for users (Current & anticipated future use)					Threat posed to users	Ecological Importance				Threat faced by ecological component of the RU	Management Considerations	Practical Considerations			Priority Rating
	Position of RU	Culture services to society	Supporting livelihoods	Strategic requirements	Supporting and regulating services	Contribution to the economy	Threat posed to users	High Ecological importance and Sensitivity	EC or PES of A/B	Freshwater Ecosystem Priority Areas	Priority conservation plans	Threat posed to ecology	PES lower than a D or lower than MC	Availability of data	Accessibility	Safety risk	
10_7	0	0.5	0.5	0	0	1	0.5	0.5	0	1	1	0.5	0	1	1	0.5	**0.5**
10_8	1	0.5	0.5	1	1	1	1	0	0	0	0	0	0	0.5	1	1	**0.8**
10_9	1	0.5	0.5	0	0	0.5	0.5	0.5	0	0	0	0.5	0	1	1	1	**0.8**
10_10	0	0.5	0.5	0	0.5	1	1	0.5	0	1	0	1	0	0.5	1	1	**0.6**
10_11	0	0.5	1	0	0.5	1	1	1	0	1	0.5	1	0	1	1	1	**0.7**
10_12	1	0.5	0.5	0	0	1	1	0.5	0.5	0	0.5	1		0	1	0.5	**0.9**
IUA 11																	
11_1	1	0.5	0.5	0	0.5	0.5	0.5	0.5	0	1	1	0.5	0	0	0	1	**0.7**
11_2	1	0.5	1	0	1	0.5	0.5	0.5	0	1	1	1	0	1	1	0.5	**1.0**
11_3	1	0.5	0.5	0	0.5	1	1	0.5	0	0	0	1	0	0	1	0.5	**0.9**
IUA 12																	
12_1	0	0.5	0.5	0	0.5	0.5	0	0.5	0	0.5	0.5	0	0	0	0.5	0.5	**0.2**
12_2	1	0.5	0.5	0	0.5	0.5	0	0.5	0	1	0	0.5	0	1	0.5	1	**0.9**
12_3	0	1	1	0	0.5	0	0	0.5	0	0	0	0.5	0	0	1	0.5	**0.3**
12_4	1	1	1	0	0.5	0.5	0.5	0.5	0	1	0	0.5	0	1	0.5	0.5	**1.0**

Resource Unit	Position of resource unit within IUA	Importance for users (Current & anticipated future use)					Threat posed to users	Ecological Importance				Threat faced by ecological component of the RU	Management Considerations	Practical Considerations			Priority Rating
	Position of RU	Culture services to society	Supporting livelihoods	Strategic requirements	Supporting and regulating services	Contribution to the economy	Threat posed to users	High Ecological importance and Sensitivity	EC or PES of A/B	Freshwater Ecosystem Priority Areas	Priority conservation plans	Threat posed to ecology	PES lower than a D or lower than MC	Availability of data	Accessibility	Safety risk	
IUA 13																	
13_1	0	1	0.5	0	0	0	0	1	0.5	0	0	0.5	0	0	0.5	0.5	**0.3**
13_2	1	1	1	0	0.5	0.5	0.5	0.5	0.5	0	0	0.5	0	0	0.5	0.5	**0.8**
13_3	0	1	1	0	0	0	0	1	0	0.5	1	0.5	0	0	0.5	0.5	**0.3**
13_4	0	0.5	1	0	0	0.5	0.5	1	0.5	1	0.5	0.5	0	0	0.5	0.5	**0.5**
13_5	1	1	0.5	1	0	0.5	1	0.5	0.5	0	0.5	0.5	0	1	1	0.5	**1.0**
IUA 14																	
14_1	1	0.5	0.5	1	1	1	0	1	1	1	1	0.5	0	0	0.5	0.5	**1.0**
14_2	1	0.5	0.5	1	1	1	0	0.5	0.5	0	1	0.5	0	0	0.5	0.5	**0.9**
14_3	0	0.5	0.5	1	1	1	0	0.5	1	1	1	0.5	0	0	0.5	0.5	**0.5**
14_4	1	0.5	0.5	0	1	0.5	0	0.5	0	1	1	0.5	0	0	0.5	0.5	**0.8**
14_5	1	0.5	0.5	0	1	1	0	1	1	0	1	0.5	0	0	0.5	0.5	**0.9**
14_6	0	0.5	0.5	0	1	1	0	0.5	0.5	0	1	0.5	0	0	0.5	0.5	**0.4**
14_7	1	0.5	0.5	1	1	1	0	0.5	0	1	1	0.5	0	0	0.5	0.5	**0.9**
14_8	0	0.5	0.5	0	1	1	0	0.5	0	0	1	0.5	0	0	0.5	0.5	**0.4**

Resource Unit	Position of resource unit within IUA	Importance for users (Current & anticipated future use)					Threat posed to users	Ecological Importance				Threat faced by ecological component of the RU	Management Considerations	Practical Considerations			Priority Rating
	Position of RU	Culture services to society	Supporting livelihoods	Strategic requirements	Supporting and regulating services	Contribution to the economy	Threat posed to users	High Ecological importance and Sensitivity	EC or PES of A/B	Freshwater Ecosystem Priority Areas	Priority conservation plans	Threat posed to ecology	PES lower than a D or lower than MC	Availability of data	Accessibility	Safety risk	
IUA 15																	
15_1	1	1	0.5	1	1	1	0.5	1	0	0	1	1	0	0	1	0.5	**1.0**
15_2	1	1	0.5	0	0	1	0.5	0.5	0	0	1	1	0	0	1	0.5	**0.9**

