Report no. RDM/WMA04/00/CLA/0221

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: DRAFT RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS REPORT

FINAL

June 2021

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

DEPARTMENT OF WATER AND SANITATION

Chief Directorate: Water Ecosystems Management

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

DRAFT RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS REPORT
WP 11255

Study Report No.

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ACRONYMNS

ASPT	Average Score per Taxon
BAS	Best Attainable State
CD: WE	Chief Directorate: Water Ecosystems
DCU	Dolomite compartment unit
DLMT	Dolomite
DRM	Desktop Reserve Method
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Ecological Category
E. coli	*Escherichia coli*
EIS	Ecological importance and sensitivity
EWR	Ecological Water Requirements
FEPAs	Freshwater Ecosystem Priority Areas
FRAI	Fish Response Assessment Index
GMU	Groundwater Management Unit
ha	hectares
GRAII	Groundwater Resource Assessment Phase II
HGM	Hydrogeopmorphic
IHI	Index of habitat integrity
IUA	Integrated Unit of Analysis
IUAs	Integrated Units of Analysis
IWRM	Integrated Water Resource Management
NLC	National land cover
NMAR	Natural Mean Annual Runoff
MIRAI	Macroinvertebrate Response Assessment Index
NL	Numerical Limit
NWA	National Water Act
PES	Present Ecological State
RDM	Resource Directed Measures
REC	Recommended Ecological Category
REMP	River EcoStatus Monitoring Programme
RHAMM	Rapid Habitat Assessment Method and Model

RHP	River Health Programme
RQOs	Resource Quality Objectives
RUs	Resource Units
Userspec	User specification
SASS5	South African Scoring System version 5
SAWQGs	South African Water Quality Guidelines
SPI	Specific Pollution sensitivity Index
TCTA	Trans Caledon Transfer Authority
TDS	Total Dissolved Solids
TWQR	Target Water Quality Range
VEGRAI	Vegetation Response Assessment Index
VMAR	Virgin Mean Annual Runoff
WARMS	Water Use Authorisation and Registration Management System
WMA	Water Management Area
WMS	Water Management System
WQ	Water Quality
WRC	Water Resource Class
WRCS	Water Resource Classification System
WfWetlands	Working for Wetlands
WWTWs	Wastewater Treatment Works

TABLE OF SCIENTIFIC UNITS AND SYMBOLS

As	Arsenic
Al	Aluminium
NH_3	Ammonia
Cd	Cadmium
Chl-*a*	Chlorophyll *a*
Cl	Chloride
CN	Cyanide (free)
Cu	Copper
DIN	Dissolved Inorganic Nitrogen
F	Fluoride
Fe	Iron
EC	Electrical Conductivity
Hg	Mercury
ug/l	Micrograms per litre
Q	Abstraction Volume/Rate
l/s	litres per second
mg/l	milligrams per litre
m^3/s	cubic metres/second
ml	millilitres
Mg	Magnesium
Mn	Manganese
mS/m	milliSiemens per metre
Mm^3/a	million cubic metres per annum
Na	Sodium
NO_2	Nitrite
NO_3	Nitrate
Pb	Lead
pH	power of hydrogen
PO_4	Orthophosphate
SO_4	Sulphate
U	Uranium
Zn	Zinc
AAEN	*Awaous aeneofuscus*
ALAB	*Anguilla bengalensis*
AMOS	*Anguilla mossambica*
ANAT	*Amphilius natalensis*
BANO	*Barbus (Enteromius) anoplus*
BNAT	*Labeobarbus natalensis*
BPAL	*Barbus (Enteromius) pallidus*
BPAU	*Barbus (Enteromius) paludinosus*
BTRI	*Barbus (Enteromius) trimaculatus*
BVIV	*Barbus (Enteromius) viviparus*
CGAR	*Clarias gariepinus*
LMOL	*Labeo molybdinus*
LRUB	*Labeo rubromaculatus*
OMOS	*Oreochromis mossambicus*
PPHI	*Pseudocrenilabrus philander*
TIN	*Total Inorganic Nitrogen*
TPSA	*Tilapia sparmanii*

EXECUTIVE SUMMARY

The Chief Directorate: Water Ecosystems Management 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 and are defined by the National Water Act as “clear goals relating to the quality of the relevant water resources” (DWAF, 2006).

RQOs are descriptive or quantitative and are the goals defined to protect the water resource and the alignment to the catchment vision and class of the water resource. In determining the RQOs, it is important to recognise that different water resources will require different levels of protection.

The main objective of the study was to determine RQOs for all significant water resources in the Thukela catchments. The RQOs have been determined in accordance with the DWS’s Procedure to Determine and Implement Resource Quality Objectives.

The determination of the RQOs have considered the requirements of meeting the Water Resource Class, the desired protection level, current and future water use and the needs of water users. The RQO process has also taken account of land based activities and considered anticipated potential impacts that these activities may have on water resources within the WMA. The study has been primarily of a technical nature being guided by stakeholder and specialists’ involvement.

Through this study the resource units (RU) for the water resources in Thukela catchments were delineated and prioritised. Following on from RU prioritisation, as part of Step four of the RQO development process, selection of components and the identification of sub-components and indicators were finalised. The selected sub-components and indicators prioritised per resource unit form the basis for development of RQOs and associated numerical limits. As part of the RQO development process, a key component has been stakeholder consultation.

Step 5 of the RQO Determination procedure comprises the development of the draft resource quality objectives. This report presents the proposed RQOs and numerical limits for the significant water resources in the Thukela catchments based on the sub-components and indicators prioritised per resource unit.

The draft RQOs proposed will be taken through various stakeholder consultation processes to obtain comments, guidance, and inputs.

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1 INTRODUCTION

Resource Directed Measures (RDM) is enabled through Chapter 3 of the National Water Act (Act No.36 of 1998) (NWA) which provides for the protection of water resources through the Classification of water resources, determination of Resource Quality Objectives (RQOs) and determination of the Reserve. These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources on one hand and the need to develop and use them on the other.

1.1. Background

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

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

The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation (DWS) has initiated the development of Resource Quality Objectives (RQOs) for the Thukela catchments. With the water resources in these catchment areas having been classified, RQOs are to be determined as the next step of the protection framework.

In terms of the National Water Act, RQOs are based on the Water Resource Class and may relate to the following:

- the Reserve,
- In-stream flow,
- Water level,
- Presence and concentration of particular substances in the water,
- Characteristics and quality of the water resource,
- In-stream and riparian habitat quality,
- Characteristics and distribution of aquatic biota, and
- Regulation or prohibition of in-stream or land-based activities which may affect the quantity of water in or quality of the water resource, and
- Any other characteristic of the water resource in question.

RQOs encompass the following four components of the resource:

- Water quantity,

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

RQOs are important management objectives against which the outputs of resource monitoring will be assessed. Compliance monitoring will provide an indication of whether the Water Resource Class (WRC) is being maintained and RQOs will form important sustainability indicators for water resource management.

1.2. Study Overview

The main objectives of the study are to determine appropriate water resource classes and Resource Quality Objectives (RQOs) for all significant water resources in the Thukela River catchment that would facilitate sustainable use of the water resources while maintaining ecological integrity, specifically maintaining, 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 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 have therefore been key components to the process.

1.3. Purpose of this Report

Based on the components and sub-components that have been prioritised for the Resource Units (RUs) (Report Numbers: RDM/WMA04/00/CON/CLA/0520 and RDM/WMA04/00/CON/CLA/0620) draft RQOs and numerical limits for these may now be formulated. This report therefore presents the proposed draft RQOs and numerical limits for the significant water resources in the Thukela catchments. RQOs are essentially narrative statements but sometimes provide broad quantitative descriptions of the water resource. The RQOs relate to the components, sub-components, and selected indicators of each RU in the Thukela catchments. RQOs have been

set for rivers, dams, wetlands, and groundwater. Numerical limits translate the narrative RQOs into numerical values which can be monitored and assessed for compliance. Numerical limits have been proposed, where applicable, for the RQOs set. Supporting information relating to the approach followed, the context and the rationale where applicable, on the proposed RQOs and numerical limits formulated are included.

1.4. Study Area

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

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

Sub-catchment	Description	Tertiary drainage regions	Catchment area [(1)] (km^2)
Upper Thukela	The catchment of the Thukela River to just upstream of the confluence of the Bushmans River	V11, V12, V13 and V14	7 645
Mooi/Sundays	The catchment of the Mooi, Bushmans and Sundays River as well as of smaller tributaries, down to the confluence of the Buffalo River with the Thukela River.	V20, V60, V70	8 496
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 ranges from 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 are Klip River, which passes through Ladysmith, Sundays River, and Buffalo River, which rises above Newcastle. Major tributaries into the Thukela River from the south are Little Thukela River, Bloukrans River, Bushmans River, passing through Estcourt, and Mooi River passing through the town of Mooi River.

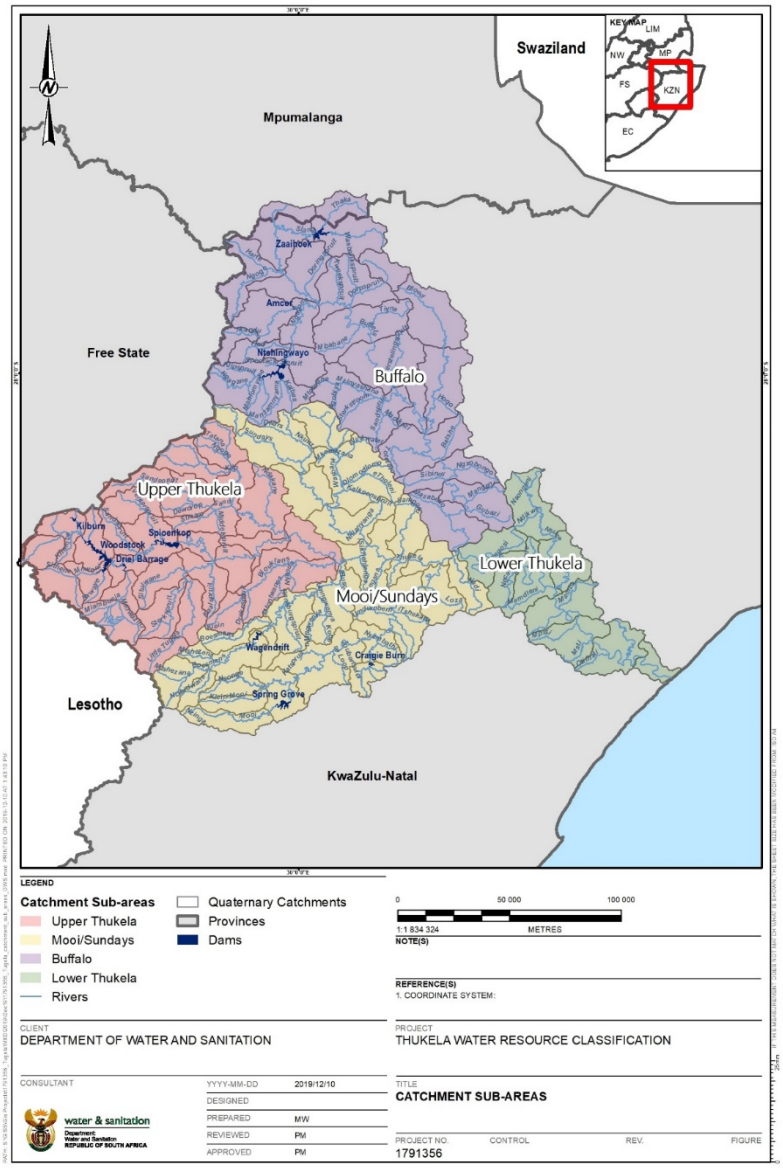

Figure 1: Thukela catchment sub-areas

2 INTEGRATED UNITS OF ANALYSIS

As part of the classification process the IUAs for the catchment were delineated and the EWR sites and river nodes were specified. These outputs from the classification process form the basis for the RQO determination process, and primarily for the RU definition.

Fifteen (15) IUAs were delineated and are detailed in Study Report: RDM/WMA04/00/CON/CLA/0320. These IUAs were presented 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

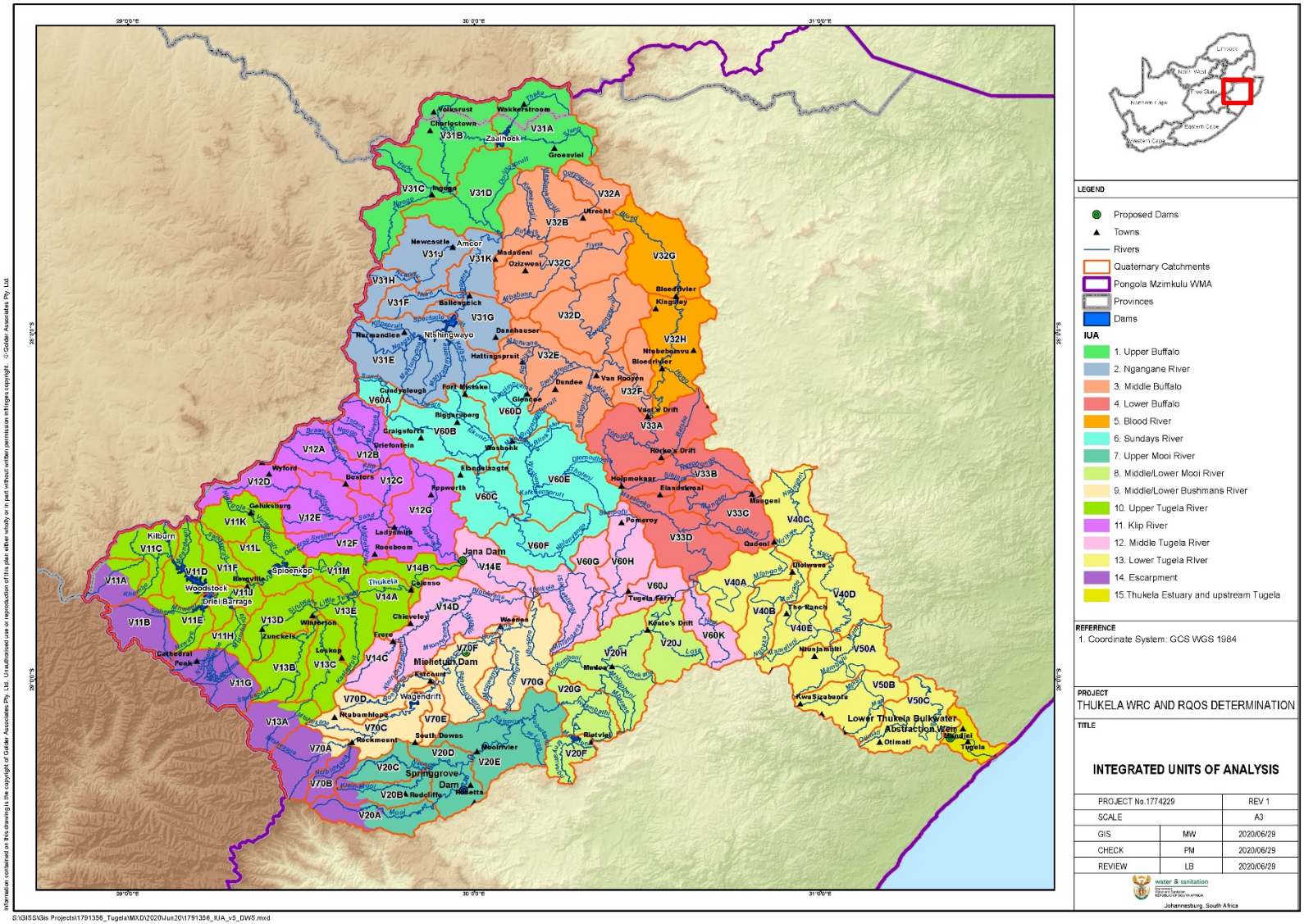

Figure 2: Integrated Units of Analysis

3 RESOURCE UNITS' PRIORITISATION

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

The RQO determination procedure proposes RQOs for each resource unit, however this may not always be possible due the potentially large number of RUs that could be delineated for a catchment. In order to prioritise and select the most useful RUs for RQO determination, the rationalisation process developed as part of the RQO Determination Procedure (DWA, 2011) was applied. Based on the priority ratings obtained through application of the RU prioritisation tool, priority RUs were selected for RQO determination, which were then taken through stakeholder consultation to confirm priority.

The Resource Unit Prioritisation Tool used for prioritisation, incorporates a multi criteria decision analyses approach to assess the importance of monitoring each RU as part of management operations to identify important RUs. The criteria assessed per RU included:

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

Based on the priority ratings obtained through application of the RU prioritisation tool, inputs from specialists, and a workshop with local catchment water resource managers, fifty four (54) RUs were selected and prioritised as described in Table 3 and illustrated in Figure 4. These preliminary results were circulated for review in report: *Preliminary Resource Units Selection and Prioritisation Report,* Number: RDM/WMA04/00/CON/CLA/0520.