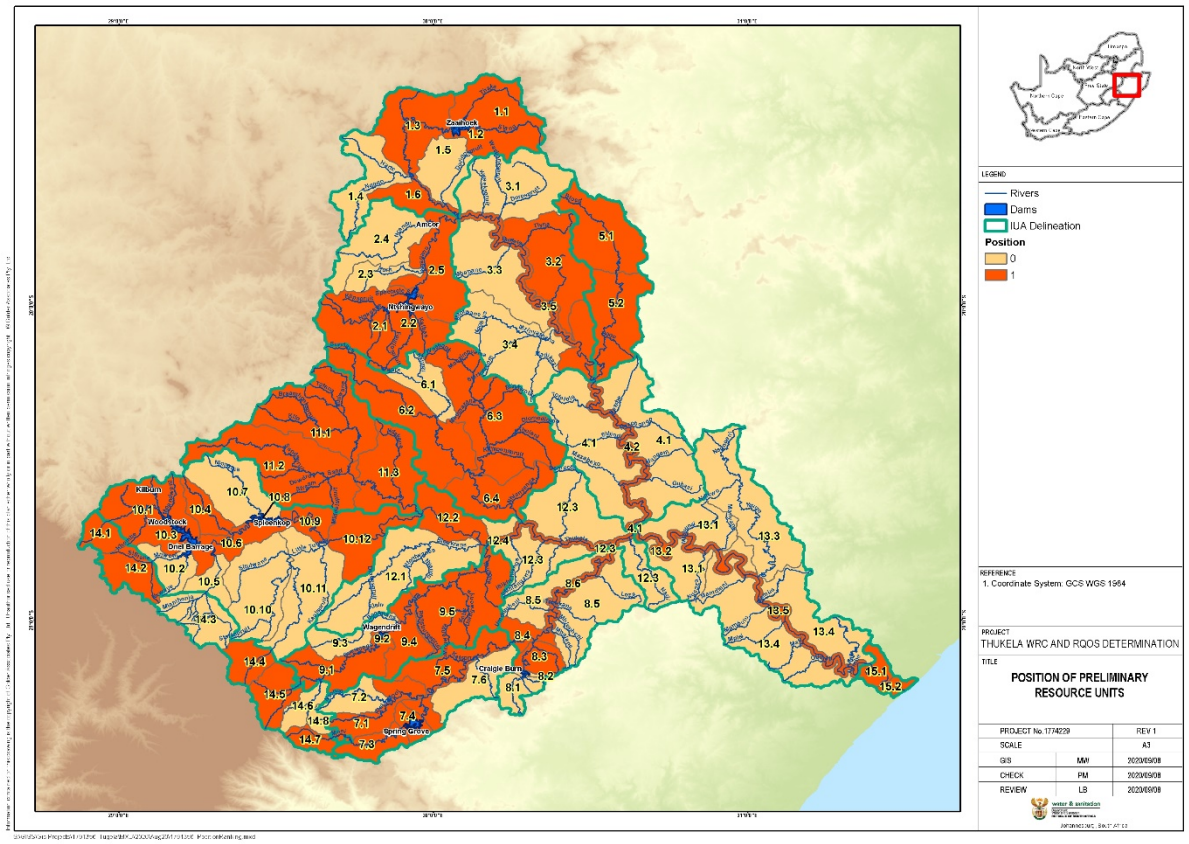

Figure A.1: Ranking of Position of RU

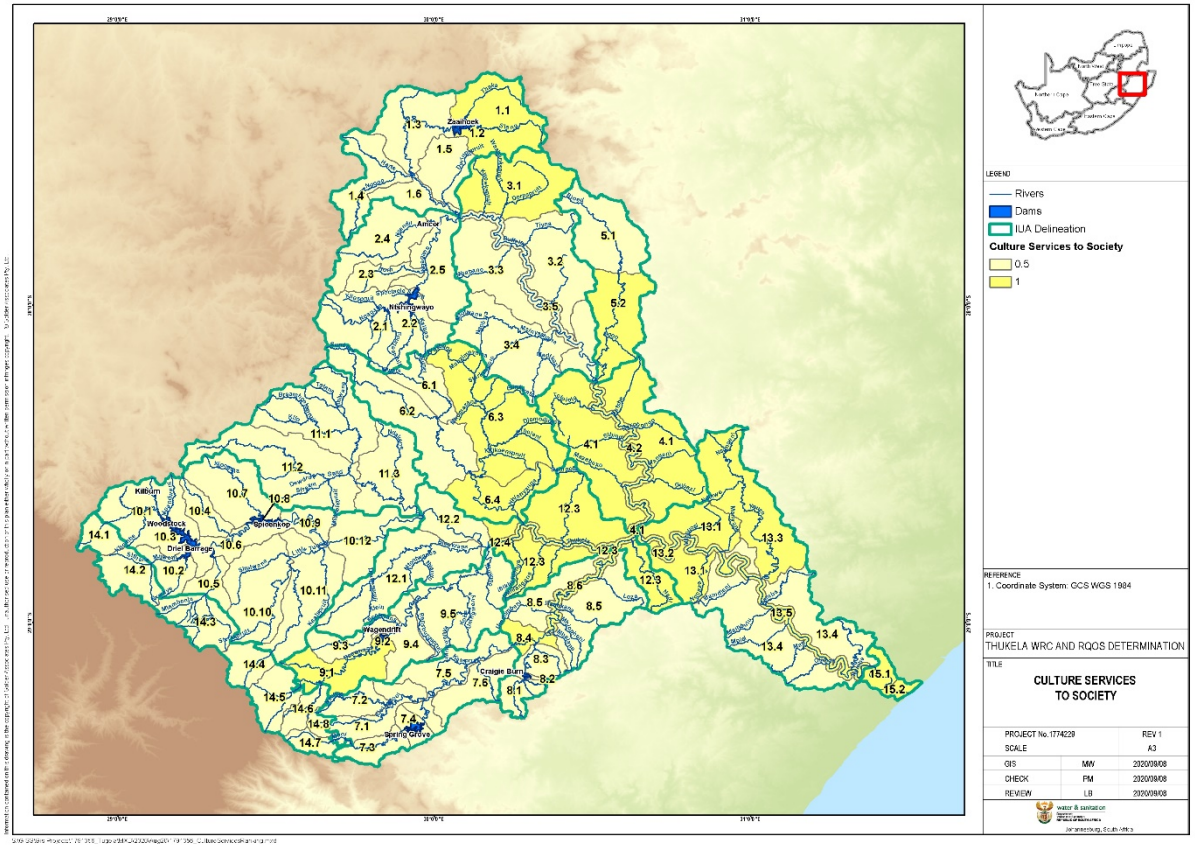

Figure A.2: Ranking of Cultural services to society

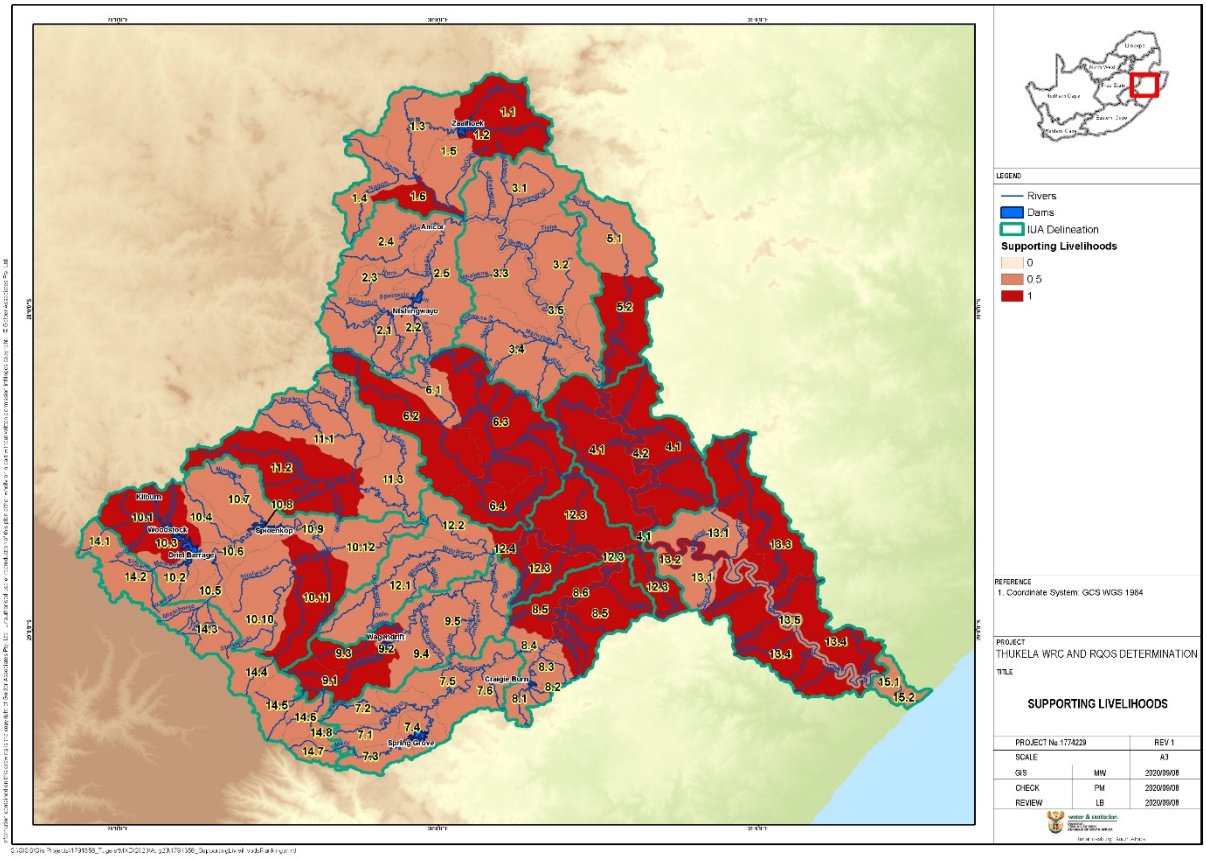

Figure A.3: Ranking of Supporting livelihoods

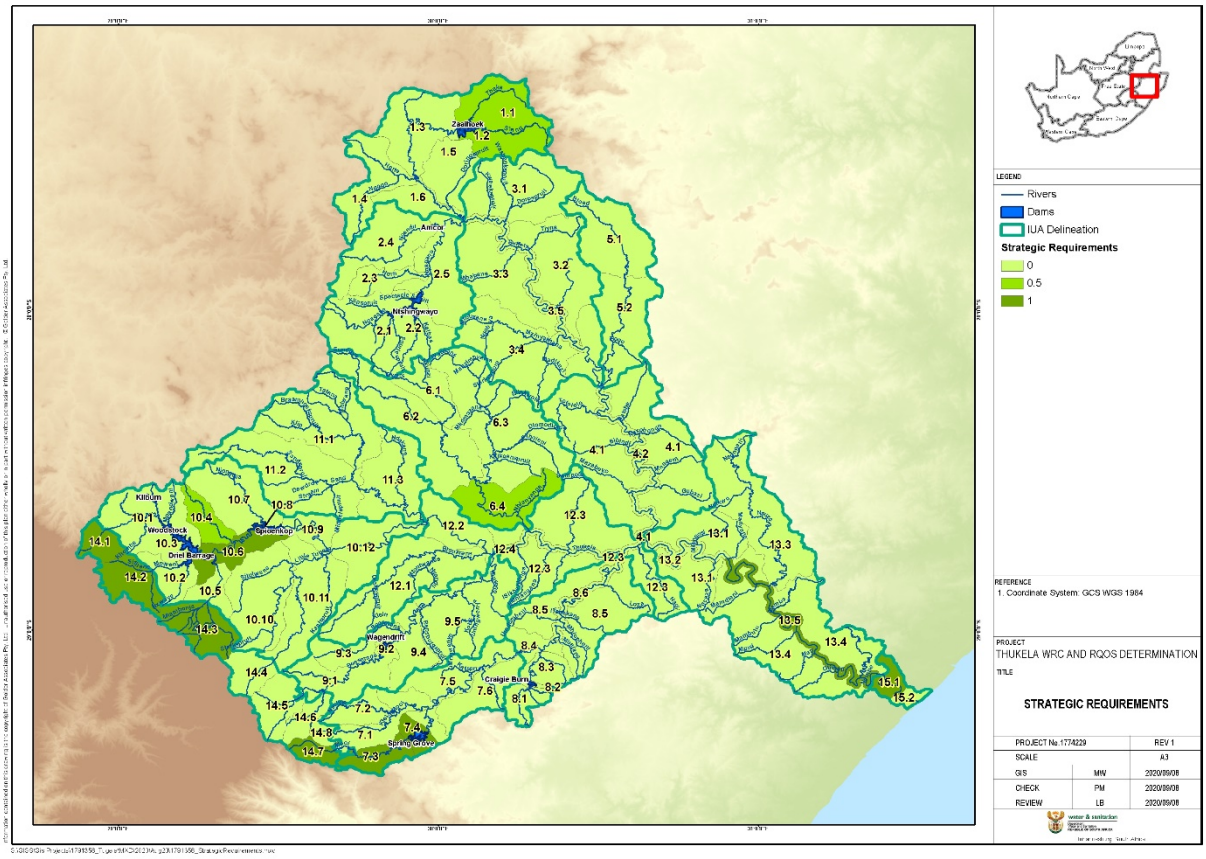

Figure A.4: Ranking of Strategic requirements

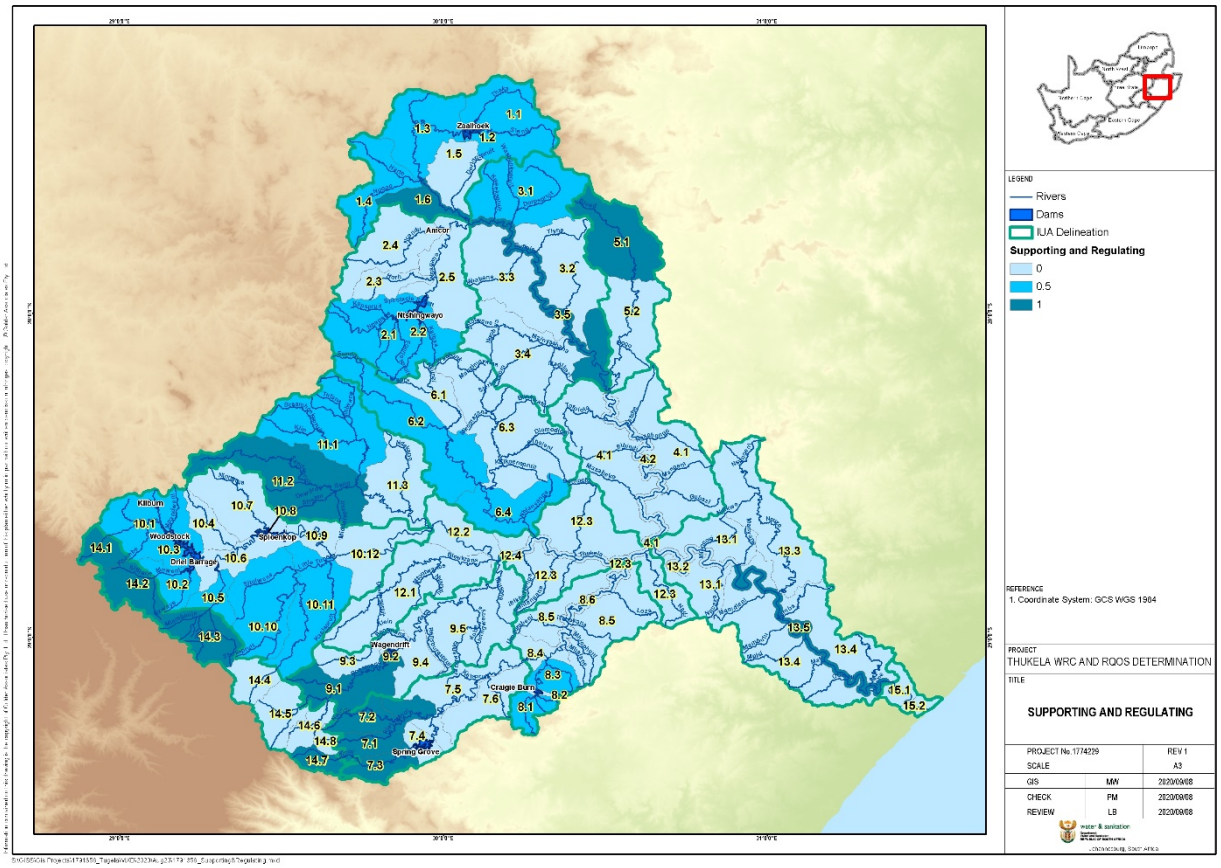