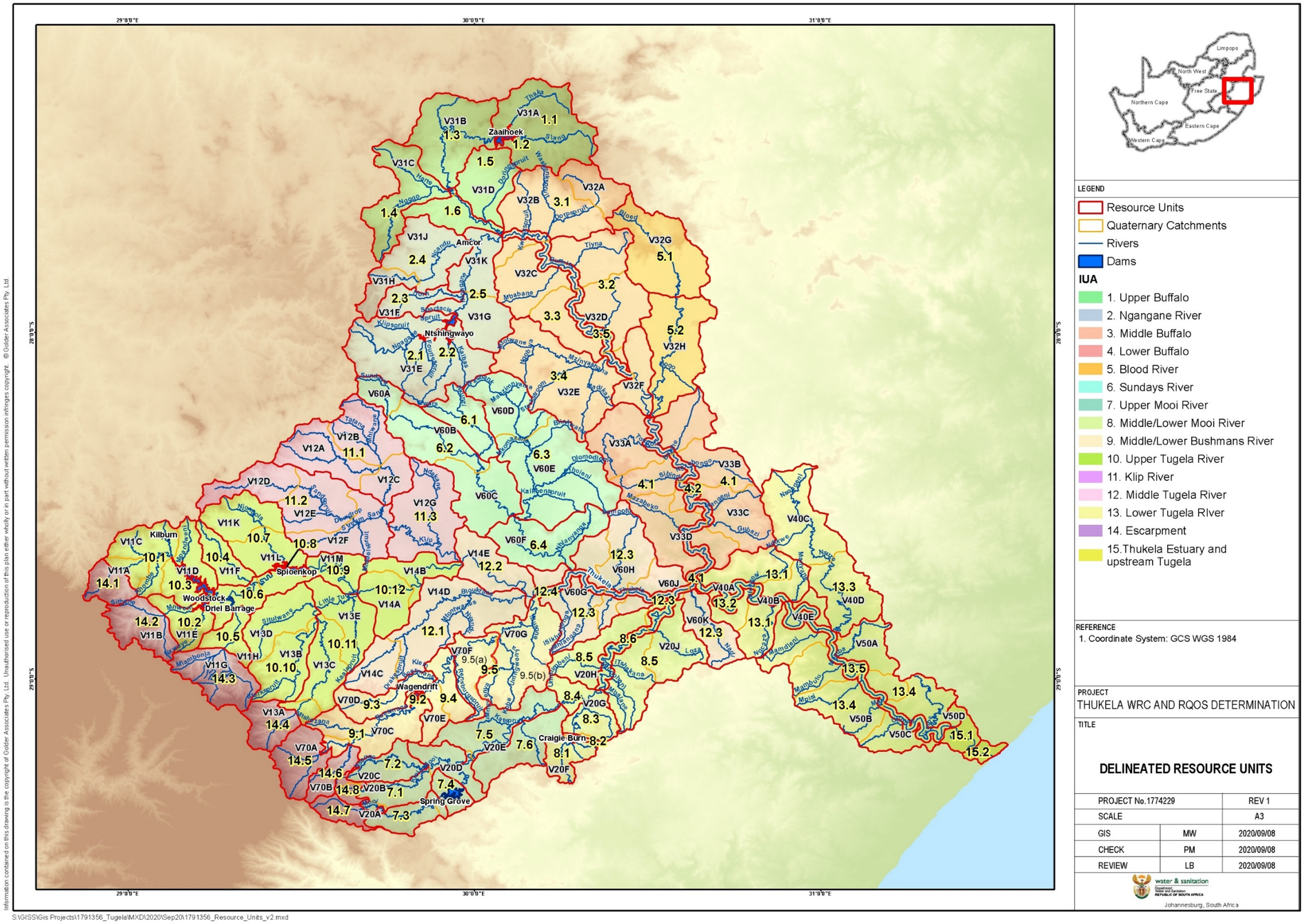

Figure 3: Delineated Resource Units

Table 3: Prioritised Resource Units in the Thukela catchment

RU Number	Resource Unit (Description)	Quaternary catchment
IUA 1: Upper Buffalo River		
1.1	Wetland resource unit: Wakkerstroom	V31A
1.2	Zaaihoek Dam	V31A
1.3	Buffalo and Slang	V31B
1.6	Buffalo to confluence to Ngagane	V31C, D
IUA 2: Ngagane River		
2.1	Upper Ngagane to Ntshingwayo Dam	V31E
2.2	Ntshingwayo Dam	V31E
2.3	Horn to confluence with Ngagane	V31F
2.4	Ncandu to confluence with Ngagane	V31H, J
2.5	Ngagane from Ntshingwayo Dam to confluence with Buffalo	V31G, K
IUA 3: Middle Buffalo River		
3.2	Tiyna, Eersteling	V32C, D
3.5	Buffalo from Ngagane to Blood River confluence	V32B, C, D, E, F
IUA: 4: Lower Buffalo River		
4.2	Buffalo from Blood to Thukela confluence	V33A, B, C, D
IUA 5: Blood River		
5.1	Wetland RU: Blood River	V32G
5.2	Blood River from outlet of V32G to confluence with the Buffalo	V32H
IUA 6: Sundays River		
6.1	Nkunzi to confluence with Sundays	V60B
6.2	Sundays from source to confluence with Wasbank	V60A, B, C
6.3	Wasbank to confluence with Sundays	V60D, E
6.4	Sundays from Wasbank to Thukela confluence, including Nhlanyanga	V60F
IUA 7: Upper Mooi River		
7.1	Klein - Mooi from source to Mooi confluence	V20B (lower portion), D
7.2	Nsonge tributary catchment	V20C
7.3	Mooi upstream of Spring Grove Dam	V20A (lower), V20D (upper)
7.4	Spring Grove Dam	V20D
7.5 (a) and (b)	Downstream Spring Grove Dam to outlet of V20E	V20D (lower) and V20E
7.6	Joubertsvlei to confluence with Mooi	V20E

RU Number	Resource Unit (Description)	Quaternary catchment
IUA 8: Middle/ Lower Mooi River		
8.2	Craigieburn Dam	V20F
8.3	Mnyamvubu downstream dam to confluence with Mooi	V20G
8.4	Mooi to Mnyamvubu confluence	V20G
8.6	Mooi from Mnyamvubu to Thukela confluence	V20H, J
IUA 9: Middle/ Lower Bushmans River		
9.2	Wagendrift Dam	V70C
9.3	Little Bushmans to confluence with Bushmans	V70D
9.4	Bushmans from Wagendrift Dam to confluence with Rensburgspruit downstream of Estcourt	V70E, F, G
9.5 (a) and (b)	Bushmans from Rensburgspruit Dam to confluence with Thukela	V70F, G
IUA 10: Upper Thukela River		
10.1	Thukela, Putterill, Majaneni, Khombe tributary catchments	V11A (lower portion), C, D
10.3	Woodstock Dam	V11D, E
10.4	Sandspruit tributary catchment	V11F
10.6	Tugela between Driel and Spioenkop Dam	V11J, L
10.8	Spioenkop Dam	V11L
10.9	Spioenkop Dam to Little Thukela confluence	V11M
10.10	Sterkspruit, Situlwane tributary catchment	V13B, D
10.11	Little Tugela from IUA14 outlet to confluence with Thukela River	V13A (lower portion), C, E
10.12	Tugela from Little Tugela confluence to proposed Jana Dam/ Klip confluence	V14A, B
IUA 11: Klip River		
11.1	Sandspruit and triburtaries	V12D, E and F
11.2	Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments	V12A, B, C,
11.3	Klip from Ladysmith to confluence with Thukela	V12G
IUA 12: Middle Thukela River		
12.2	Thukela From Klip confluence to Bushmans confluence	V14E
12.4	Thukela from Bushmans confluence to downstream Mooi confluence	V60G, H, J, K
IUA 13: Lower Thukela River		
13.2	Thukela from d/s Mooi confluence to Middeldrift transfer	V40A, B
13.5	Thukela from Middeldrift to reach in V50D	V40E, V50A, B, C

RU Number	Resource Unit (Description)	Quaternary catchment
IUA 14: Escarpment		
14.1	Upper reaches of Thukela River	V11A
14.2	Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River)	V11B
14.4	Upper reaches of Little Thukela River	V13A
14.5	Upper reaches of Boesmans River	V70A
14.7	Upper reaches of Mooi River	V20A
IUA 15: Thukela Estuary and upstream Thukela reach		
15.1	Thukela reach upstream Estuary to Mngeni transfer	V50D (upper portion)
15.2	Estuary (8.5 km upstream)	V50D

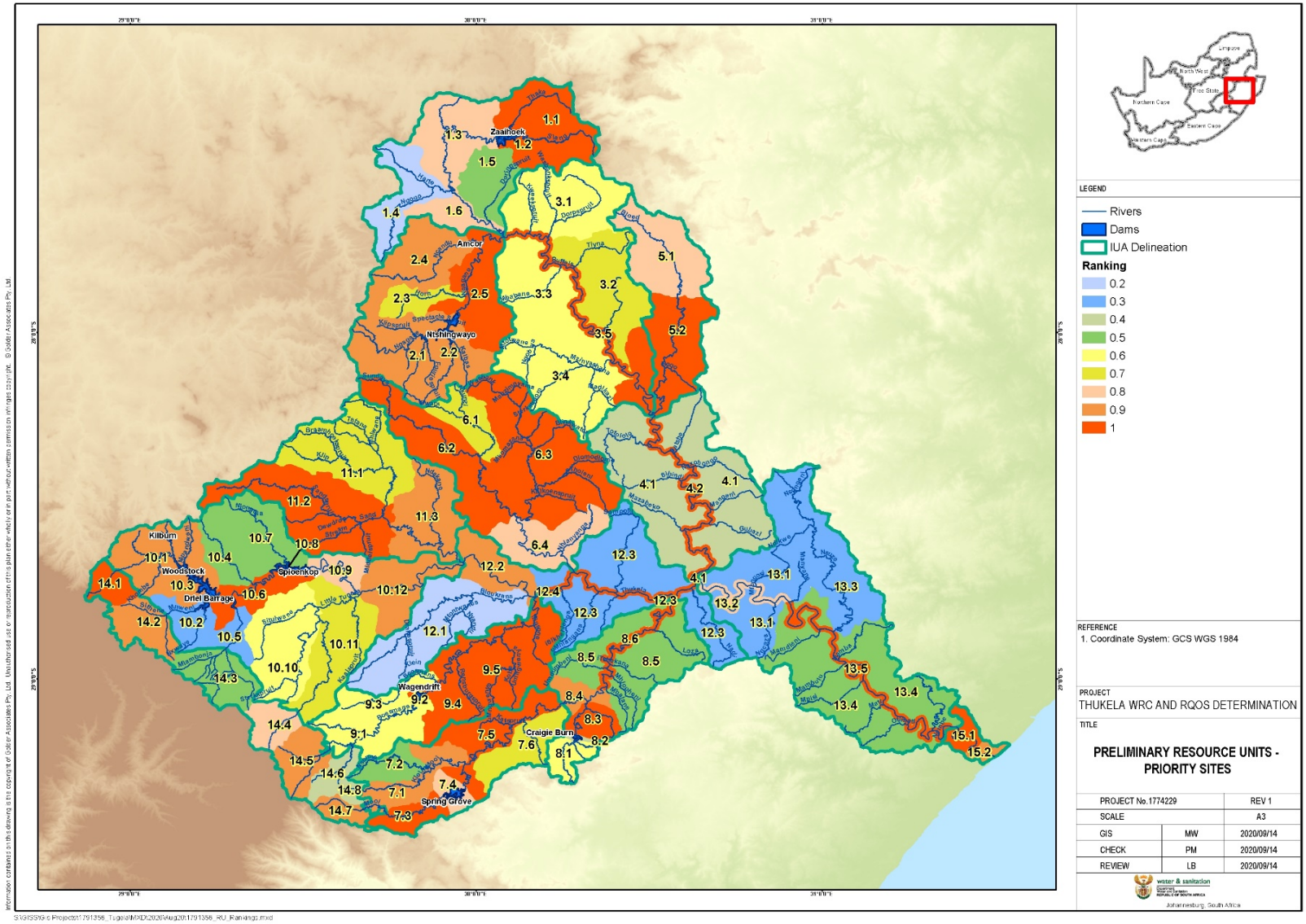

Figure 4: Prioritised Resource Units for the Thukela Catchment

3.2 Priority Groundwater Areas

Groundwater RU prioritisation was 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).

Table 4 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.

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

Table 4: Description of the Priority 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%	

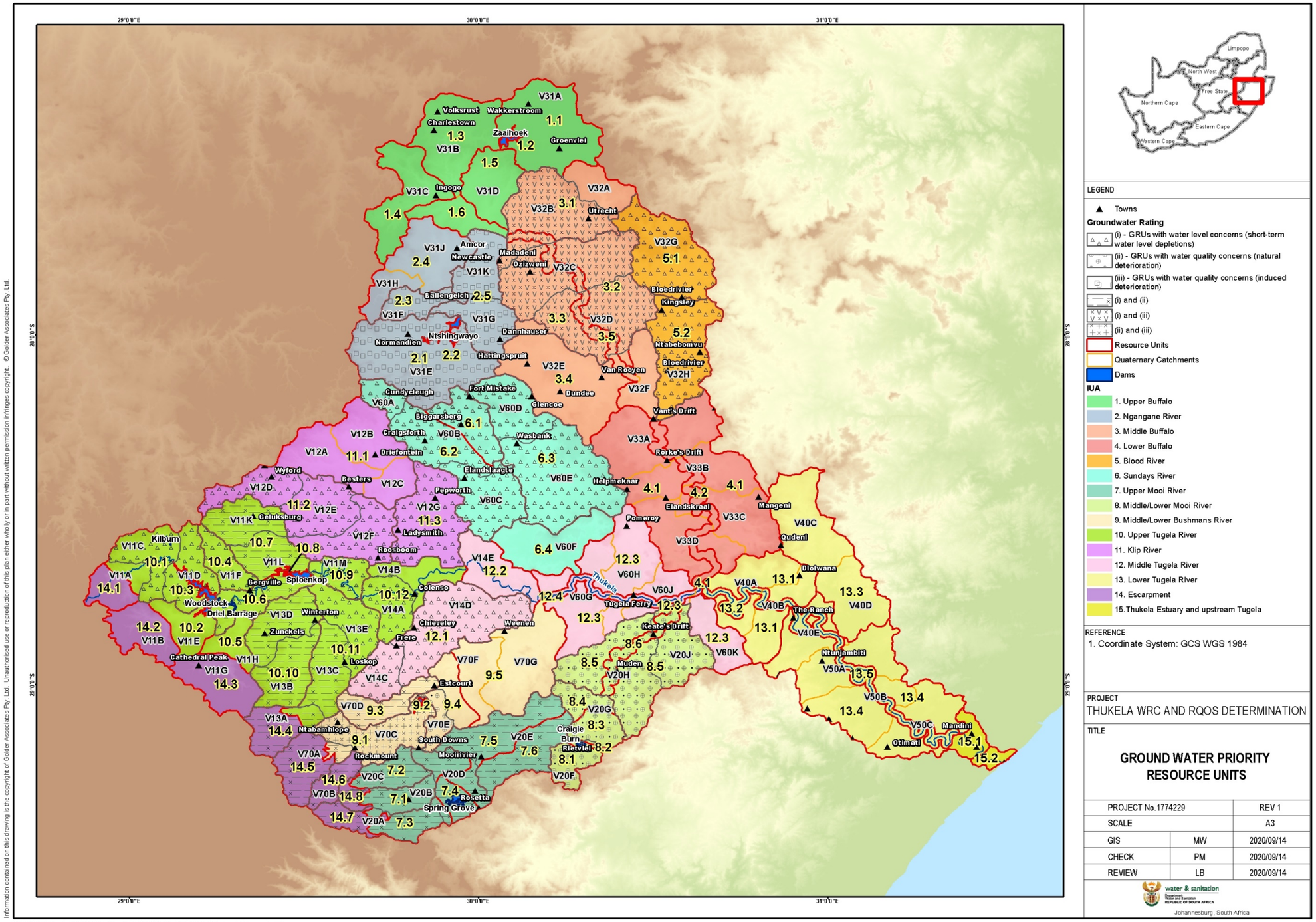

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Figure 5: Groundwater Resource Units

3.2 Priority 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 5 sets out the proposed priority wetlands, also illustrated in Figure 6.

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

Table 5: 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)	
	1.1 and marginally into 1.2	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.