Figure A.5: Ranking of Supporting and regulating services

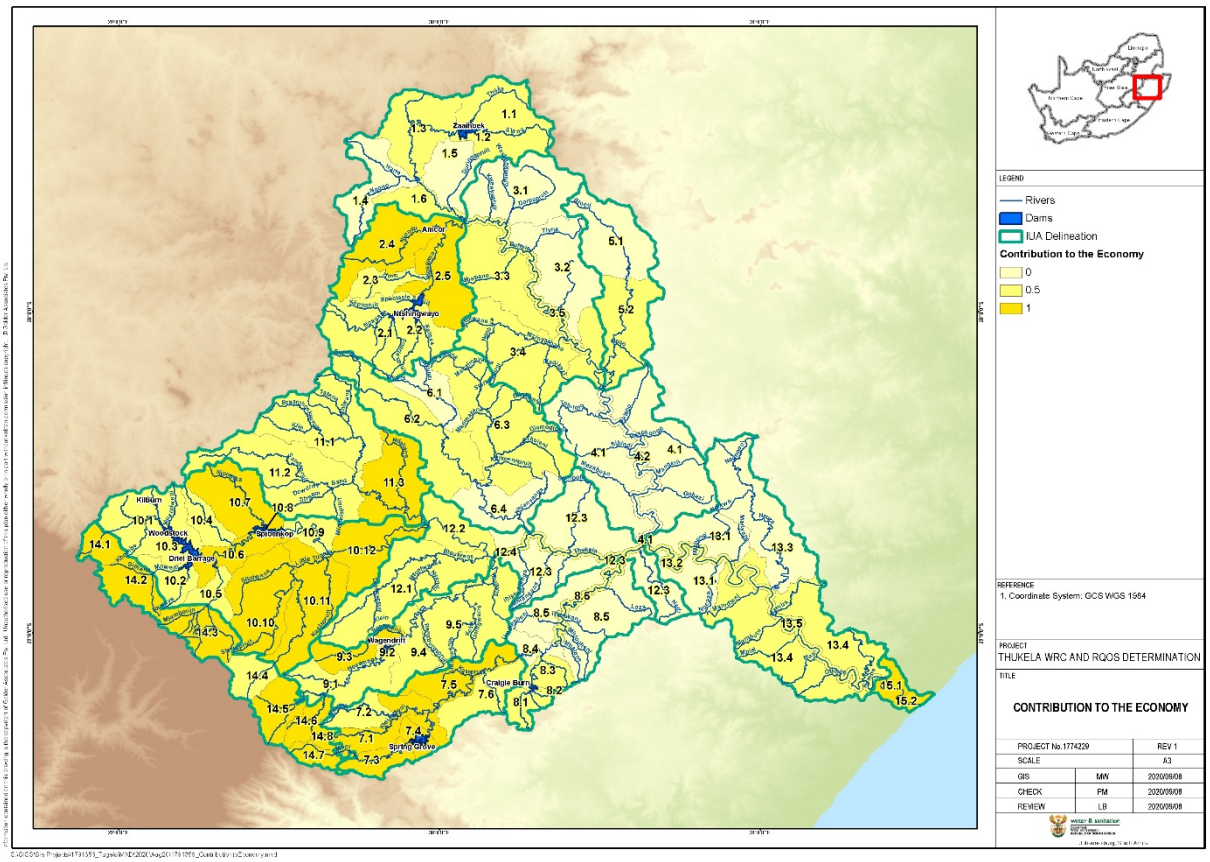

Figure A.6: Ranking of Contribution to the economy

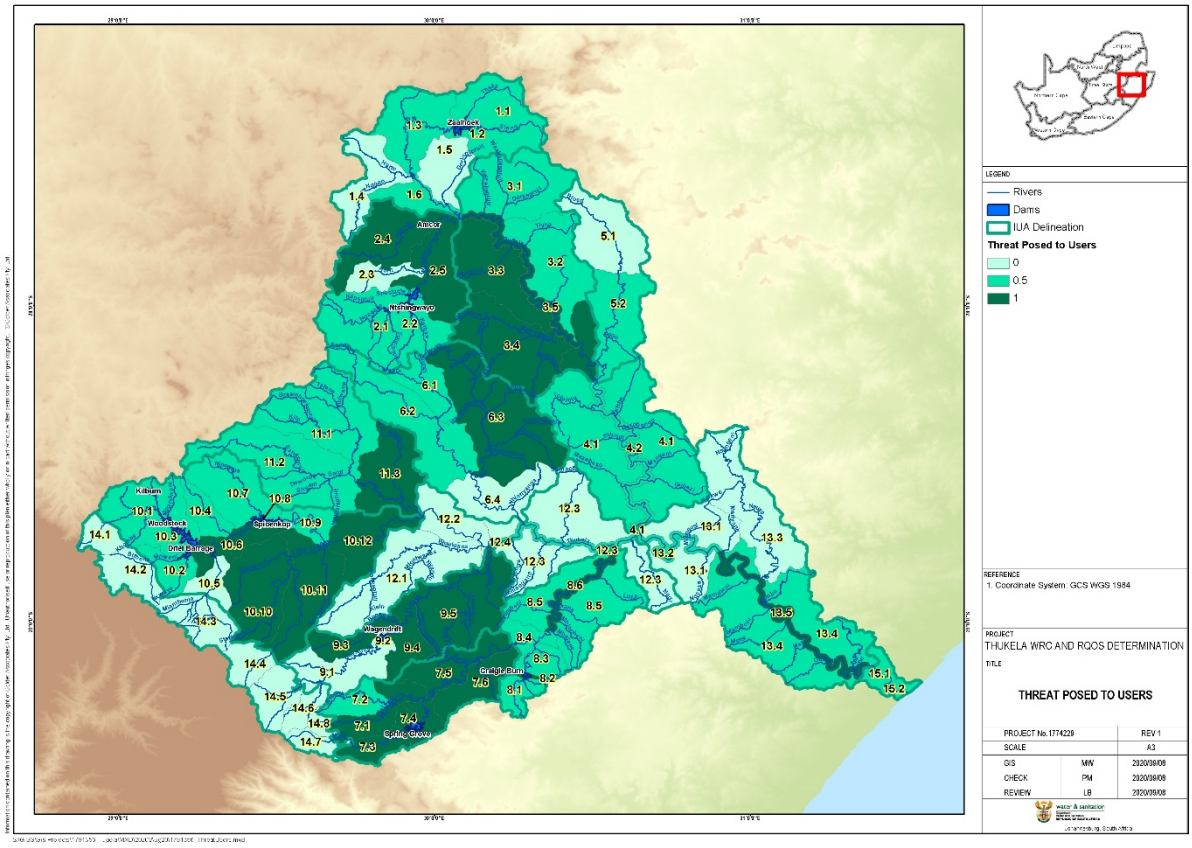

Figure A.7: Ranking of Threat posed to users

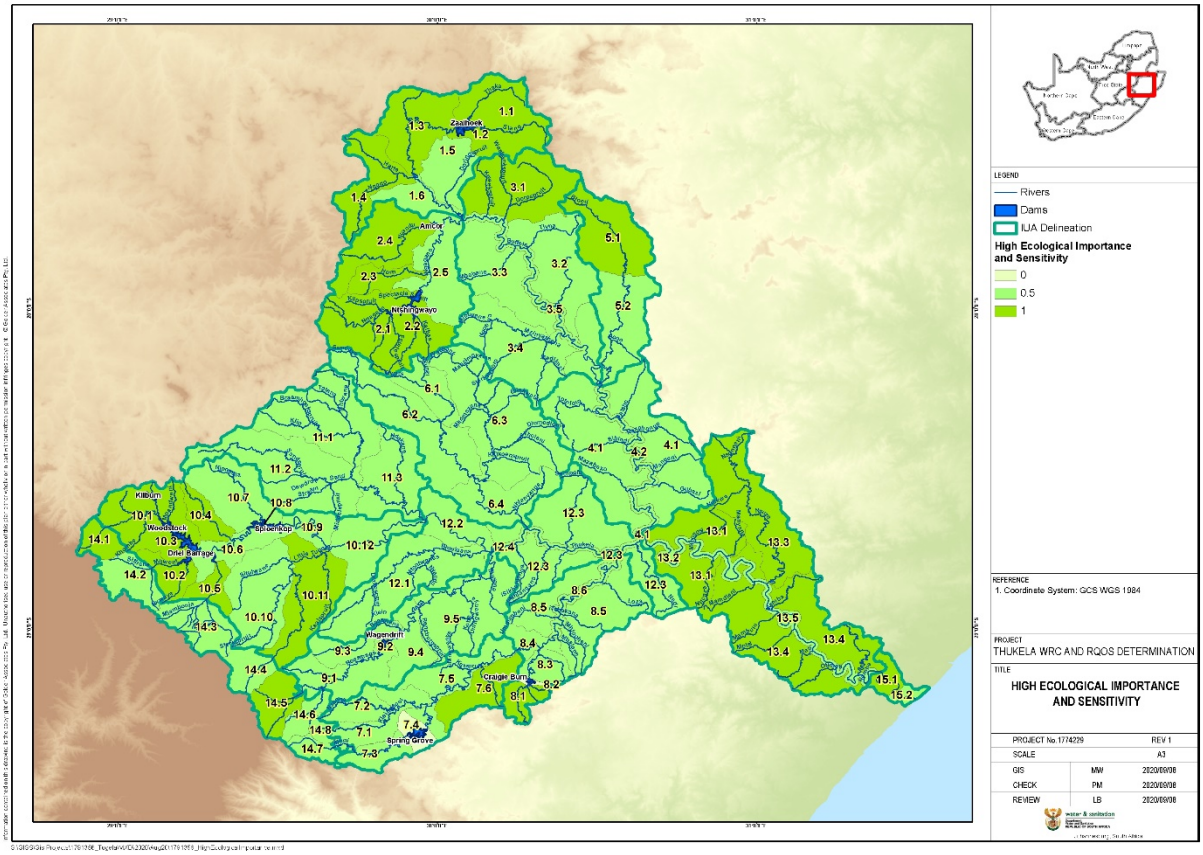

Figure A.8: Ranking of High Ecological importance and Sensitivity

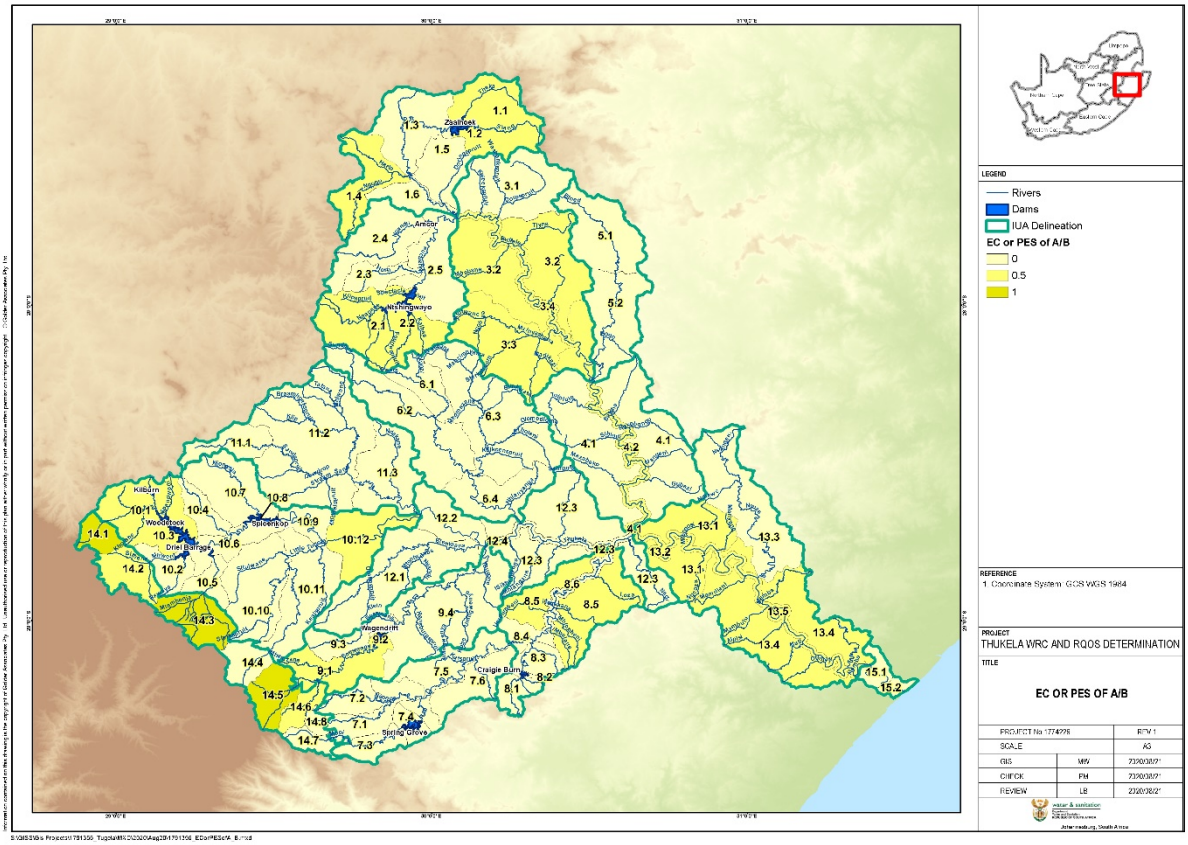

Figure A.9: Ranking of EC or PES of A/B