Notes: CR: Critically Endangered; EN: Endangered; LC: Least Concern; VU: Vulnerable

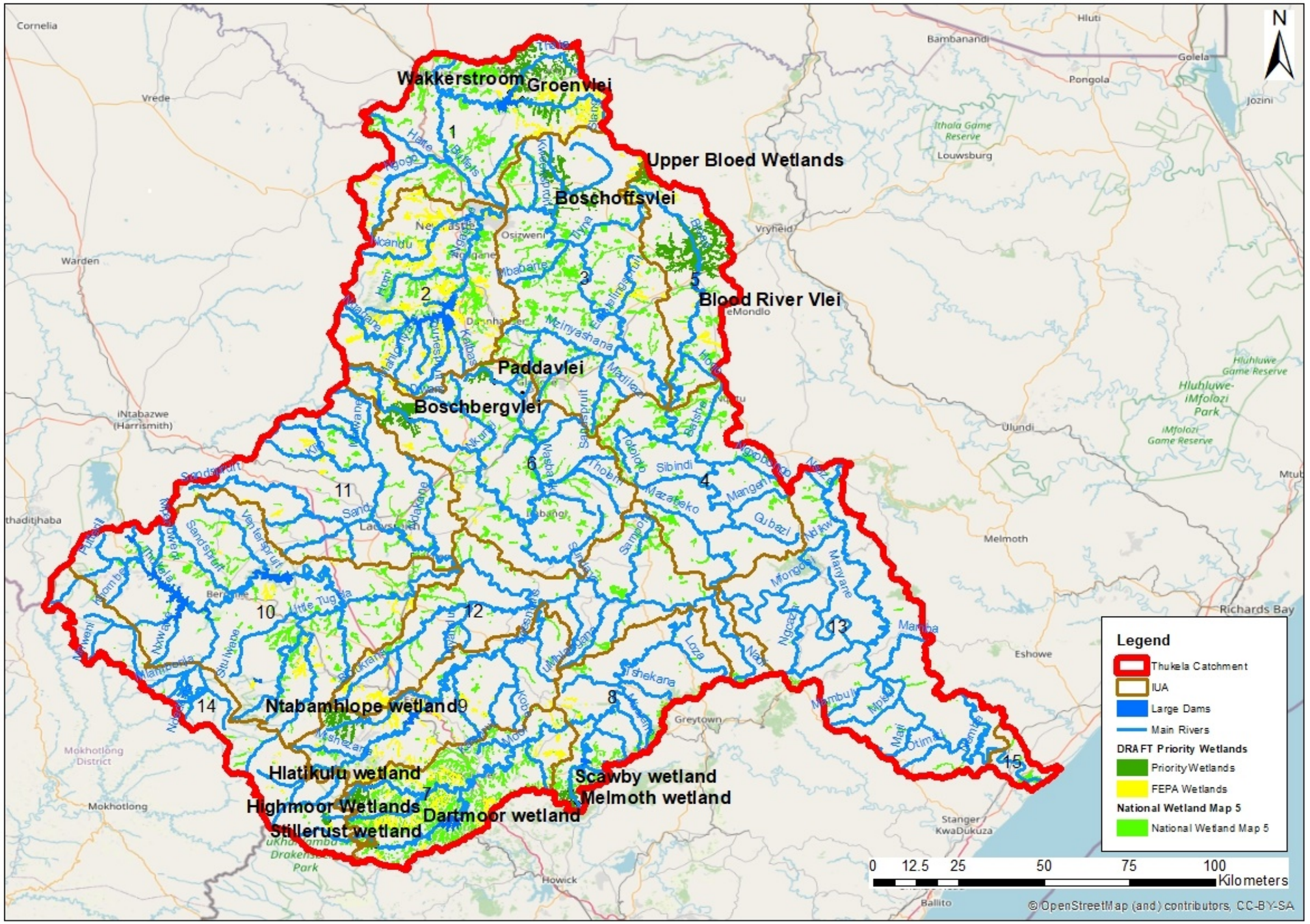

Figure 6: Priority wetlands identified within the study area

4 PRIORITISATION OF SUB-COMPONENTS AND SELECTION OF INDICATORS

Step 4 of the RQO development process, required the selection of components and the identification of proposed sub-components and indicators for which RQOs should be formulated for water resources within the prioritised resource units of the Thukela Catchment.

The selection of components and the identification of proposed sub-components and indicators for which RQOs are set, has two key objectives:

- To identify and prioritise sub-components including habitat, quantity, quality, and biota that may be important to users or the environment; and
- To select those sub-components and associated indicators such as flow, salinity, fish, and invertebrates, for which RQOs and numerical limits should be developed.

The resource unit evaluation was undertaken for the water resources in the Thukela Catchment using desktop information, local expert knowledge, previous studies, specialist studies and a detailed understanding of the catchment. The assessment was undertaken in a workshop environment with technical specialists and then presented discussed with catchment managers and key stakeholders. The overall priorities identified through the evaluation process were used to guide the selection of sub-components for RQO determination. Once the sub-components were selected, suitable indicators for monitoring were then identified. Sub-components for wetlands and groundwater were also selected through independent approaches based on assessment and evaluation of relevant aspects. These were then presented to stakeholders to obtain agreement on the proposed components and the identification of proposed sub-components and indicators.

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

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

Sub-components for rivers and dams include:

- **Quantity**
    - Low Flows
    - High Flows
- **Quality**
    - Nutrients
    - Salts
    - Systems variables
    - Toxics

  - Pathogens
- **Habitat**
  - Instream habitat
  - Riparian habitat
- **Biota**
  - Fish
  - Aquatic and riparian plant species
  - Mammals
  - Birds
  - Amphibians and reptiles
  - Periphyton
  - Aquatic invertebrates
  - Diatoms

For all prioritised wetlands the sub-components Quality, Quantity and Habitat were selected for RQO development. Biota was included as a sub-component where available species data was available to support RQO development.

The sub-components identified for groundwater RQOs include:

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

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

- **Quantity**
  - Low Flows
  - High Flows (Floods)
- **Hydrodynamics**
  - Mouth Condition
  - Abiotic states
- **Quality**
  - Salinity
  - Dissolved inorganic nitrogen
  - Dissolved inorganic phosphate
  - Water clarity
  - Dissolved oxygen
  - Toxic substances
  - Pathogens

- **Physical Habitat**
  - Intertidal
  - Subtidal
  - Substrate type
- **Biota**
  - Microalgae
  - Macrophytes
  - Invertebrates
  - Fish
  - Birds

5. SETTING OF RESOURCE QUALITY OBJECTIVES AND NUMERICAL LIMITS

Based on the prioritisation of sub-components undertaken in Step 4, RQOs have now been developed for rivers, dams, wetlands, groundwater, and the estuary in the Thukela Catchment. Numerical limits are proposed where applicable for the draft RQOs recommended for the water resources. Numerical limits translate the narrative RQOs into numerical values which can be monitored and assessed for compliance.

The basic approaches to the drafting of RQOs for rivers, dams, wetlands, groundwater, and the estuary are briefly outlined below. The draft RQOs proposed will be reviewed, updated, and refined based on stakeholder consultation still to be undertaken.

5.1 Rivers and Dams

The drafting of the RQOs for rivers and dams have been based on and included the following aspects which were applied accordingly in the context of each resource unit:

- Understanding of the catchment context and priorities,
- Collation and assessment of available data and information (present state and historic),
- Assessment of ecological classification and river health information,
- Assessment of water quality information,
- Incorporation of the requirements of the Water Resource Classification – Water Resource Classes and Ecological Categories recommended,
- Present Ecological State,
- Incorporation of flow specifications (summaries of required flow durations (tables) and summary tables of drought, low and high flow requirements per month (tab tables) as specified in the Classification and preliminary Reserve results),
- Incorporation of any direction of change required for any sub-components,
- Consideration of land based impacts,
- Stakeholder requirements,
- Feasibility of achievement of desired state,
- Alignment between resource units,

- Specification of quantifiable numerical limits in line with the draft RQOs, and
- Determination of appropriate measures, sampling methods and sampling frequency.

The RQOs developed for the Thukela Catchments' rivers and dams relate to and are based on/or derived from the following:

- The Water Resource Classes (and Reserve where applicable) and associated Ecological Categories:
    - As per the specifications of the Water Resource Classification.
- The instream flows are prescribed as specified at ecological water requirement sites and biophysical nodes:
    - Flows were determined as part of Water Resource Classification process and included ecological water requirements also considering strategic/user demands which are high in the Thukela Catchment.
    - High Flows or Low Flows (Maintenance and Drought Flows) or both were selected based on prioritisation in the specific RU.
    - RQO flow specifications are those prescribed in terms of the Water Resource Classification component of the study and where applicable the existing Reserve studies were used.
    - RQOs are specified in terms of flow requirements at nodes and EWR sites (meeting ecological requirements and user specifications).
- The presence and concentration of particular substances in the water resource (more stringent value of either the ecological category (PES or Class) or present water quality state):
    - The sub-components of salts, nutrients, pathogens, toxics, or system variables were selected when water quality was prioritised in a RU. Sub-component(s) of importance to the user and/ or the ecological system was selected.
    - Indicators of relevance and appropriateness to the sub-components were then identified. For example, for areas of elevated salts – electrical conductivity; nutrients – orthophosphate, inorganic nitrogen, and/ or system variables – pH. Consideration of impacts and user requirements (as described by the South Africa Water Quality Guidelines for Domestic, Agriculture, Industry, Recreation, Ecosystem use) as well as ease of monitoring was considered.
    - RQOs were then developed for the sub-components and limits set for the indicators. Decision criteria applied:
        - Ecological category of water resource – maintenance or improvement,
        - Consideration of present state water quality of resource – Maintenance or improvement, and
        - User requirements - strictest user requirements.

- RQOs were then set, and numerical limits specified based on one or more of the above decision criteria. If present state water quality was stricter than ecological water quality, the RQO was set based on *status quo* quality. If not, the ecological water quality specification was adopted. The Water Resource Class and related ecological category was met, user requirements were complied with and alignment with downstream/ upstream reaches was applied.
- Numerical and narrative RQOs were produced using all existing data sources.
- The key water quality issues/impacts in the resource unit were also considered and relevant indicators were included if applicable.

- The characteristics and quality of the water resource including instream and riparian habitat (maintenance or improvement of ecological state):
  - Instream and/or Riparian component of the habitat was prioritised for a RU,
  - Ecological categories per component, Ecostatus, habitat integrity and the land use activities and available data were considered,
  - Maintenance or improvement of a component was recommended based on Present State and Recommended Ecological Category (REC) specified. Any potential threats were considered,
  - Vegetation components were assessed (general vegetation structure and composition, invasion by alien species, abundance of terrestrial species) to determine the overall state of the riparian zone, and
  - RQOs were specified in terms of meeting the Target Ecological Category (TEC).
- The characteristics and distribution of aquatic and semi-aquatic biota (maintenance or improvement of ecological state):
  - Sub-components were selected for a RU if Biota was prioritised as a component. Fish, macroinvertebrates, or diatoms were selected based on relevance to a specific RU,
  - Ecological Categories per component, Ecostatus and habitat integrity, land use activities present, and relevant, available data were considered,
  - Maintenance or improvement of the biotic sub-component was recommended based on Present Ecological State (PES) and Target Ecological Category (TEC). Any important species as well as potential threats were also considered,
  - RQOs were specified in terms of meeting the Target Ecological Category (TEC) (and Water Resource Class); recommended condition and monitoring,
  - For Fish, available information provided by the PES/EIS project was used as a key source of information, and data obtained through the River EcoStatus Monitoring Programme (REMP). Aerial footage (Google Earth), and all relevant information were used to determine the expected present suitability of each reach for each species. This was transferred to the Fish Response Assessment Index (FRAI) and refined based on expert judgement and additional information. The FRAI results

were then used to describe narrative RQOs and numerical limits for each sub-component indicator, and

- For macroinvertebrates, available information provided by the PES/EIS project was used as a key source of information, data obtained through the River EcoStatus Monitoring Programme (REMP) and macroinvertebrate data retrieved from the Rivers Database. Narrative RQOs were set according to the specific Ecological Category as determined by the Macroinvertebrate Response Assessment Index (MIRAI) for a specific site representative of the resource unit or area considered. Numerical limits were then set for the specific MIRAI Ecological Category, and for the SASS5 (South African Scoring System Version 5) total score and ASPT (Average Score Per Taxon).

5.2 Groundwater

The proposed groundwater RQOs that have been set for comment are based on the following set of sub-components related to the characteristics of the groundwater component of the catchment:

- Groundwater Quantity – based on:
  - Sustainable Use – addresses the optimal management of an aquifer's storage balance between (i) recharge from rainfall, and (ii) abstraction form the aquifer. A specific indicator has been used to stipulate the sustainable use as a factor of the total water use[3] over the annual rainfall recharge to the aquifer.
  - Water Level (aquifer saturation) – addressed the depth to the local water table in an aquifer system. The water level is used as an indicator of the actual saturated thickness of the aquifer and the norm is to calculate this thickness from the (measured) water level down to the "last, main" water strike in specific borehole.
- Groundwater Quality – based on:
  - Salinity – based on the total dissolved solids present in the groundwater is merely a natural norm due to long-term water-rock interaction along the groundwater flow path. Due to some aquifer formation types the resulting groundwater could be "naturally saline". Anthropogenic activities produce a large range of waste materials and liquids that may enter the saturated groundwater system. Depending on the concentrations, the impact on the groundwater could be significant causing the groundwater resources to be unacceptable for any type of use.
  - Specific hydrochemical constituents – more serious pollution resulting from industrial/mining/ agricultural practices can deteriorate the groundwater quality that it becomes a serious risk for other water resources such as pans, dams, and rivers.
- Protection Criteria – protection of a groundwater resource (viz. an aquifer system) is required to address management protocols specifically focussing on the impacts of water use practices in the catchment/resource unit(s).

[3] Total water use includes (i) basic human need, (ii) groundwater component of the baseflow (to sustain the EWR requirement), and (iii) groundwater use (abstraction via boreholes and forestry).

5.3 Wetlands

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

5.4 Estuary

The character and function of estuaries tends to differ substantially from the receiving rivers so are managed as individual Resource Units (RUs). In order to find a balance between protecting and sustaining a relevant water resource and the need to use them, to benefit all users, a freshwater Reserve is set and managed using Resource Quality Objectives (RQOs). Resource Quality Objectives provide clear goals that relate to the quality and quantity of the relevant water resources, capturing the Management Class of the Classification System (DWA, 2011). In addition, the ecological needs that are determined in the ecological Reserve are described as measurable management goals in the RQOs to guide resource managers on how to manage the resource needs of the relevant estuaries. Resource Quality Objectives are set for the short to medium term, 5 to 10 years, for the following abiotic (drivers) and biotic (responses) components:

Abiotic drivers

1. Hydrology - Quality, quantity and timing of instream flow.
2. Hydrodynamics - Mouth state.
3. Water quality.
4. Physical habitat.

Biotic responses

5. Characteristics and condition of biota; microalgae, macrophytes, invertebrates, fish, and birds.

No Thresholds of Potential Concern (TPC) or Ecospecs were developed for the Thukela Estuary during the Ecological Reserve determination study (DWAF, 2004), so RQOs have been developed based on the tipping points between river categories (B and C) and yield scenarios (7 and 8) based on the Target Ecological Category (TEC) of a C. In terms of RQOs for recreational use, the targets proposed were based on water quality guidelines for South Africa's coastal marine waters, recreational use (DEA, 2012) and for inland water (DWAF, 1996), where the estuary represents a gradient from fresh to saline water.

In order to maintain an open estuary mouth and connectivity between the estuary and the adjacent coastal zone, a minimum inflow of 5 m^3/s is required. River discharge is measured at the Mandini gauging weir (V2H005), which is located just upstream of the newly commissioned Lower Thukela Bulk Water Supply Scheme (LTBWSS) abstraction weir. The

LTBWSS is currently in Phase 1 where up to 55 ML/d of raw water is abstracted from the Thukela River, via a weir, for treatment and distribution. Phase 2 of the LTBWSS, planned for the near future (5-10 years), will double the capacity of the associated water treatment plant, increasing abstraction to 110 ML/d. Abstraction rates of 55 ML/d and 110 ML/d translate into losses of river flow of 0.64 m^3/s and 1.27 m^3/s, respectively. It is essential that the quantity and timing of ecological flows required to achieve the Target Ecological Category (TEC) take the LTBWSS abstraction into account.

The TEC (C) was equivalent to the PES (C) of the Thukela Estuary (DWAF, 2004) based on the Estuary Health Index (EHI) results (Table 1). More recently, the PES was reviewed and recalculated to be a D based on updated abiotic and biotic scores (Table 1).

Table 1. Estuary Health Index (EHI) scores allocated to the Thukela Estuary (present state) based on the 2001-2004 Estuarine Flow Requirements study (DWAF, 2004) and latest National Biodiversity Assessment (van Niekerk *et al*. 2019)

Variable	Score (DWAF, 2004)	Score (van Niekerk *et al*., 2019)
Hydrology	87 (B)	70 (C)
Hydrodynamics & mouth condition	80 (B)	75 (C)
Water quality	54 (D)	54 (D)
Physical habitat alteration	80 (B)	70 (C)
Habitat health score	**75 (C)**	**67 (C)**
Microalgae	65 (C)	60 (D)
Macrophytes	60 (D)	60 (D)
Invertebrates	60 (D)	40 (D)
Fish	70 (C)	45 (D)
Birds	70 (C)	45 (D)
Biotic Health Score	**65 (C)**	**48 (D)**
Estuarine Health Index scores	**70 (C)**	**58 (D)**

6. PROPOSED RESOURCE QUALITY OBJECTIVES FOR THE THUKELA CATCHMENT

The sections to follow detail the proposed RQOs for rivers, dams, wetlands, groundwater, and the estuary in the Thukela Catchment. Detail is given per resource unit and IUA and includes the context and the rationale, where applicable, on the proposed RQOs and numerical limits formulated to guide and provide understanding to the reader on the reasoning and context to on the proposed RQOs.

6.1 River and Dam Resource Quality Objectives

6.1.1 IUA 1: Upper Buffalo River

Table 6: Resource Units delineated for IUA 1: Upper Buffalo River

RU	Delineation	Catchment
1.1	Wetland resource unit: Wakkerstroom	V31A
1.2	Zaaihoek Dam	V31A
1.3	Buffalo and Slang	V31B
1.6	Buffalo to confluence to Ngagane	V31C, D

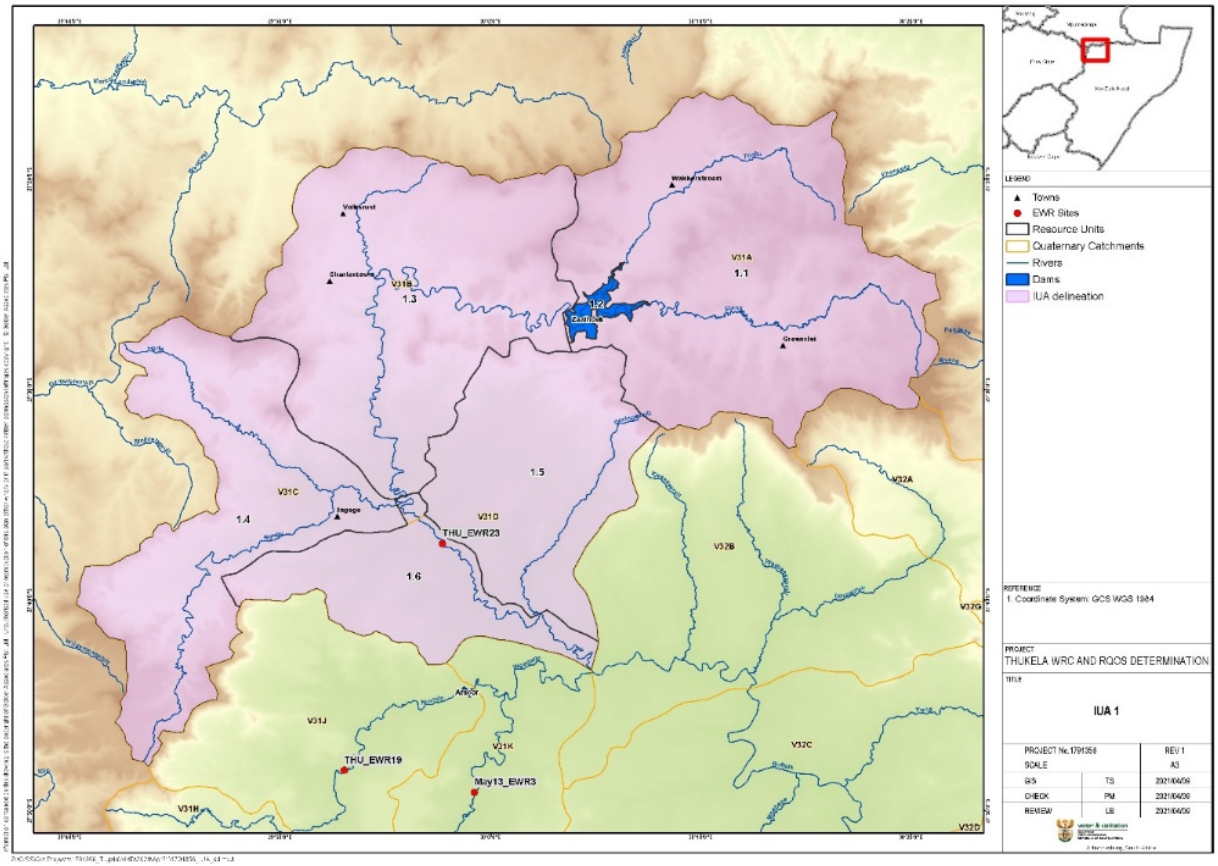

Figure 7: IUA 1 - Upper Buffalo Resource Units

Table 7: IUA 1 Buffalo River RUs description

IUA 1 – Buffalo River
Resource Unit 1.1: Wetland resource unit: Wakkerstroom - Quaternary catchment V31A
Main stem river. 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; Peatlands; Rivers are in a B ecological category. High household, tourism, and society value. Proposed Groenvlei Agri village. Sampling points on WMS. *Note: this RU has both river and wetland related RQOs*
Resource Unit 1.2: Zaaihoek Dam - Quaternary catchment V31A
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.
Resource Unit 1.3: Buffalo and Slang - Quaternary catchment 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.
Resource Unit 1.6: Buffalo to confluence with Ngagane – Quaternary catchment 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.

Table 8: Draft RQOs for IUA 1: Upper Buffalo River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
1.1 Wetland resource unit: Wakkerstroom **V31A**	Quantity	Low flows	EWR maintenance low and drought flows: Slang River at V3R003 in V31A NMAR = 97.065 x$10^6$$m^3$ TEC=B category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Maintenance and drought flows - specifically required for wetlands upstream of the Zaaihoek Dam (V3R003) Monitoring of flows at V3R003		Maintenance	Drought	Desktop for TEC=B (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.221	0.007	
					Nov	0.418	0.081	
					Dec	0.610	0.075	
					Jan	0.83	0.180	
					Feb	1.069	0.231	
					Mar	0.812	0.176	
					Apr	0.576	0.127	
					May	0.319	0.004	
					Jun	0.185	0.039	
					Jul	0.142	0.036	
					Aug	0.121	0.032	
					Sep	0.137	0.035	
	Quality	Nutrients	Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the present ecological state (PES B)	Ortho-phosphate as P	≤0.01 mg/L (50th percentile)			Maintain the current state.
				Total Inorganic Nitrogen (TIN)	≤0.5 mg/L (50th percentile)			
		Salts	Total Dissolved Solids needs to be maintained to support aquatic ecosystem and sustain the present ecological state (PES B)	Total Dissolved Solids	≤120 mg/L (95th percentile)			
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained in a PES B ecological category.	*Barbus (Enteromius) anoplus* (BANO) *Amphilius natalensis* (ANAT) *Anguilla mossambica* (AMOS)	During survey in all flow habitat classes all species present. BANO and ANAT ≥ 5 individuals per species			Slang and Thaka must achieve PES B/ EI: High/ ES: Very High
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained within a B ecological category or improved upon.	Baetidae 2 sp Perlidae Tricorythidae Hydropsychidae 1 sp Leptoceridae Ancyidae Psephenidae	At least 2 biotopes sampled: assemblages to be ≥ A abundances			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Diatoms	Ecological water quality should be maintained as *good quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: ≥15 PTV: 20 to < 40%	
Resource Unit	**Component**	**Sub-component**	**RQO**	**Indicator**	**Numerical Limit**	**Context of the RQO and/or Numerical limit**
1.2 Zaaihoek Dam **V31A**	Quantity	Dam level	Update and review operating rules to sustain optimal dam levels to support users and downstream aquatic ecosystem. The dam level must be managed to protect ecosystem function as well as downstream users.	Minimal operating level required in the dam.		Operating rules
	Quality	Nutrients	Nutrient levels must be maintained to sustain good water quality state and ecological condition. Impacts must be limited to prevent deterioration.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.01 mg/L (50th percentile)	
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤0.5 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained to sustain good water quality state and ecological condition.	Total Dissolved Solids	≤120 mg/L (95th percentile)	
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem as the driver.
			Maintain baseline clarity	Turbidity	Must not deviate more than 10% from background levels	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
1.3 EU	Quantity	Low flows	EWR maintenance low and drought	Maintenance and		Maintenance	Drought	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
			flows: Buffalo River at outlet of V31B NMAR = 161.44 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	drought flows required for the upstream Buffalo River		Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	Desktop for TEC=C (Baseflows)
					Oct	0.404	0.075	
					Nov	0.698	0.127	
					Dec	0.991	0.123	
					Jan	1.367	0.467	
					Feb	1.764	0.488	
					Mar	1.353	0.373	
					Apr	0.972	0.278	
					May	0.565	0.078	
					Jun	0.346	0.085	
					Jul	0.275	0.086	
					Aug	0.243	0.078	
					Sep	0.404	0.075	
	Quality	Nutrients	Nutrient levels must be improved to sustain the aquatic ecosystem health and to meet the prescribed ecological state	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.5 mg/L (50th percentile)			Improvement in water quality required. Maintenance of present ecological state. C category. Protection of ecological integrity.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1 mg/L (50th percentile)			
		Salts	Salinity levels must be maintained or improved to support downstream users.	Total Dissolved Solids	≤350 mg/L (95th percentile)			
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL (95th percentile)			User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
		Toxics	Ammonia concentration should not be a threat to human or ecological health	Ammonia as N	≤0.0725 mg/L			*Strictest ecological spec*
	Habitat	Instream	Natural flow pattern must be maintained in C Ecological Category. Alien invasive controls must be	IHI and IHAS	IHI ≥C Ecological Category (60 – 79%) IHAS to be *good* habitat availability (>65%)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			implemented, maintained and/ improved.			
		Riparian habitat	The riparian vegetation must be maintained at VEGRAI ≥ C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	VEGRAI	VEGRAI survey every 5 years. VEGRIA ≥C Ecological Category (>60%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained in a PES C ecological category.	*Barbus (Enteromius) anoplus* (BANO) *Amphilius natalensis* (ANAT) *Anguilla mossambica* (AMOS) *Labeo rubromaculatus* (LRUB)	During survey in all flow habitat classes all species present. *Barbus (Enteromius) anoplus (BANO) and Amphilius natalensis (ANAT)* ≥ 5 individuals per species. *Labeo rubromaculatus* (LRUB) habitat requirement – deep pools and fast deep flow class.	
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained within a C ecological category or improved upon.	Baetidae 2 sp Perlidae Heptageniidae Hydropsychidae 2 sp Elmidae Leptophlebidae	At least 2 biotopes sampled: assemblages to be ≥ B abundances	
		Diatoms	Ecological water quality should be maintained as *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 -14 PTV: 20 to < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
1.6 Buffalo to confluence with Ngagane **V31C, D** **(THU_EWR23)**	Quantity	Low flows	EWR maintenance low and drought flows: Buffalo River at the EWR site THU_EWR23 (-27.6221, 29.9617) in V31D NMAR = 221.96 x$10^6$$m^3$ TEC=C category	Maintenance and drought flows required for the Buffalo River		Maintenance	Drought	THU_EWR23 for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.563	0.107	
					Nov	0.952	0.170	
					Dec	1.342	0.167	
					Jan	1.866	0.641	
					Feb	2.412	0.648	
					Mar	1.854	0.518	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
			The maintenance low flows and drought flows must be attained to support the upstream and downstream aquatic ecosystem to the Ngagane River confluence.		Apr	1.335	0.382	
					May	0.784	0.146	
					Jun	0.484	0.128	
					Jul	0.386	0.121	
					Aug	0.342	0.114	
					Sep	0.386	0.143	
	Quality	Nutrients	Nutrient levels must be maintained or improved to sustain the aquatic ecosystem health and to meet the prescribed ecological state (C ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.5 mg/L (50th percentile)			Maintenance of present ecological state. C category. Protection of ecological integrity.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1 mg/L (50th percentile)			
		Salts	Salinity levels must be maintained or improved to support downstream users.	Total Dissolved Solids	≤350 mg/L (95th percentile)			
				Sulphate	≤80mg/L (95th percentile)			Present state is good quality and to be maintained
				Chloride	≤30mg/L (95th percentile)			
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
			Alkalinity should be maintained at acceptable levels to support downstream users.	Alkalinity as mg/l $CaCO_3$	≤120 mg/l as $CaCO_3$			Industrial user water quality guideline (SAWQG, 1996) – Acceptable target water quality upper limit
		Toxics	The concentrations of toxins should not be toxic to aquatic organisms and a threat to human health.	Aluminium (Al)	≤ 0.105 milligrams/litre (mg/l) (95th percentile)			Strictest of Ecological specifications. Ecological Reserve manual (2008), South African Water Quality Guidelines (1996) Manganese/Iron – Domestic user water quality guideline (SAWQGs, 1996).
				Manganese (Mn)	≤ 0.15 milligrams/litre (mg/l) (95th percentile)			
				Cadmium (Cd)	≤ 0.0012 milligrams/litre (mg/l) (95th percentile)			
				Iron (Fe)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)			
				Lead (Pb) hard	≤ 0.0095 milligrams/litre (mg/l) (95th percentile)			
				Copper (Cu) hard	≤ 0.0073 milligrams/litre (mg/l) (95th percentile)			
				Nickel (Ni)	≤ 0.07 milligrams/litre (mg/l) (95th percentile)			
				Ammonia (as N)	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Habitat	Instream	Natural flow pattern must be maintained in C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	IHI and IHAS	Instream Habitat Integrity (class D) ≥D Ecological Category (40 – 59%) Riparian Integrity - Class ≥B Ecological Category (80 – 90%) IHAS to be *good* habitat availability (>65%)	
		Riparian habitat	The riparian vegetation must be maintained at VEGRAI ≥ C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained in a PES C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Amphilius natalensis* (ANAT) *Anguilla mossambica* (AMOS) *Labeo rubromaculatus* (LRUB) *Barbus (Enteromius) pallidus* (BPAL) *Barbus (Enteromius) paludinosus* (BPAU)	During survey in all flow habitat classes all species present. BANO, BPAL, BPAU – habitat indicators; and ANAT ≥ 5 individuals per species FRAI EC: C (60 - 79%)	
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained within a C ecological category or improved upon.	SASS 5 MIRAI Baetidae 2 sp Atyidae Hydracarina Heptageniidae Leptophlebiidae Ecnomidae Elmidae Tricorythidae	3 biotopes sampled; assemblages to be ≥ B abundances. SASS 5 scores: 120 – 200 ASPT score: 5.5 – 6.5 MIRAI EC: C (60 – 79%)	
		Diatoms	Ecological water quality should be maintained as *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12-14 PTV: < 20%	

6.1.2 IUA 2: Ngagane River

Table 9: Resource Units delineated for IUA 2: Ngagane River

RU	Delineation	Catchment
2.1	Upper Ngagane to Ntshingwayo Dam	V31E
2.2	Ntshingwayo Dam	V31E
2.3	Horn to confluence with Ngagane	V31F
2.4	Ncandu to confluence with Ngagane	V31H, J
2.5	Ngagane from Ntshingwayo Dam to confluence with Buffalo	V31G, K

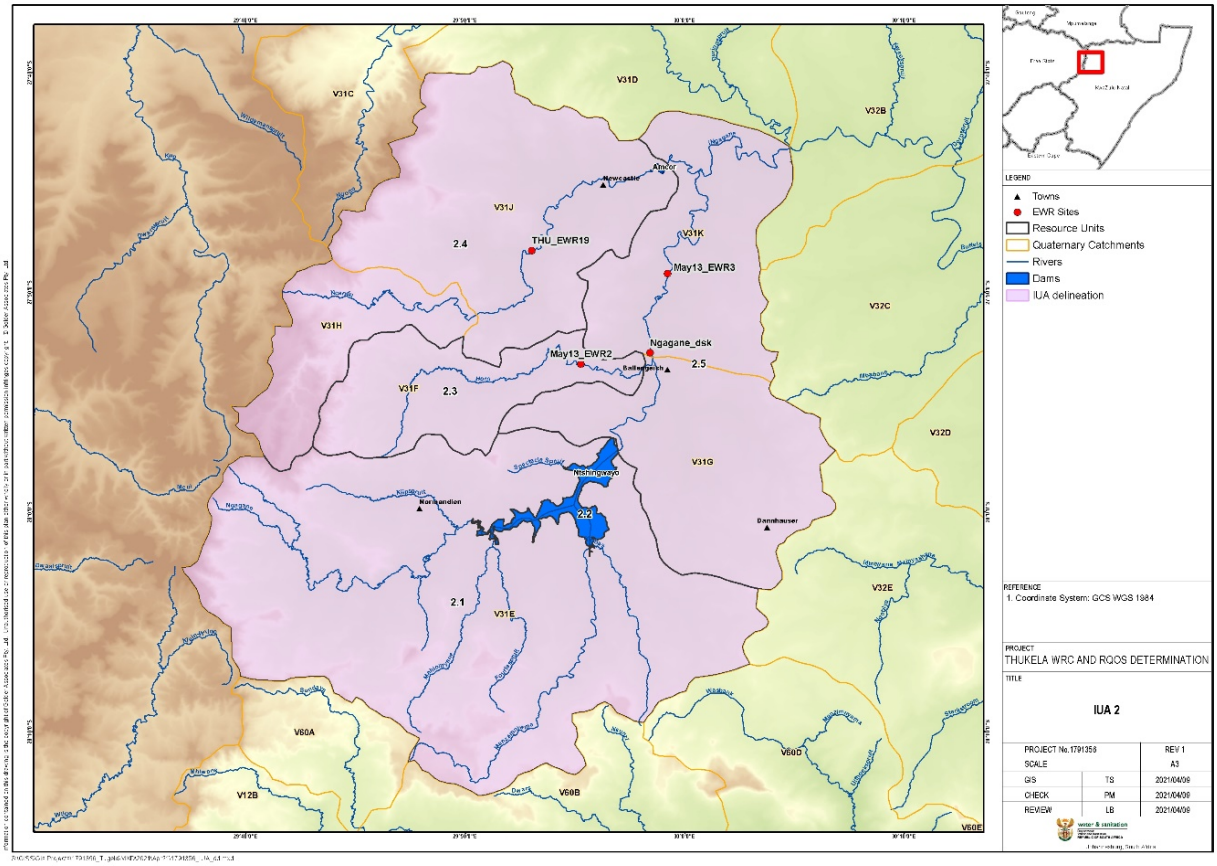

Figure 8: IUA 2 – Ngagane River Resource Units

Table 10: IUA 2 Buffalo River RUs description

IUA 2 – Ngagane River
Resource Unit 2.1: U**pper Ngagane to Ntshingwayo Dam - Quaternary catchment V31E**
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 category C. Some FEPA (prioritized) wetlands. Impacts from old mines that include discard dumps (not rehabilitated) and unlined pollution control dams. Sampling points on WMS.
Resource Unit 2.2: Ntshingwayo Dam - Quaternary catchment V31E

IUA 2 – Ngagane River
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.
Resource Unit 2.3: Horn to confluence with Ngagane - Quaternary catchment V31F
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.
Resource Unit 2.4: Ncandu to confluence with Ngagane - Quaternary catchment 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.
Resource Unit 2.5: Ngagane from Ntshingwayo Dam to confluence with Buffalo – Quaternary catchment V31D
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.