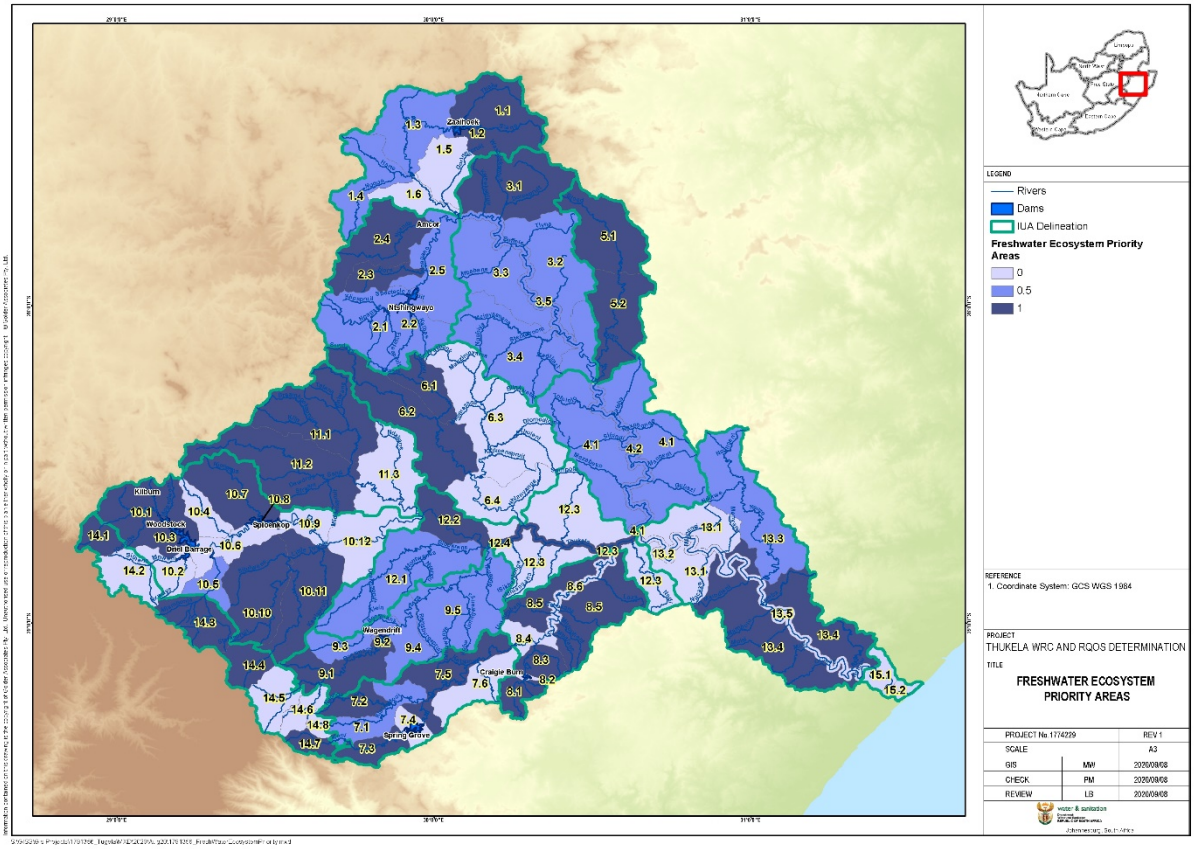

Figure A.10: Ranking of Freshwater Ecosystem Priority Areas

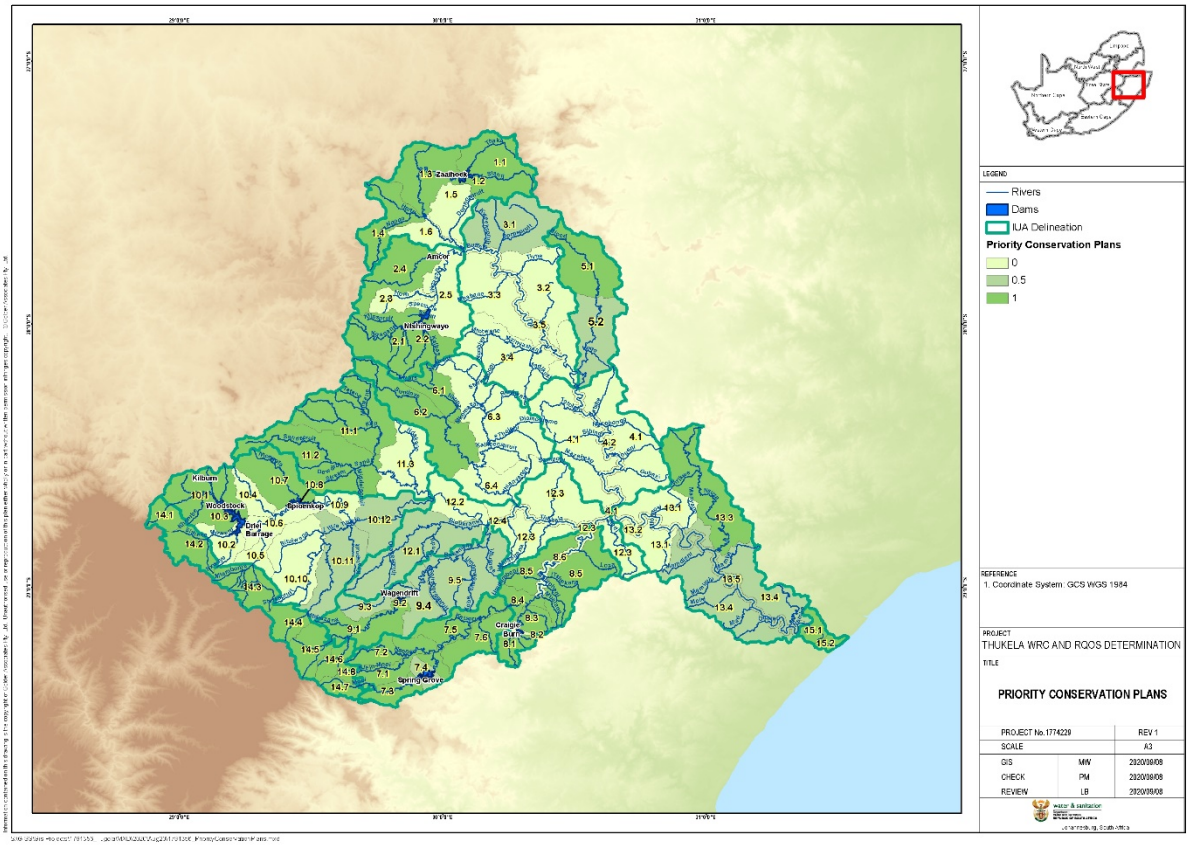

Figure A.11: Ranking of Priority conservation plans

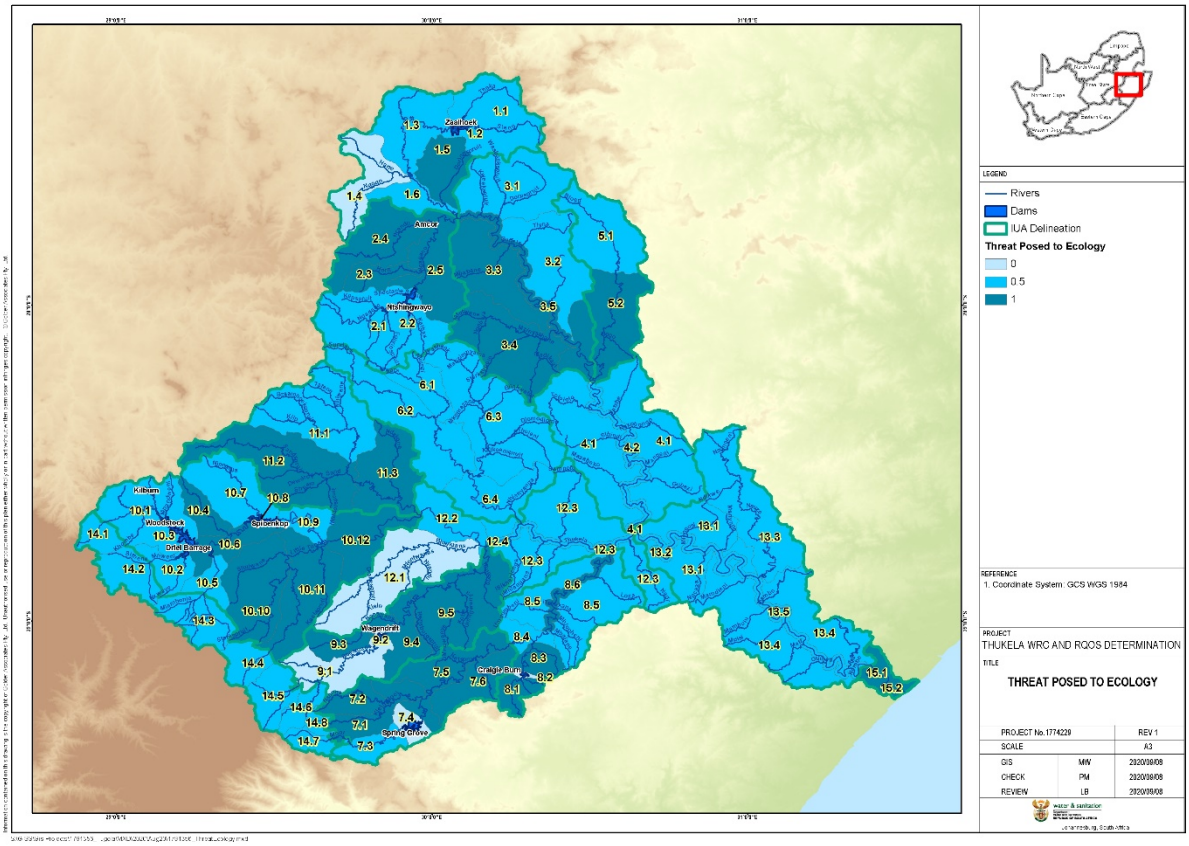