Table 11: Draft RQOs for IUA 2: Ngagane River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
2.1 Upper Ngagane to Ntshingwayo Dam **V31E**	Quantity	Low flows	EWR maintenance low and drought flows: Ngagane River at Klipspruit confluence in V31E NMAR = 32.089 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Maintenance and drought flows required for the wetlands and Ngagane River upstream of the Chelmsford Dam (V3R001)		Maintenance	Drought	Desktop for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.054	0.020	
					Nov	0.082	0.014	
					Dec	0.112	0.009	
					Jan	0.168	0.074	
					Feb	0.229	0.100	
					Mar	0.189	0.083	
					Apr	0.139	0.062	
					May	0.082	0.037	
					Jun	0.051	0.023	
					Jul	0.037	0.018	
					Aug	0.054	0.020	
					Sep	0.082	0.014	
	Quality	Nutrients	Nutrient levels must be maintained or improved to sustain the aquatic ecosystem health and to meet the prescribed ecological state (C ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤ 0.05 mg/L (50th percentile)			Maintenance of present ecological state. C category. Protection of ecological integrity and user requirements. Aquatic ecosystem as the driver.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤ 1 mg/L (50th percentile)			
		Salts	Salinity concentration must be maintained or improved to support downstream users.	Total Dissolved Solids	≤ 350 mg/L (95th percentile)			
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			
	Habitat	Instream	Natural flow pattern must be maintained in C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	IHI and IHAS	Instream Habitat Integrity (class A/B) Ecological Category (80 – 100%) Riparian Integrity - Class ≥C Ecological Category (60 – 79%) IHAS to be *adquate* habitat availability (>55 - 65%)			
		Riparian habitat	The riparian vegetation must be maintained at VEGRAI ≥ C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60%)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained in a PES C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Amphilius natalensis* (ANAT) *Labeo rubromaculatus* (LRUB) *Barbus (Enteromius) pallidus* (BPAL) *Barbus (Enteromius) paludinosus* (BPAU)	During survey in all flow habitat classes all species present. BANO, BPAL, BPAU – habitat indicators; and ANAT ≥ 5 individuals per species FRAI EC: C (60 - 79%)	Presence of AMOS will decline because of in-stream discontinuity (low migration potential).
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained within a C ecological category or improved upon.	SASS 5 MIRAI Baetidae >2 spp Atyidae Heptageniidae Leptophlebiidae Hydropsychidae >1 spp	At least 2 biotopes sampled; assemblages to be ≥ B abundances MIRAI EC: C (60 – 79%)	
		Diatoms	Ecological water quality should be maintained as *good quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 15 - 17 PTV: 20 to <40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
2.2 Ntshingwayo Dam **V31E**	Quantity	Dam level	Update and review operating rules to sustain optimal dam levels to support users and downstream aquatic ecosystem. The dam level must be managed to protect ecosystem function as well as downstream users.	Minimal operating level required in the dam.		
	Quality	Nutrients	Concentration of total nitrate must be maintained to sustain ecosystem health and the water quality	Total Inorganic Nitrogen (TIN)	≤1.0 mg/L (50^{th} percentile)	Based on current state water quality.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
			requirements of water users. The dam must be maintained as a mesotrophic system or better. Good current state to be maintained. Prevent algal blooms.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.05 mg/L (50th percentile)	Good present state condition.
		Salts	The salinity in the dam must be maintained to support ecosystem health and the water quality requirements of the downstream users. Good current state to be maintained.	Total Dissolved Solids	≤120 mg/L (95th percentile)	
		System variables	pH must be maintained within the prescribed range.	pH	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem as the driver.
			Maintain system to ensure increase in clarity	Turbidity	≥0.4 m 5th percentile	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming Units per 100 mL	
	Habitat	Riparian vegetation Health	To manage the water resource for maintenance of aquatic ecosystem diversity (instream, biotic and semi-aquatic species, riparian zones). Conserve, maintain, rehabilitate, and establish artificial shoreline and riparian zones. The natural riparian zone should be preserved as far as possible, including removing alien invasives, to ensure necessary habitat.	80% riparian vegetation cover	Riparian zone vegetation survey at least every three years.	The dam provides important refuge habitat for aquatic and semi-aquatic biota (mammals, birds, fish, etc.) and all components of its management (recreation, eco-tourism, abstraction, water quality impacts, dam releases).
	Biota	Mammals	Habitat must be maintained to support the Red List species.	Oribi (*Ourebia ourebia*)		Red List species
		Birds	Habitat must be maintained to support the Red List species.	Southern Bald Ibis (*Geronticus calvus*) Grey Crowned Crane (*Balearica regulorum*) Blue Crane (*Anthropoides paradiseus*) African Marsh Harrier (*Circus ranivorus*) Corned Crake (*Crex crex*) African Grass Owl (*Tito capensis*) Secretarybird (*Sagittarius serpentarius*) Whitebellied Korhaan (*Eupodotis senegalensis*)		

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
				Ground Woodpecker (*Geocolapts olivaceus*)		

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
2.3 Horn to confluence with Ngagane **V31F (May 13_EWR 2)**	Quantity	Low flows	EWR maintenance low and drought flows: Horn River at the EWR site May13_EWR2 (-27.888, 29.921) in V31F NMAR = 21.61 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Maintenance and drought flows required for the Horn River Monitoring of flows at V3H009		Maintenance	Drought	May13_EWR2 for TEC=C (Base flows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.086	0.01	
					Nov	0.134	0.009	
					Dec	0.183	0.009	
					Jan	0.272	0.047	
					Feb	0.362	0.063	
					Mar	0.295	0.051	
					Apr	0.209	0.037	
					May	0.117	0.021	
					Jun	0.069	0.013	
					Jul	0.053	0.01	
					Aug	0.05	0.01	
					Sep	0.061	0.011	
	Quality	Nutrients	Nutrient levels must be improved to sustain the aquatic ecosystem health and to meet the prescribed ecological state (C category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤ 0.02 mg/L (50th percentile)			Maintain present ecological state. Water quality improvement required.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)			
		Salts	Instream salinity must be improved to meet the recommended ecological category and the water quality requirements of the water users. Land based impacts and discharges must be controlled and managed to protect the resource.	Total Dissolved Solids	≤ 350 mg/L (95th percentile)			
				Sulphate	≤ 165mg/L (95th percentile)			Present state is TDS 500mg/l Sulphate 155 Chloride 40mg/l
				Chloride	≤ 120 mg/L (95th percentile)			
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Toxics	The concentrations of toxins should not be toxic to aquatic organisms and a threat to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Strictest of ecological specifications. Ecological Reserve manual (2008), South African Water Quality Guidelines (1996) Manganese/Iron – Domestic user water quality guideline (SAWQGs, 1996). Cobalt – – Irrigation user water quality guideline (SAWQGs, 1996) Zinc - Aquatic Ecosystem water quality guideline (SAWQGs, 1996).
				Aluminium (Al)	≤ 0.105 milligrams/litre (mg/l) (95th percentile)	
				Manganese (Mn)	≤ 0.15 milligrams/litre (mg/l) (95th percentile)	
				Iron (Fe)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
				Lead (Pb) hard	≤ 0.0095 milligrams/litre (mg/l) (95th percentile)	
				Copper (Cu) hard	≤ 0.0073 milligrams/litre (mg/l) (95th percentile)	
				Nickel (Ni)	≤ 0.07 milligrams/litre (mg/l) (95th percentile)	
				Cobalt (Co)	≤ 0.05 milligrams/litre (mg/l) (95th percentile)	
				Zinc (Zn)	≤ 0.002 milligrams/litre (mg/l) (95th percentile)	
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL (95^{th} percentile)	User specification. Limit is the target water quality range for full contact recreational use – South African Water

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						Quality Guidelines (1996).
	Habitat	Instream	Natural flow pattern must be maintained in B/C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	IHI and IHAS	Instream Habitat Integrity (class B/C) Ecological Category (60 – 90%) Riparian Integrity - Class ≥A/B Ecological Category (80 – 100%) IHAS to be *good* habitat availability (>65%)	
		Riparian habitat	The riparian vegetation must be maintained at VEGRAI ≥ C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained or improved to a PES C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Amphilius natalensis* (ANAT) *Anguilla mossambica* (AMOS) *Labeo rubromaculatus* (LRUB) *Barbus (Enteromius) pallidus* (BPAL) (BNAT)	During survey in all flow habitat classes all species present. BANO, BPAL – habitat indicators; and ANAT ≥ 5 individuals per species FRAI EC: C (60 - 79%)	FRAI currently a D; must improve to a C – water quality and system connectivity improvement.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained within a C ecological category or improved upon.	SASS 5 MIRAI Baetidae 2 spp Leptophlebiidae Tricorythidae Leptoceridae Perlidae Hydropsychidae >2spp	3 biotopes sampled; assemblages to be ≥ B abundances; SASS 5 scores: ≥213 ASPT score: ≥7.2 MIRAI EC: C (60 – 79%)	
		Diatoms	Ecological water quality should be maintained as *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12-14 PTV: 20 to < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
2.4 Ncandu to confluence with Ngagane **V31H, J (EWR 19)**	Quantity	Low flows	EWR maintenance low and drought flows: Ncandu River at the EWR site THU_EWR19 (-27.8017, 29.8840) in V31J NMAR = 50.83 x$10^6$$m^3$ TEC=B/C category The maintenance low flows and drought flows must be attained to support the upstream and downstream aquatic ecosystem of the Ncandu River.	Maintenance and drought flows required for the Ncandu River		Maintenance	Drought	THU_EWR19 for TEC=B/C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.151	0.023	
					Nov	0.238	0.02	
					Dec	0.327	0.02	
					Jan	0.488	0.128	
					Feb	0.651	0.170	
					Mar	0.529	0.139	
					Apr	0.373	0.099	
					May	0.208	0.057	
					Jun	0.120	0.034	
					Jul	0.091	0.027	
					Aug	0.087	0.026	
					Sep	0.105	0.029	
	Quality	Nutrients	Nutrient levels must be improved to sustain the aquatic ecosystem health and to meet the ecological state	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.05 mg/L (50th percentile)			Improve current state.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1 mg/L (50th percentile)			
		Salts	Instream salinity must be maintained or improved upon to support the aquatic ecosystem and the water quality requirements of the water users	Total Dissolved Solids	≤350 mg/L (95th percentile)			
			In-stream quality must be maintained	Sulphate	≤ 165mg/L (95th percentile)			No WQ monitoring data
			In-stream quality must be maintained	Chloride	≤ 120mg/L (95th percentile)			
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
		Toxics	The concentrations of toxins should not be toxic to aquatic organisms and a threat to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)			Strictest of ecological specifications. Ecological Reserve manual (2008), South African Water
				Aluminium (Al)	≤ 0.105 milligrams/litre (mg/l) (95th percentile)			
				Manganese (Mn)	≤ 0.15 milligrams/litre (mg/l) (95th percentile)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
				Cadmium (Cd)	≤ 0.0012 milligrams/litre (mg/l) (95th percentile)	Quality Guidelines (1996) Manganese and Iron – Domestic user water quality guideline (SAWQGs, 1996).
				Iron (Fe)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
				Lead (Pb) hard	≤ 0.0095 milligrams/litre (mg/l) (95th percentile)	
				Copper (Cu) hard	≤ 0.0073 milligrams/litre (mg/l) (95th percentile)	
				Nickel (Ni)	≤ 0.07 milligrams/litre (mg/l) (95th percentile)	
				Cobalt (Co)	≤ 0.05 milligrams/litre (mg/l) (95th percentile)	
				Zinc (Zn)	≤ 0.002 milligrams/litre (mg/l) (95th percentile)	
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
				Benzene	≤0.01 milligrams/litre (mg/l) (95th percentile)	WHO drinking water quality guideline. Human health limit. No available monitoring data.
				Toluene	≤0.7 milligrams/litre (mg/l) (95th percentile)	WHO drinking water guideline. Human health limit. No available monitoring data
				Oil and grease	2.5 mg/l	General and special standards for effluent in terms of NWA, 1956. No monitoring data.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL (95th percentile)	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Habitat	Instream	Natural flow pattern must be maintained in B Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	IHI and IHAS	Instream Habitat Integrity (class B) Ecological Category (80 – 90%) Riparian Integrity - Class ≥B Ecological Category (80 – 90%) IHAS to be *good* habitat availability (>65%)	
		Riparian habitat	The riparian vegetation must be maintained at VEGRAI ≥ C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained or improved to a PES B/C ecological category.	FRAI *Amphilius natalensis* (ANAT) *Anguilla mossambica* (AMOS) *Labeo rubromaculatus* (LRUB) *Barbus (Enteromius) paludinosus* (BPAU) *Labeobarbus natalensis* (BNAT) *Barbus (Enteromius) viviparus* (BVIV)	During survey in all flow habitat classes all species present. BVIV, BNAT, BPAU – habitat indicators; and ANAT ≥ 5 individuals per species FRAI EC: B/C (70 - 89%)	FRAI currently a C/D at 60%; must improve to a B/C – water quality and lack of flow depth classes.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained within a B/C ecological category or improved upon.	SASS 5 MIRAI Baetidae >2 spp Heptageniidae Leptophlebiidae Tricorythidae Leptoceridae	3 biotopes sampled; assemblages to be ≥ B abundances; SASS 5 scores: ≥190 ASPT score: ≥6.0 MIRAI EC: B/C (70 – 89%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
				Perlidae Hydropsychidae >1spp Elmidae Psephenidae Dixidae		
		Diatoms	Ecological water quality should be maintained as *good quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 15 - 17 PTV: < 20%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
2.5 Ngagane from Ntshingwayo Dam to confluence with Buffalo **V31G, K (May 13_EWR 3)**	Quantity	Low flows	EWR maintenance low and drought flows: Ngagane River at the EWR site May13_EWR3 (-27.819, 29.987) in V31K NMAR = 160.12 x$10^6$$m^3$ TEC=C/D category The maintenance low flows and drought flows must be attained to support the upstream and downstream aquatic ecosystem of the Ngagane River to the confluence with the Buffalo River.	Maintenance and drought flows required for the Ngagane River		Maintenance	Drought	May13_EWR3 for TEC=C/D (Baseflows, freshets/ floods)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.366	0.091	
					Nov	0.560	0.068	
					Dec	0.762	0.051	
					Jan	1.138	0.527	
					Feb	1.541	0.711	
					Mar	1.269	0.587	
					Apr	0.928	0.433	
					May	0.539	0.202	
					Jun	0.326	0.112	
					Jul	0.243	0.123	
					Aug	0.234	0.119	
					Sep	0.273	0.111	
		Freshets	EWR freshets to be released from Chelmsford Dam (V3R001) and Horn River	Freshets required for the Ngagane River		Freshet (m^3/s)	Days	
					Nov	10.0	2	
					Dec	12.0	2	
					Jan	15.0	2	
					Feb	20.0	2	
					Mar	10.0	2	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Quality	Nutrients	Nutrient levels must be improved to sustain the aquatic ecosystem health and to meet the prescribed ecological state (C ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.05 mg/L (50th percentile)	Present state.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤ 2.0 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained or improved to support downstream users.	Total Dissolved Solids	≤350 mg/L (95th percentile)	C Category – Slight improvement of Present state
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem as the driver.
		Toxics	The concentrations of toxins should not be toxic to aquatic organisms and a threat to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Strictest of ecological specifications. Ecological Reserve manual (2008), South African Water Quality Guidelines (1996) Manganese and Iron – Domestic user water quality guideline (SAWQGs, 1996). Cobalt – – Irrigation user water quality guideline (SAWQGs, 1996) Zinc - Aquatic Ecosystem water quality guideline (SAWQGs, 1996).
				Aluminium (Al)	≤ 0.105 milligrams/litre (mg/l) (95th percentile)	
				Cadmium (Cd) soft	≤ 0.0012 milligrams/litre (mg/l) (95th percentile)	
				Manganese (Mn)	≤ 0.15 milligrams/litre (mg/l) (95th percentile)	
				Iron (Fe)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
				Lead (Pb) hard	≤ 0.0095 milligrams/litre (mg/l) (95th percentile)	
				Copper (Cu) hard	≤ 0.0073 milligrams/litre (mg/l) (95th percentile)	
				Nickel (Ni)	≤ 0.07 milligrams/litre (mg/l) (95th percentile)	
				Cobalt (Co)	≤ 0.05 milligrams/litre (mg/l) (95th percentile)	
				Zinc (Zn)	≤ 0.002 milligrams/litre (mg/l) (95th percentile)	
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						drinking water guideline.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
				Oil and grease	2.5 mg/l	General and special standards for effluent in terms of NWA, 1956. No monitoring data
			Hydrocarbons	Benzene	≤0.01 milligrams/litre (mg/l) (95th percentile)	WHO drinking water guideline. Human health limit. No available monitoring data.
				Toluene	≤0.7 milligrams/litre (mg/l) (95th percentile)	WHO drinking water guideline. Human health limit. No available monitoring data
		Pathogens	Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL (95^{th} percentile)
	Habitat	Instream	Natural flow pattern must be maintained in C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	IHI and IHAS	Instream Habitat Integrity (class C) Ecological Category (60 – 79%) Riparian Integrity - Class ≥B Ecological Category (80 – 90%) IHAS to be *good* habitat availability (>65%)	Keep it at a C to maintain a C/D
		Riparian habitat	The riparian vegetation must be maintained at VEGRAI ≥ C Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Fish	Flow and water quality sensitive Fish species to be maintained or improved to a PES C/D ecological category.	FRAI *Amphilius natalensis* (ANAT) *Barbus (Enteromius) paludinosus* (BPAU) *Labeobarbus natalensis* (BNAT) *Barbus (Enteromius) pallidus* (BPAL) *Barbus (Enteromius) anoplus* (BANO)	During survey in all flow habitat classes all species present. BNAT, BPAL and BANO – 2 of 3 spp present as habitat indicators; and ANAT ≥ 3 individuals per species FRAI EC: C/D (60 - 79%)	
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained within a C/D ecological category or improved upon.	SASS 5 MIRAI Baetidae >2 spp Heptageniidae Leptophlebiidae Tricorythidae Leptoceridae Hydropsychidae >1spp Elmidae Economidae	3 biotopes sampled; assemblages to be ≥ B abundances; SASS 5 scores: ≥213 ASPT score: ≥7.2 MIRAI EC: C/D (50 – 79%)	
		Diatoms	Ecological water quality should be maintained as *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