Figure A.12: Ranking of Threat posed to ecology

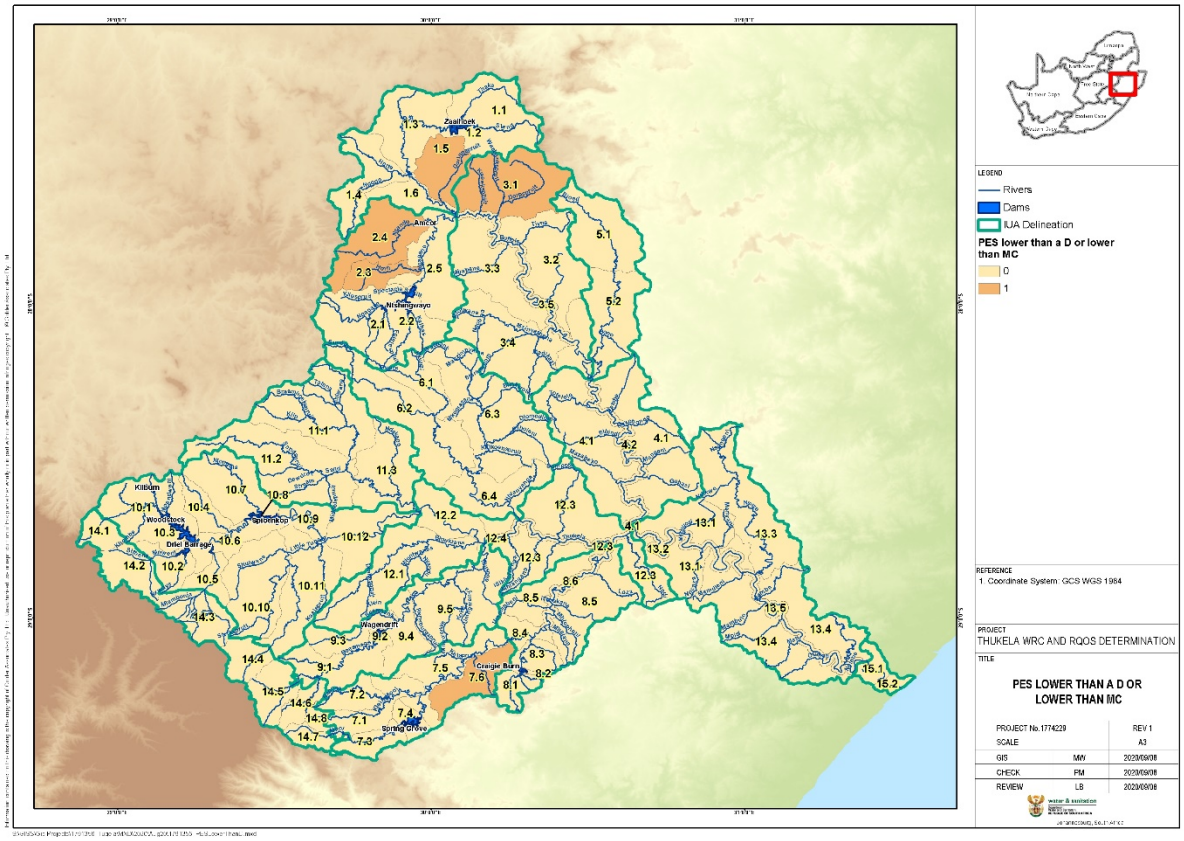

Figure A.13: Ranking of PES lower than a D or lower than MC

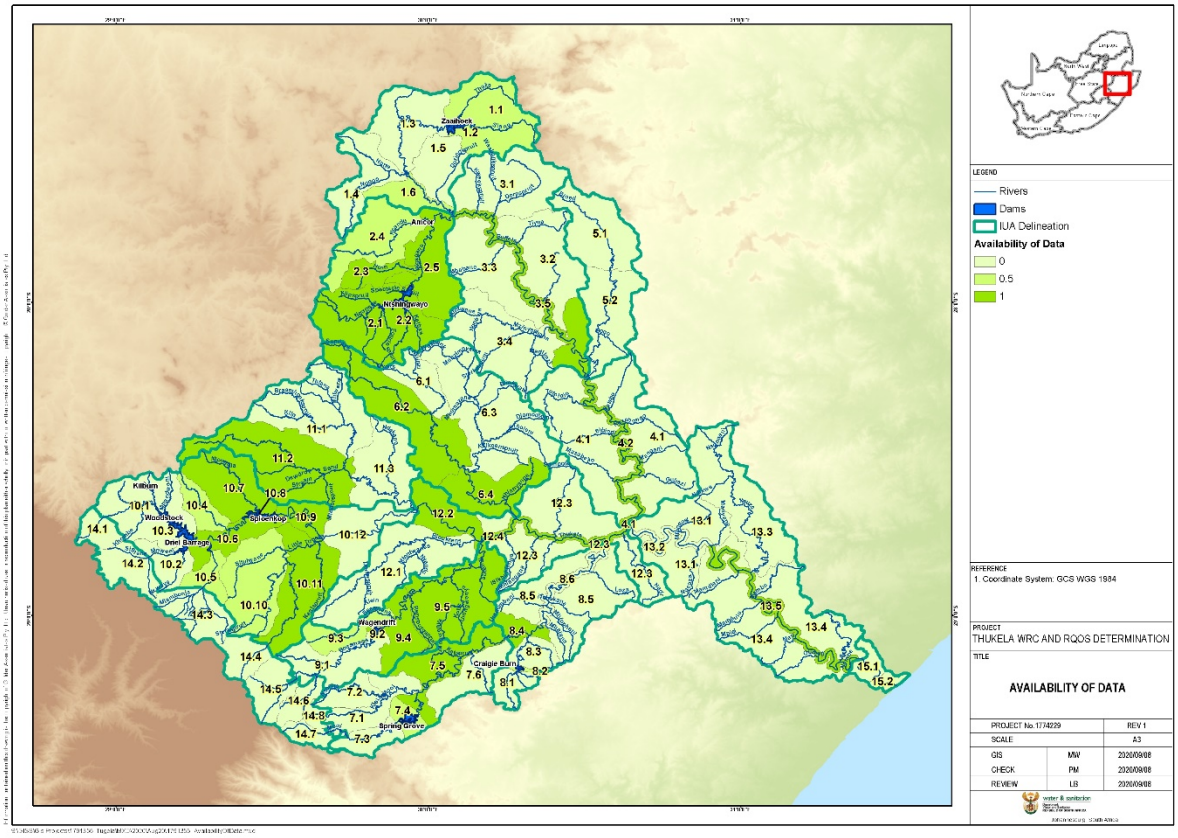