6.1.3 IUA 3: Middle Buffalo River

Table 12: Resource Units delineated for IUA 3: Middle Buffalo River

RU	Delineation	Catchment
3.1	Dorps (including Kweek and Wasbankspruit) to confluence with Buffalo	V32A, B
3.2	Tiyna, Eersteling	V32C, D
3.4	Mzinyashana including Sterkstroom and Sandspruit	V32E
3.5	Buffalo from Ngagane to Blood River confluence	V32B, C, D, E, F

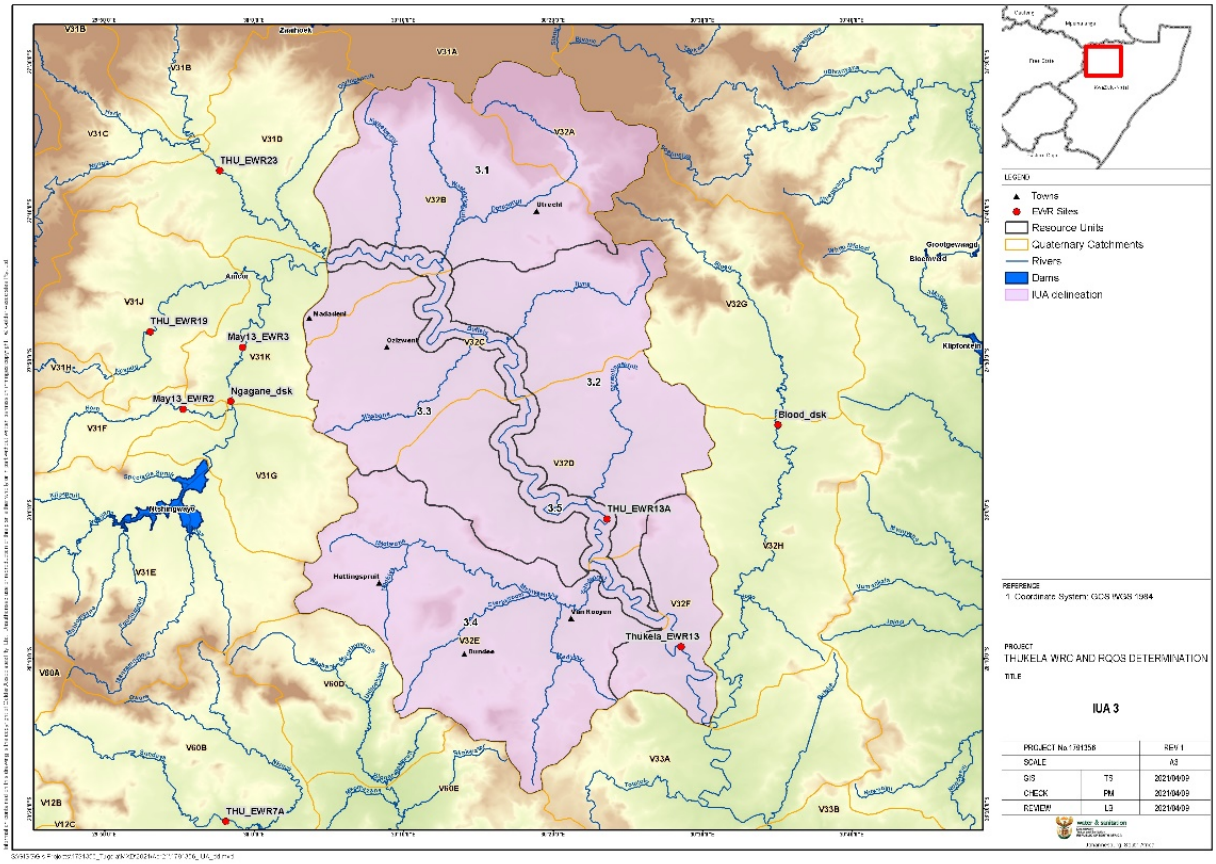

Figure 9: IUA 3 - Middle Buffalo River Resource Units

Table 13: IUA 3: Middle Buffalo River RUs description

IUA 3 – Middle Buffalo River
Resource Unit 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 Ultrecht; Category D because of quantity, fairly natural. Old mining activities that impact water quality – decants; Sabalele Nature Reserve in the town along the Dorpsruit River; Old mines along Swartkop Farms – quality concerns; sediment issues and vegetation impacts.
Resource Unit 3.2: Tiyna, Eersteling- Quaternary catchment V32C, D

IUA 3 – Middle Buffalo River
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.
Resource Unit 3.4: Mzinyashana including Sterkstroom and Sandspruit V32E
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),
Resource Unit 3.5: Buffalo from Ngagane to Blood River confluence – Quaternary catchment V32B, C, D, E, F
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.

Table 14: Draft RQOs for IUA 3: Middle Buffalo River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
3.1 Dorps (including Kweek and Wasbankspruit) to confluence with Buffalo **V32A, B**	Quality	Nutrients	Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the ecological state (B ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤ 0.02 mg/L (50th percentile)	Improved quality will improve the biological system
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤ 1.0 mg/L (50th percentile)	
		Salts	Salinity levels must be maintained to support aquatic ecosystem and sustain the ecological state (B ecological category)	Total Dissolved Solids	≤200 mg/L (95th percentile)	No monitoring data
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL (95th percentile)	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
3.2 Tiyna, Eersteling- Quaternary catchment **V32C, D**	Quality	Nutrients	Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the present ecological state (B ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.02 mg/L (50th percentile)	Improved quality will improve the biological system
				Total Inorganic Nitrogen (NO_3^-) as Nitrogen	≤ 1.0 milligrams/litre (50th percentile)	
		Salts	Salinity levels must be maintained to support aquatic ecosystem and sustain the present ecological state (B ecological category)	Total Dissolved Solids	≤200 mg/L (95th percentile)	No monitoring data for tributaries
				Sulphate	≤ 165mg/L (95th percentile)	
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem as the driver.
			Maintain baseline status	Turbidity	A 10% variation from background concentration. Limits must be determined.	No baseline data available. Monitoring required to determine present state.
	Biota	Diatoms	Ecological water quality should be maintained as *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
3.4 Mzinyashana including Sterkstroom and Sandspruit **V32E**	Quality	Nutrients	Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the ecological state (B ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤ 0.02 mg/L (50th percentile)	Improved quality will improve the biological system No monitoring data
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤ 1.0 mg/L (50th percentile)	
		Salts	Salinity levels must be maintained to support aquatic ecosystem and sustain the ecological state (B ecological category)	Total Dissolved Solids	≤200 mg/L (95th percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL (95th percentile)	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
3.5 Buffalo from Ngagane to Blood River confluence **V32B, C, D, E and F (EWR 13)**	Quantity	Low flows	EWR maintenance low and drought flows: Buffalo River at the EWR site Thukela_EWR13 (-28.153, 30.476) in V32F NMAR = 695.05 x$10^6$$m^3$ TEC=C/D category The maintenance low flows and drought flows must be attained to support the upstream and downstream aquatic ecosystem to Blood River confluence.	Maintenance and drought flows required for the upstream and downstream Buffalo River Monitoring of flows at V3H010		Maintenance	Drought	Thukela_EWR13 for TEC=C/D (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.86	0.418	
					Nov	1.304	0.482	
					Dec	1.765	0.418	
					Jan	2.531	1.493	
					Feb	3.276	1.928	
					Mar	2.63	1.55	
					Apr	1.925	1.141	
					May	1.184	0.709	
					Jun	0.757	0.461	
					Jul	0.603	0.371	
					Aug	0.563	0.348	
					Sep	0.647	0.397	
	Quality	Nutrients	Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.1 mg/L (50th percentile)			PES D; target C/D. Current water quality very poor, urban (domestic and
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			the ecological state (ecological category C/D)			industrial) and siltation.
		Salts	Salinity concentrations must be maintained to support aquatic ecosystem and sustain the ecological state (ecological category C/D)	Total Dissolved Solids	≤350 mg/L (95th percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Habitat	Instream	Natural flow pattern must be improved to a C/D Ecological Category. Alien invasive (*Eucalyptus* spp, exotic *Acacia* spp) controls must be implemented, maintained and/ improved.	IHI and IHAS	Instream Habitat Integrity (class C/D) Ecological Category (50 – 79%) Riparian Integrity - Class ≥C/D Ecological Category (50 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)	Currently Instream Habitat Integrity D (54%) Riparian Integrity E (33%) – both need to be improved in respect of alien removal and bank erosion.
		Riparian habitat	The riparian vegetation must be maintained at VEGRAI ≥ C/D Ecological Category. Alien invasive controls must be implemented, maintained and/ improved.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C/D Ecological Category (>50 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained or improved to a PES C/D ecological category.	FRAI *Labeo rubromaculatus* (LRUB) *Barbus (Enteromius) paludinosus* (BPAU) *Labeobarbus natalensis* (BNAT) *Barbus (Enteromius) pallidus* (BPAL) *Barbus (Enteromius) anoplus* (BANO)	During survey in all flow habitat classes all species present. BNAT, BPAL and BANO – 2 of 3 spp present as habitat indicators; and LRUB ≥ 3 individuals per species. FRAI EC: C/D (60 - 79%)	Current MIRAI is a D (56.8 %) to be improved to a C/D. Diatoms currently indicating poor ecological water quality (Class D) – SPI: 9.1 and PTV: 37.8%

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be improved to a C/D ecological category.	SASS 5 MIRAI Baetidae >2 spp Hydropsychidae >1spp Elmidae Hydracarina	3 biotopes sampled; assemblages to be ≥ B abundances; SASS 5 scores: 77 - 180 ASPT score: 5.5 – 7.0 MIRAI EC: C/D (50 – 79%)	FRAI: 59.5% (adjusted score). Automated FRAI was a Class E at 30%. Due to a lack of biotopes and flow depth classes at this specific site. Water quality – siltation and domestic and industrial pollution.
		Diatoms	Ecological water quality should be improved to *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

6.1.4 IUA 4: Lower Buffalo River

Table 15: Resource Units delineated for IUA 4: Lower Buffalo River

RU	Delineation	Catchment
4.2	Buffalo from Blood to Thukela confluence	V33A, B, C, D

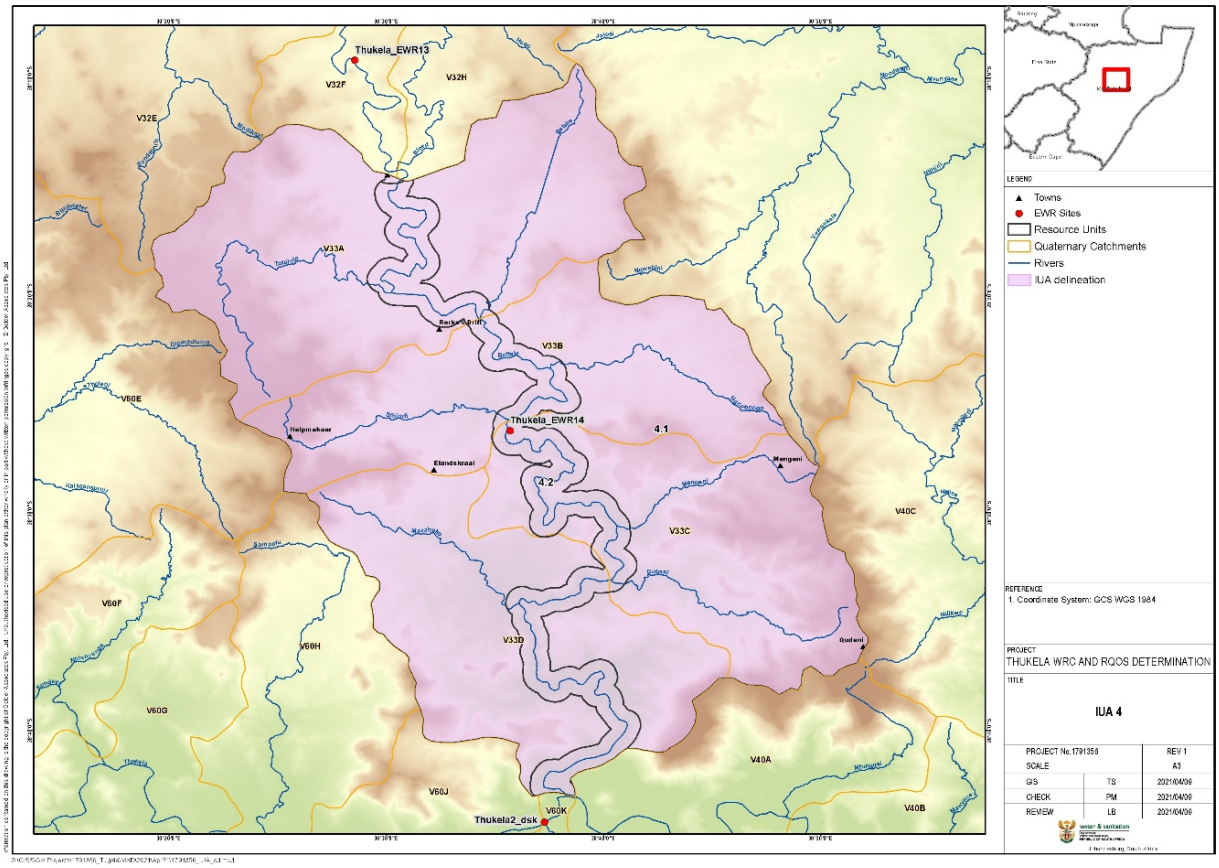

Figure 10: IUA 4 – Lower Buffalo River Resource Units

Table 16: IUA 4: Lower Buffalo River RUs description

IUA 4 – Lower Buffalo River
Resource Unit 4.2: Buffalo from Blood to Thukela confluence - V33A, B, C and D
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. EWR site: Thukela_EWR14

Table 17: Draft RQOs for IUA 4: Lower Buffalo River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
4.2 Buffalo from Blood to Thukela confluence **V33A, B, C and D (EWR 14)**	Quantity	Low flows	EWR maintenance low and drought flows: Buffalo River at the EWR site Thukela_EWR14(-28.437, 30.595) in V33B NMAR = 831.09 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream and downstream aquatic ecosystem to Thukela River confluence.	Maintenance and drought flows required for the upstream and downstream Buffalo River		Maintenance	Drought	Thukela_EWR14 for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	1.600	0.400	
					Nov	1.900	0.400	
					Dec	2.700	0.400	
					Jan	4.400	0.800	
					Feb	5.947	1.200	
					Mar	4.700	0.950	
					Apr	3.300	0.900	
					May	2.100	0.600	
					Jun	1.670	0.500	
					Jul	1.320	0.400	
					Aug	1.230	0.400	
					Sep	1.440	0.400	
	Quality	Nutrients	Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the present ecological state (C/D ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.1 mg/L (50th percentile)			Maintain the current ecological state. Slight improvement in present state water quality required.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be be maintained to support aquatic ecosystem and sustain the present ecological state (C/D ecological category)	Total Dissolved Solids	≤350 mg/L (95th percentile)			
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
			Baseline clarity must be maintained.	Turbidity	A 10% variation from background concentration. Limits must be determined.			No baseline data available. Monitoring required to determine present state.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target water quality range for full contact recreational use – South African

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						Water Quality Guidelines (1996).
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a C Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C) Ecological Category (60 – 79%) Riparian Integrity - Class ≥C Ecological Category (60 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60 - 79%)	VEGRAI monitoring to be conducted in the upper reaches, particularly in V33A and V33B.
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a PES C ecological category.	FRAI *Labeobarbus natalensis* (BNAT) *Labeo molybdinus* (LMOL) *Barbus (Enteromius) anoplus* (BANO)	Ensure all flow habitat classes are present for the following species: BNAT, BANO – 2 of 3 spp present as habitat indicators; and LMOL ≥ 3 individuals per species. FRAI EC: C (60 - 79%)	Water quality issues related to surface run-off and erosion owing to land-use (particularly within V33A and V33B)
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained and/or improved to a C ecological category.	SASS 5) MIRAI Atyidae Baetidae >2 spp Tricorythidae Heptageniidae Hydropsychidae >1spp Elmidae	At least 2 biotopes sampled; assemblages to be ≥ B abundances; MIRAI EC: C (60 – 79%)	
		Diatoms	Ecological water quality should be improved to *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

6.1.5 IUA 5: Blood River

Table 18: Resource Units delineated for IUA 5: Blood River

RU	Delineation	Catchment
5.1	Wetland RU: Blood River	V32G
5.2	Blood River from outlet of V32G to confluence with the Buffalo River	V32H

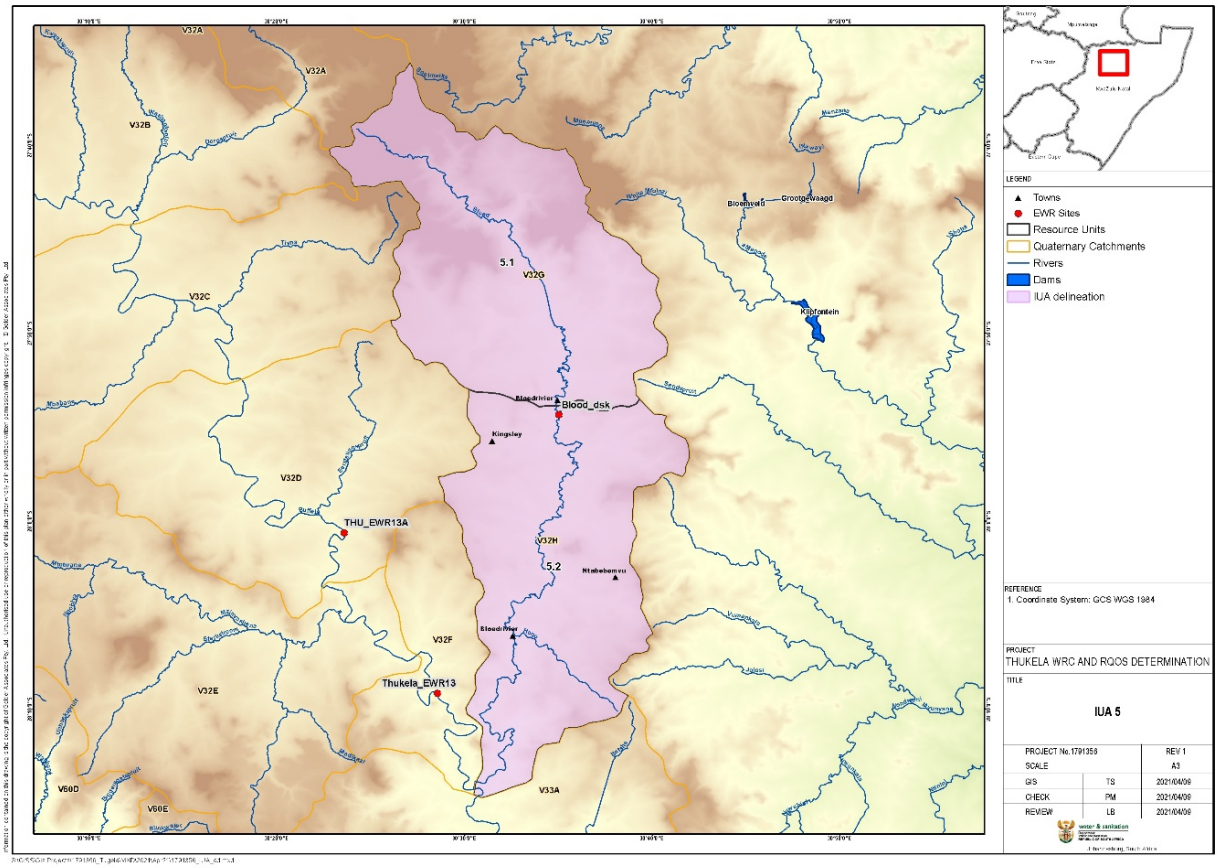

Figure 11: IUA 5 - Blood River Resource Units

Table 19: IUA 5: Blood River RUs description

IUA 5 – Blood River
Resource Unit 5.1: Wetland RU: Blood River Quaternary catchment 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. *Note: this RU has both river (quality) and wetland RQOs*
Resource Unit 5.2: Blood River from outlet of V32G to confluence with the Buffalo River – Quaternary catchment V32H
River is in a category C; large rural villages; extensive subsistence agriculture; limited formal irrigation; extensive erosion. No sampling points and accessibility unsure.