Figure A.14: Ranking of Availability of data

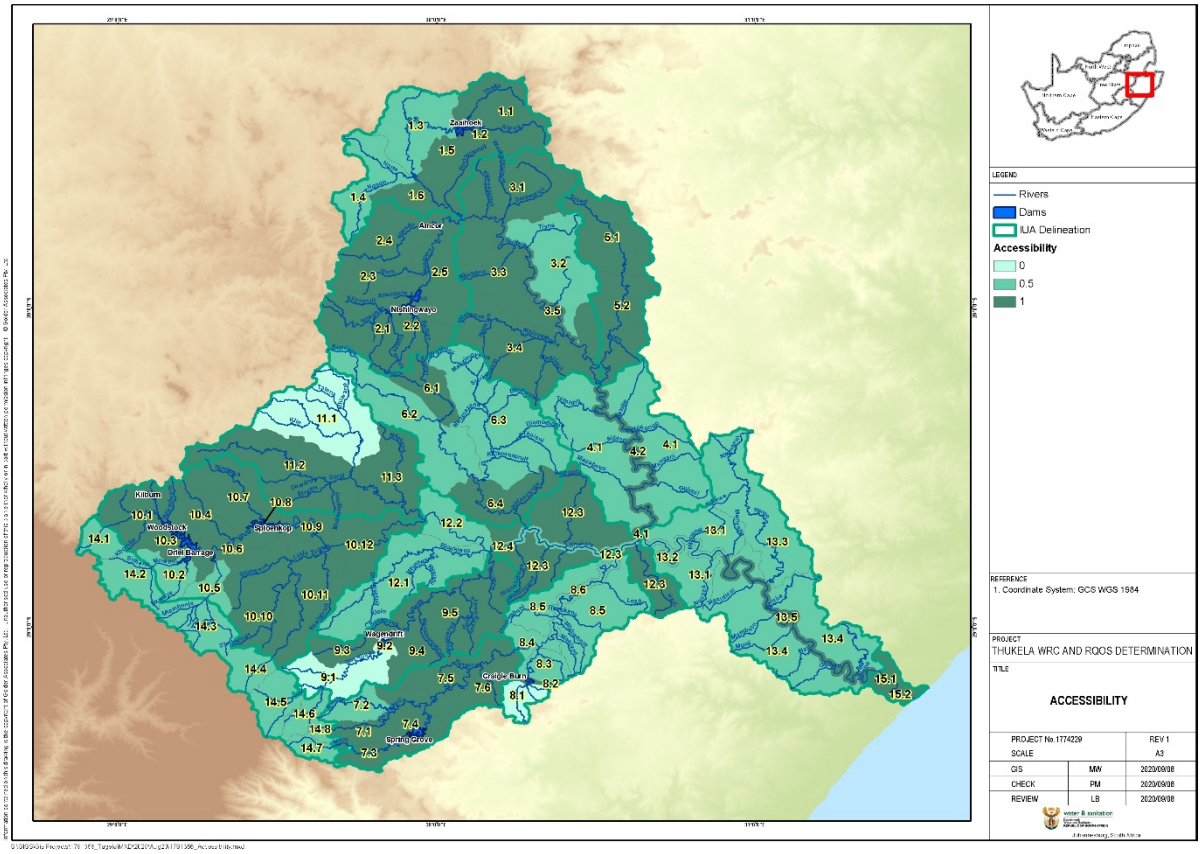

Figure A.15: Ranking of Accessibility for monitoring

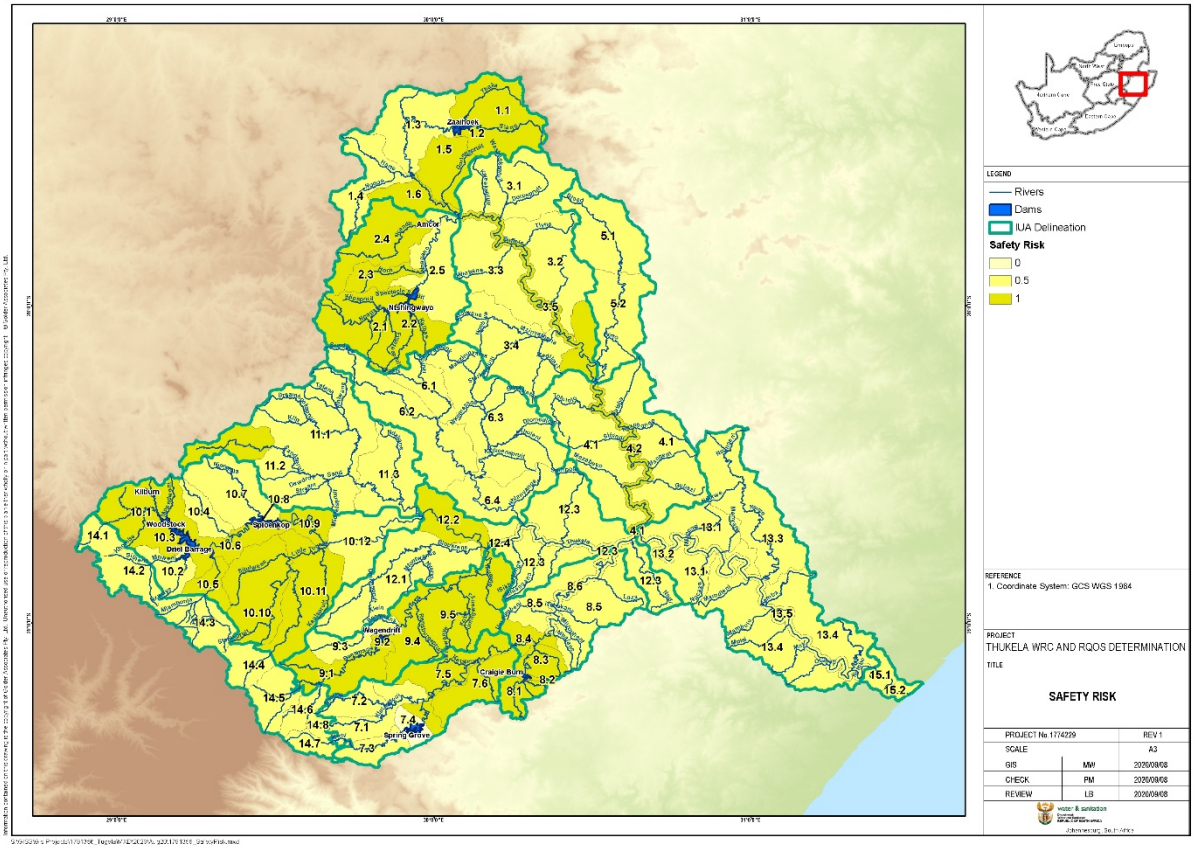

Figure A.16: Ranking of Safety risk