Table 20: Draft RQOs for IUA 5: Blood River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
5.1 Wetland RU: Blood River **V32G**	Quality	Nutrients	Nutrient levels must be maintained to support aquatic ecosystem and sustain the present ecological state (B ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.02 mg/L (50th percentile)	Maintain the current state.
				Total Inornanic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained to support aquatic ecosystem and sustain the present ecological state (B ecological category)	Total Dissolved Solids	≤200 mg/L (95th percentile)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained in a PES B ecological category.	*Barbus (Enteromius) anoplus* (BANO) *Amphilius natalensis* (ANAT) *Anguilla mossambica* (AMOS)	During survey in all flow habitat classes all species present. BANO and ANAT ≥ 5 individuals per species	Slang and Thaka must achieve PES B/ EI: High/ ES: Very High
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained within a B ecological category or improved upon.	Baetidae 2 sp Perlidae Tricorythidae Hydropsychidae 1 sp Leptoceridae Ancyidae Psephenidae	At least 2 biotopes sampled; assemblages to be ≥ A abundances	
		Diatoms	Ecological water quality should be maintained as *good quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	≥15 20 to < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
5.2 Blood River from outlet of V32G to confluence with the Buffalo River **V32H**	Quantity	Low flows	EWR maintenance low and drought flows: Blood River at the outlet of V32H NMAR = 94.71 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Maintenance and drought flows required for the upstream Blood River		Maintenance	Drought	Desktop for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.240	0.088	
					Nov	0.343	0.081	
					Dec	0.434	0.049	
					Jan	0.613	0.361	
					Feb	0.782	0.487	
					Mar	0.625	0.415	
					Apr	0.459	0.296	
					May	0.295	0.156	
					Jun	0.209	0.105	
					Jul	0.172	0.091	
					Aug	0.164	0.091	
					Sep	0.195	0.091	
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)			Maintain C ecological category Improvement in the current state required. salinity levels (present state 390 mg/l) Phosphate high
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to support aquatic ecosystem and sustain the ecological state	Total Dissolved Solids	≤350 mg/L (95th percentile)			
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Habitat	Instream	Natural flow pattern must be maintained in a C Ecological Category	IHI and IHAS	Instream Habitat Integrity (class C) Ecological Category (60 – 79%) Riparian Integrity - Class ≥C Ecological Category (60 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a PES C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeo rubromaculatus* (LRUB) *Labeobarbus natalensis* (BNAT) *Tilapia sparrmanii* (TSPA)	Ensure all flow habitat classes are present for the following species: BNAT, BANO and TSPA – 2 of 3 spp present as habitat indicators; and LRUB ≥ 3 individuals per species. FRAI EC: C (60 - 79%)	Erosion and sedimentation from overgrazing.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained and/or improved to a C ecological category.	SASS 5 MIRAI Atyidae Baetidae >1 spp Tricorythidae Heptageniidae Perlidae Pyralida Hydropsychidae >1spp Elmidae Psephenidae	3 biotopes to be sampled; assemblages to be A to B abundances; MIRAI EC: C (60 – 79%)	
		Diatoms	Ecological water quality should be improved to *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

6.1.6 IUA 6: Sundays River

Table 21: Resource Units delineated for IUA 6: Sundays River

RU	Delineation	Catchment
6.1	Nkunzi to confluence with Sundays	V60B
6.2	Sundays from source to confluence with Wasbank	V60A, B, C
6.3	Wasbank to confluence with Sundays	V60D, E
6.4	Sundays from Wasbank to Thukela confluence, including Nhlanyanga	V60F

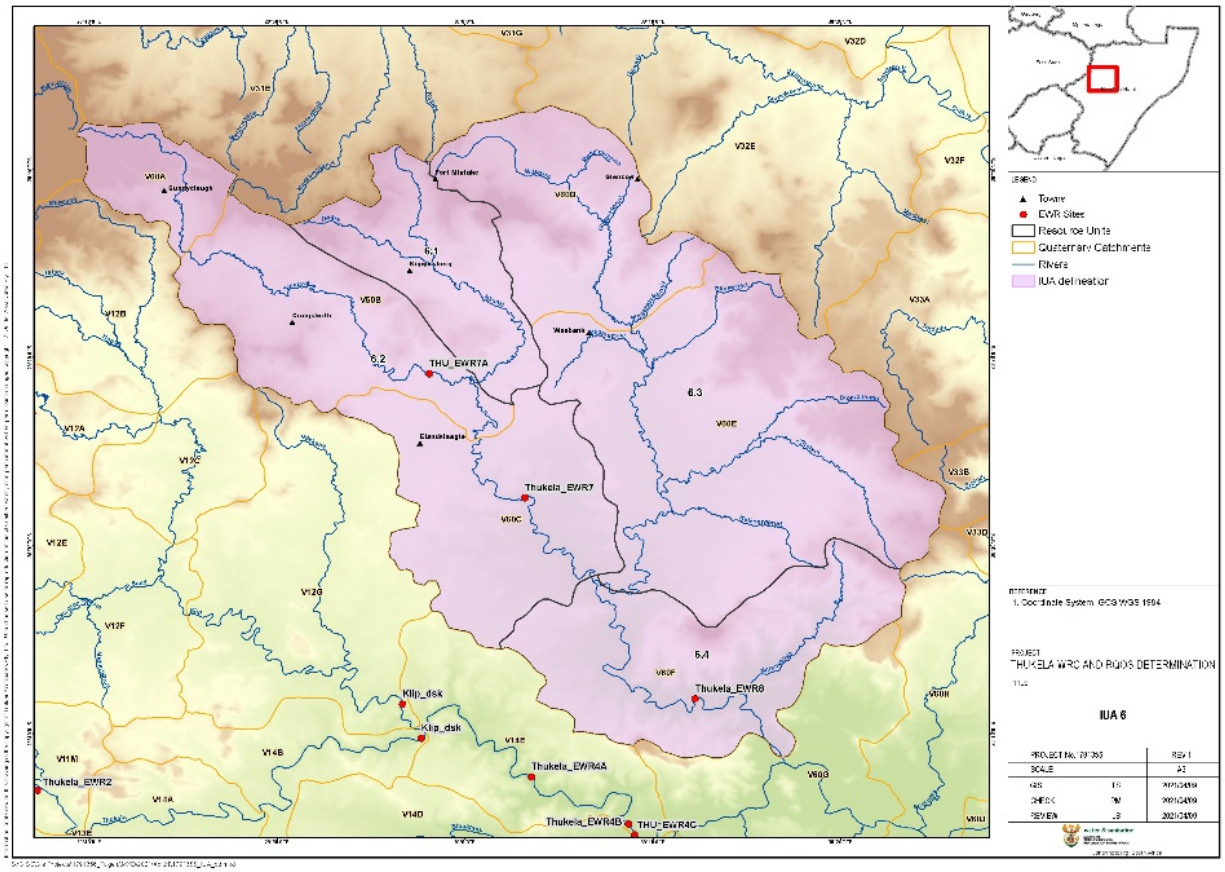

Figure 12: IUA 6 - Sundays River Resource Units

Table 22: IUA 6: Sundays River RUs description

IUA 6 – Sundays River
Resource Unit 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 NFEPA wetlands (prioritized). Abandoned mines. Acid mine drainage decant,
Resource Unit 6.2: Sundays from source to confluence with Wasbank V60A, B, C
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.

IUA 6 – Sundays River
Resource Unit 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; NFEPA 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.
Resource Unit 6.4: Sundays from Wasbank to Thukela confluence, including Nhlanyanga V60F
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.

Table 23: Draft RQOs for IUA 6: Sundays River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
6.1 Nkunzi to confluence with Sundays **V60B**	Quantity	Low flows	EWR maintenance low and drought flows: Nkunzi River at confluence with Sundays River in V60B NMAR = 24.94 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Maintenance and drought flows required for the Nkunzi River upstream of the Sundays River confluence		Maintenance	Drought	Desktop for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.068	0.030	
					Nov	0.091	0.040	
					Dec	0.100	0.030	
					Jan	0.145	0.061	
					Feb	0.191	0.08	
					Mar	0.158	0.067	
					Apr	0.137	0.058	
					May	0.106	0.046	
					Jun	0.086	0.038	
					Jul	0.070	0.031	
					Aug	0.063	0.028	
					Sep	0.065	0.029	
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state (C ecological category)	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)			Maintenance of ecological state of river Maintain WQ present status – prevent deterioration Salinity = 330 mg/l PO4 = 0.05mg/l Ammonia levels are also high
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to support aquatic ecosystem and sustain the ecological state (C ecological category)	Total Dissolved Solids	≤350 mg/L (95th percentile)			
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
			Baseline clarity must be maintained.	Turbidity	A 10% variation from background concentration. Limits must be determined.			
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Habitat	Instream	Natural flow pattern must be maintained in a C Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C) Ecological Category (60 – 79%) Riparian Integrity - Class ≥C Ecological Category (60 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. Exotic *Acacia* spp to be removed, and high bank erosion managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a PES C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeo rubromaculatus* (LRUB) *Labeobarbus natalensis* (BNAT) *Tilapia sparrmanii* (TSPA) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO and TSPA – 2 of 3 spp present as habitat indicators; and LRUB ≥ 3 individuals per species. FRAI EC: C (60 - 79%)	Loss of *Anguilla mossambica* (AMOS) because of lack of connectivity; water quality.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages must be maintained and/or improved to a C ecological category.	SASS 5 MIRAI Baetidae 2 spp Tricorythidae Heptageniidae Hydropsychidae 2spp Economidae Psephenidae	3 biotopes to be sampled; assemblages to be A to B abundances; MIRAI EC: C (60 – 79%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Diatoms	Ecological water quality should be improved to *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
6.2 Sundays from source to confluence with Wasbank **V60A, B, C (Thukela_EWR 7)**	Quantity	Low flows	EWR maintenance low and drought flows: Sundays River at the EWR site Thukela_EWR7 (-28.458, 30.053) in V60C NMAR = 90.26 x$10^6$$m^3$ TEC=C/D category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Maintenance and drought flows required for the Sundays River Monitoring of flows at V6H004		Maintenance	Drought	Thukela_EWR7 for TEC=C/D (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.180	0.120	
					Nov	0.240	0.140	
					Dec	0.350	0.105	
					Jan	0.500	0.220	
					Feb	0.700	0.280	
					Mar	0.520	0.240	
					Apr	0.350	0.210	
					May	0.260	0.160	
					Jun	0.200	0.140	
					Jul	0.160	0.120	
					Aug	0.150	0.120	
					Sep	0.160	0.110	
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)			Maintain the current ecological state (C/D ecological category) Maintain good water quality status
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to support aquatic ecosystem and sustain the ecological state	Total Dissolved Solids	≤200 mg/L (95th percentile)			
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target water quality range for full contact recreational use –

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						South African Water Quality Guidelines (1996).
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem as the driver.
			Baseline clarity must be maintained.	Turbidity	A 10% variation from background concentration. Limits must be determined.	
	Habitat	Instream	Natural flow pattern must be improved to a C/D Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C) Ecological Category (60 – 79%) Riparian Integrity - Class ≥C/D Ecological Category (60 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)	Current riparian integrity class D (51%); needs to improve to a C/D
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C/D Ecological Category. Exotic *Acacia* spp to be removed, and high bank erosion managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C/D Ecological Category (>60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC C/D ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeo rubromaculatus* (LRUB) *Labeobarbus natalensis* (BNAT) *Tilapia sparrmanii* (TSPA) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO and TSPA – 2 of 3 spp present as habitat indicators; and LRUB ≥ 3 individuals. FRAI EC: C (60 - 75%)	FRAI automated score at a class D (49%) was adjusted to a C (65%). Only 3 specimens of 2 spp (BNAT and ANAT) collected so flow and water quality needs to be improved to get flow sensitive spp into the system. MIRAI currently C (71.9%) to be maintained (flow related).
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be	SASS 5 MIRAI Baetidae 2 spp Heptageniidae Hydropsychidae 2spp	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: 117 - 180 ASPT score: 5.6 – 6.5	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			maintained at a C/D ecological category.	Elmidae Hydracarina Leptophlebiiidae Aeshnidae Athericidae	MIRAI EC to be maintained: C (60 - 79%)	SASS 5 score 117 and ASPT score 5.6 measured on survey to be maintained Current diatoms index score measured during the survey was in a Class C Ecological Category (SPI: 13.1 and PTV: 0%) which needs to be maintained.
		Diatoms	Ecological water quality should be maintained at a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
6.3 Wasbank to confluence with Sundays **V60D, E**	Quantity	Low flows	EWR maintenance low and drought flows: Wasbank River at the confluence with the Sundays River in V60E NMAR = 78.33 x$10^6$$m^3$ TEC=C/D category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem of the Wasbank River.	Maintenance and drought flows required for the Wasbank River		Maintenance	Drought	Desktop for TEC=C/D (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.189	0.085	
					Nov	0.260	0.073	
					Dec	0.301	0.051	
					Jan	0.434	0.265	
					Feb	0.527	0.321	
					Mar	0.420	0.257	
					Apr	0.327	0.201	
					May	0.219	0.099	
					Jun	0.160	0.082	
					Jul	0.132	0.084	
					Aug	0.132	0.084	
					Sep	0.161	0.102	
	Quality	Nutrients	Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the target ecological state (TEC C/D)	Ortho-phosphate as P	≤0.01 mg/L (50th percentile)			The ecological status must be met (C/D category)
				Total Inorganic Nitrogen as TIN	≤0.5 mg/L (50th percentile)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Salts	Salinity concentrations must be reduced to support aquatic ecosystem and the requirements of downstream users, and sustain the ecological state.	Total Dissolved Solids	≤ 500 mg/L (95th percentile)	Water quality improvement requirement. Very high salinity (sulphate levels must be reduced). Biggarspruit – poor water quality (high salinity) – impacting Wasbank
				Sulphate	≤ 250 mg/L (95th percentile)	
				Chloride	≤ 120 mg/L (95th percentile)	
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem as the driver.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxins should not be toxic to aquatic organisms and a threat to human health.	Aluminium (Al)	≤ 0.105 milligrams/litre (mg/l) (95th percentile)	Strictest of ecological specifications. Ecological Reserve manual (2008), South African Water Quality Guidelines (1996) Manganese and Iron – Domestic user water quality guideline (SAWQGs, 1996). Cobalt – – Irrigation user water quality guideline (SAWQGs, 1996)
				Manganese (Mn)	≤ 0.15 milligrams/litre (mg/l) (95th percentile)	
				Cadmium (Cd) soft	≤ 0.0012 milligrams/litre (mg/l) (95th percentile)	
				Iron (Fe)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
				Lead (Pb) hard	≤ 0.0095 milligrams/litre (mg/l) (95th percentile)	
				Copper (Cu) hard	≤ 0.0073 milligrams/litre (mg/l) (95th percentile)	
				Cobalt (Co)	≤ 0.05 milligrams/litre (mg/l) (95th percentile)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
				Nickel (Ni)	≤ 0.07 milligrams/litre (mg/l) (95th percentile)	Zinc - Aquatic Ecosystem water quality guideline (SAWQGs, 1996).
				Zinc (Zn)	≤ 0.002 milligrams/litre (mg/l) (95th percentile)	
	Habitat	Instream	Natural flow pattern must be maintained or improved to a C/D Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C/D) Ecological Category (55 – 70%) Riparian Integrity - Class ≥C/D Ecological Category (55 – 70%) IHAS to be *adequate* habitat availability (55 - 65%)	Upper reaches of the escarpment (V60 D and E) – maintain natural riparian and terrestrial vegetation.
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C/D Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C/D Ecological Category (>55 - 70%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC C/D ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Tilapia sparrmanii* (TSPA)	Ensure all flow habitat classes are present for the following species: BNAT, BANO and TSPA – 2 of 3 spp. present as habitat indicators FRAI EC: C/D (55 - 70%)	Lack of diversity of flow and habitat modification. No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C/D, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained at a C/D ecological category.	SASS 5 MIRAI Baetidae 2 spp Heptageniidae Hydropsychidae 2spp Elmidae Leptophlebiiidae Trichorythidae Lestidae Psephenidae	Atleast 2 biotopes to be sampled; assemblages to be A to B abundances; SASS 5 score: ≥80 - 100 ASPT score: ≥4.5 MIRAI EC: C/D (55 - 70%)	
		Diatoms	Ecological water quality should be maintained at a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
6.4 Sundays from Wasbank to Thukela confluence, including Nhlanyanga **V60F**	Quantity	Low flows	EWR maintenance low and drought flows: Sundays River at the EWR site Thukela_EWR8 (-28.636, 30.204) in V60F NMAR = 197.03 x$10^6$$m^3$ TEC=D category The maintenance low flows and drought flows must be attained to support the upstream and downstream aquatic ecosystem of the lower Sundays River to the confluence with the Thukela River.	Maintenance and drought flows required for the lower Sundays River		Maintenance	Drought	Thukela_EWR8 for TEC=D (Baseflows
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.220	0.200	
					Nov	0.400	0.250	
					Dec	0.530	0.180	
					Jan	0.670	0.470	
					Feb	0.800	0.585	
					Mar	0.680	0.480	
					Apr	0.600	0.400	
					May	0.390	0.250	
					Jun	0.230	0.170	
					Jul	0.190	0.140	
					Aug	0.180	0.140	
					Sep	0.200	0.170	
	Quality	System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
			Baseline clarity must be maintained.	Turbidity	A 10% variation from background concentration. Limits must be determined.			No baseline data available. Monitoring required to determine present state
			Instream salinity must be attained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Electrical Conductivity	≤ 55 milliSiemens/metre (mS/m) (95th percentile)			
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeo rubromaculatus* (LRUB) *Labeobarbus natalensis* (BNAT) *Tilapia sparrmanii* (TSPA) *Labeo molybdinus* (LMOL)	Ensure all flow habitat classes are present for the following species: BNAT, BANO and TSPA – 2 of 3 spp present as habitat indicators; and LRUB and/ or LMOL ≥ 3 individuals per spp. FRAI EC: C (60 - 75%)			Current Class C but not attained in 2012, so will need habitat and water quality improvement. No previous surveys conducted in this RU, however to achieve a

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained or improved to a TEC C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Heptageniidae Hydropsychidae 2spp Leptophlebiiidae Tricorythidae	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Diatoms	Ecological water quality should be maintained at a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

6.1.7 IUA 7: Upper Mooi River

Table 24: Resource Units delineated for IUA 7: Upper Mooi River

RU	Delineation	Catchment
7.1	Klein - Mooi from source to Mooi confluence	V20B (lower portion), D
7.2	Nsonge	
7.3	Mooi upstream of Spring Grove Dam	V20A (lower portion), V20D (upper)
7.4	Spring Grove Dam	V20D
7.5	Downstream Spring Grove Dam to outlet of V20E	V20D (lower) and V20E
7.6	Joubertsvlei to confluence with Mooi	V20E

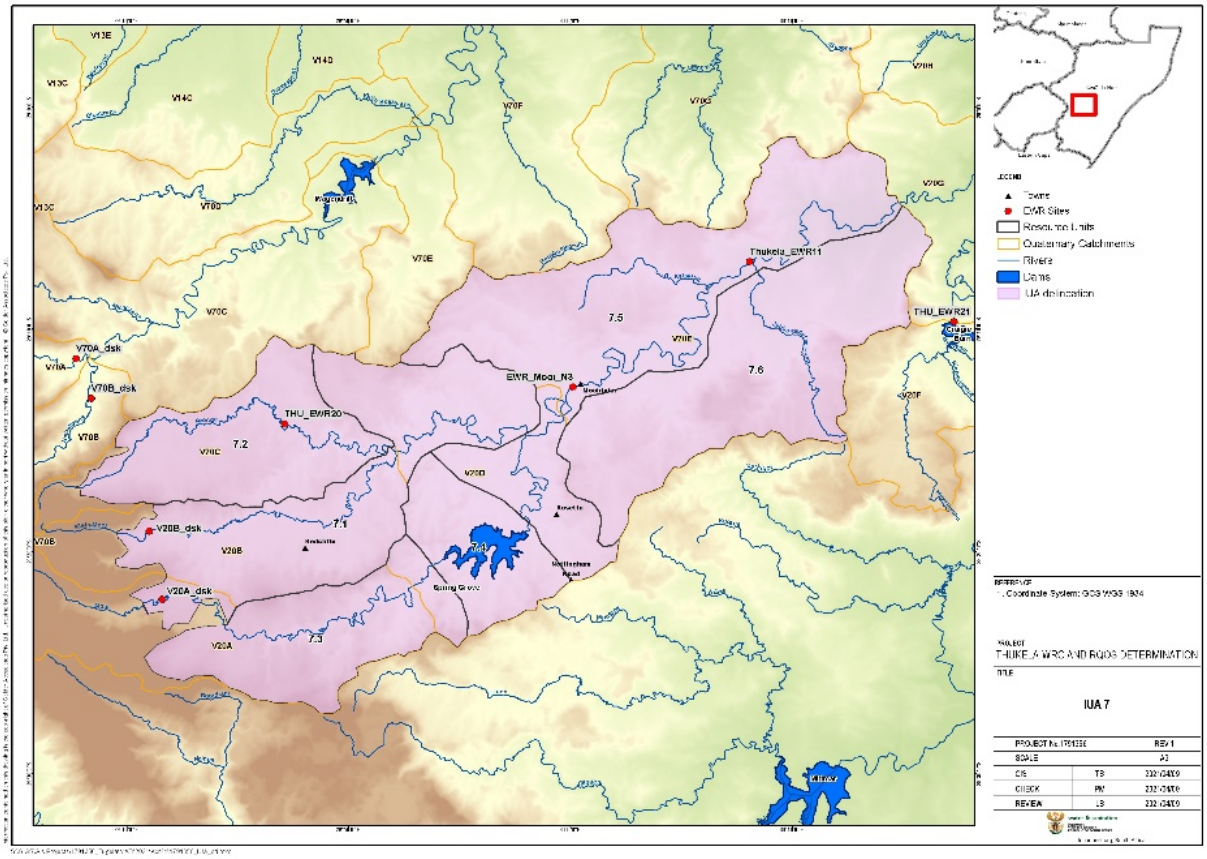

Figure 13: IUA 7 – Upper Mooi River Resource Units

Table 25: IUA 7: Upper Mooi River RUs description

IUA 7: Upper Mooi River
Resource Unit 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 NFEPA wetlands throughout the RU;

IUA 7: Upper Mooi River
Resource Unit 7.2: Nsonge Tributary 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.
Resource Unit 7.3 Mooi upstream of Spring Grove Dam V20A (lower portion), V20D (upper)
Extensive formal agriculture and irrigation, tourism; rivers are in a category C; extensive NFEPA wetlands throughout the RU; SWSA
Resource Unit 7.4 Spring Grove Dam V20D
SWSA; Water transfer and irrigation (Mooi/Mgeni transfer scheme to keep Midmar full and support Mgeni)
Resource Unit 7.5 Downstream Spring Grove Dam to outlet of V20G
Extensive formal agriculture and irrigation, tourism; rivers are in a category C; extensive NFEPA wetlands throughout the RU; urban impacts from town of Mooi River (predominantly domestic but some industrial) *Note: This has been spilt into 7.5 (a) and 7.5 (b) based on the short-term and long-term (after the Umkomaas comes online and transfers should be reduced.*
Resource Unit 7.6 Joubertsvlei to confluence with Mooi V20E
Plantations and irrigation; River is in a category E (quantity)

Table 26: Draft RQOs for IUA 7: Sundays River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
7.1 Klein - Mooi from source to Mooi confluence V20B (lower portion), D	Quantity	Low flows	EWR maintenance low and drought flows: Little Mooi River at confluence with Mooi River in V20D NMAR = 124.85 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Maintenance and drought flows required for the Little Mooi River upstream of the Mooi River confluence Monitoring of flows at V2H006		Maintenance	Drought	Desktop for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.374	0.293	
					Nov	0.496	0.375	
					Dec	0.619	0.466	
					Jan	0.83	0.614	
					Feb	0.985	0.727	
					Mar	0.881	0.650	
					Apr	0.718	0.536	
					May	0.519	0.396	
					Jun	0.395	0.309	
					Jul	0.338	0.268	
					Aug	0.318	0.254	
					Sep	0.352	0.278	
	Quality	Nutrients	Nutrient levels must be maintained to support the aquatic ecosystem and sustain the ecological state	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.01 mg/L (50th percentile)			Maintain the target ecological category – C Water quality in good condition – exception of ammonia levels. Limits based on water quality status
				Total Inornanic Nitrogen (TIN^-) as Nitrogen	≤0.5 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to support good water quality condition and sustain ecological state.	Total Dissolved Solids	≤ 120 mg/L (95th percentile)			
		System variables	pH must be maintained within the prescribed range	pH	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)			Ecological specification
				Atrazine	≤0.078 milligrams/litre (mg/l)			Ecological specification. Ecological Reserve

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be maintained or improved to a C Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be improved to a C (60 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI ≥C Ecological Category (>60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO FRAI EC: C (60 - 79%)	Lack of diversity from flow and habitat modification affecting both fish and macroinvertebrates. Spring Grove Dam limits migration of *Anguilla mossambica* (AMOS) and *Labeobarbus natalensis* (BNAT) No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained at a C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Heptageniidae Hydropsychidae 2spp Leptophlebiiidae Trichorythidae Psephenidae Perlidae Oligoneuridae Polymitarcyidae Prosopistomatidae	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
				Pyralidae		Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Diatoms	Ecological water quality should be maintained at a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
7.2 Nsonge tributary catchment **V20C (THU_EWR 20)**	Quantity	Low flows	EWR maintenance low and drought flows: Nsonge River at the EWR site THU_EWR20 (-29.2377, 29.7853) in V20C NMAR = 27.136 x$10^6$$m^3$ TEC=B/C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Maintenance and drought flows required for the Nsonge River Monitoring of flows at V2H007		Maintenance	Drought	THU_EWR20 for TEC=B/C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.109	0.063	
					Nov	0.148	0.082	
					Dec	0.188	0.102	
					Jan	0.253	0.134	
					Feb	0.302	0.159	
					Mar	0.271	0.143	
					Apr	0.219	0.118	
					May	0.155	0.086	
					Jun	0.115	0.066	
					Jul	0.097	0.057	
					Aug	0.090	0.054	
					Sep	0.101	0.060	
	Quality	Nutrients	Nutrient levels must be maintained to support aquatic ecosystem and good water quality condition	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.01 mg/L (50th percentile)			Maintain the current state. Water quality in very good state. Prevent deterioration. Limits based on current status.
				Total Inornanic Nitrogen (TIN^-) as Nitrogen	≤0.5 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to sustain good water quality state and ecological condition.	Total Dissolved Solids	≤120 mg/L (95th percentile)			
		System variables	pH must be maintained within the prescribed range	pH	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem as the driver.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target water quality range for full contact recreational use – South African

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Ecological specification
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be improved to a B/C Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class B/C) Ecological Category (75 - 85%) Riparian Integrity - Class B Ecological Category (80 – 90%) IHAS to be *adequate* habitat availability (55 - 65%)	Currently Instream Habitat Integrity is a C (75%)
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ B/C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI B/C Ecological Category (75 - 85%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO FRAI EC: C (60 - 79%)	Lack of diversity from flow and habitat modification. Lack of flow dependent spp *Anguilla mossambica* (AMOS) due to flow velocity and habitat (ie undercut banks). Automated FRAI score was a D (50%) and adjusted to a C at 66%.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be improved	SASS 5 MIRAI Baetidae 2 spp Leptophlebiiidae Trichorythidae	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: 90 - 220 ASPT: 6.4 – 7.5	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			to a TEC C ecological category.		MIRAI EC: C (60 - 79%)	Water quality concerns (sediment) Current MIRAI C/D (61.5%) to be improved to a C. Current diatoms index score measured during the survey was in a Class B Ecological Category (SPI: 15.6 and PTV: 0%) which needs to be maintained.
		Diatoms	Ecological water quality should be maintained at a *good quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 15 - 17 PTV: <20%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
7.3 Mooi upstream of Spring Grove Dam **V20A (lower portion), D (upper)**	Quantity	Low flows	EWR maintenance low and drought flows: Mooi River upstream of Spring Grove Dam in V20D NMAR = 92.98 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem of the Mooi River.	Maintenance and drought flows required for the Mooi River Monitoring of flows at V2H005		Maintenance	Drought	Desktop for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.265	0.227	
					Nov	0.361	0.188	
					Dec	0.461	0.329	
					Jan	0.609	0.496	
					Feb	0.743	0.602	
					Mar	0.689	0.558	
					Apr	0.595	0.486	
					May	0.378	0.315	
					Jun	0.258	0.216	
					Jul	0.211	0.14	
					Aug	0.201	0.134	
					Sep	0.225	0.173	
	Quality	Nutrients	Nutrient levels must be maintained to support aquatic ecosystem and good water quality condition, and sustain ecological integrity	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.01 mg/L (50th percentile)			Maintain the current state. Protect ecological integrity B/C category.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤0.5 mg/L (50th percentile)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Salts	Salinity concentrations must be maintained to sustain good water quality state and ecological condition.	Total Dissolved Solids	≤120 mg/L (95th percentile)	Water quality in good condition (maintain and protect)
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be improved to a C Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C) Ecological Category (60 - 79%) Riparian Integrity - Class C Ecological Category (60 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			Ecological Category. High erosion rate to be managed.			
	Biota	Birds	Habitat to be maintained for Red List Species for foraging, migration, and nesting.	Cape Vulture (*Gyps coprotheres*) Grey Crowned Crane (*Balearica regulorum*) Blue Crane (*Anthopoides paradiseus*) Denham's Bustard (*Neotis denhami*) Bearded Vulture (*Gypaetus barbatus*) Crowned Eagle (*Stephanoaetus coronatus)*		Red List species
		Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO FRAI EC: C (60 - 79%)	Lack of diversity from flow and habitat modification. Lack of flow dependent spp *Anguilla mossambica* (AMOS) due to flow and river fragmentation (impoundment). Water quality concerns (sediment); intensive irrigation No previous surveys conducted in this RU, however, to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to maintain or improved to a TEC of a C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiiidae Trichorythidae Heptageniidae Hydropsychidae 2spp	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	
		Diatoms	Ecological water quality should be maintained at a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
7.4 Spring Grove Dam/ Means Weir **V20D**	Quantity	Dam level	Update and review operating rules to sustain optimal dam levels to support users and downstream aquatic ecosystem. The dam level must be managed to protect ecosystem function as well as downstream users.	Minimal operating level required in the dam.		Operating rules
	Quality	Nutrients	Concentration of total nitrate must be maintained to sustain ecosystem health and the water quality requirements of water users. The dam must be maintained as an oligo-mesotrophic system.	Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤0.5 mg/L (50^{th} percentile)	
				Ortho-phosphate (PO_4^-) as Phosphorus	≤0.01 mg/L (50^{th} percentile)	
		Salts	The salinity in the dam must be maintained to support ecosystem health and the water quality requirements of the downstream users. Good current state to be maintained.	Total Dissolved Solids	≤100 mg/L (95^{th} percentile)	
		System variables	The water must be acceptable for recreational use.	pH	6.5 – 9.0 95th percentile	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
			Increased clarity with reading.	Turbidity	≥0.4 m 5th percentile	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Biota	Periphyton/ phytplankton	The Chl-*a* concentrations must be maintained in as an oligo-mesotrophic system. Aesthetic quality of the dam must be managed by control of phytoplankton/periphyton growth.	Chl *a*	11-20µg/L 50th percentile	

<table>
<tr><th>Resource Unit</th><th>Component</th><th>Sub-component</th><th>RQO</th><th>Indicator</th><th>Numerical Limit/ measure</th><th>Context of the RQO and/or Numerical limit</th></tr>
<tr><td rowspan="15">7.5 (a)*
Downstream Spring Grove Dam to outlet of V20G
V20D (lower) and V20E, portion of V20G (Thukela_EWR 11)</td><td rowspan="2">Quantity</td><td>Low flows</td><td>EWR maintenance low and drought flows:

Mooi River at the EWR site Thukela_EWR11 (-29.116, 30.135) in V20G

NMAR = 301.14 x10^{6}m^3

TEC=C/D category

The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem of the Mooi River to the confluence with the Mnyamvubu River.</td><td>Maintenance and drought flows required for the Mooi River in the short term until the uMWP-1 transfer to the Mooi/ Mngeni is in operation, then TEC=B/C requirements for compliance

Monitoring of flows at V2H004</td><td><table><tr><th></th><th>Maintenance low flows (m^3/s)</th><th>Drought flows (m^3/s)</th></tr><tr><td>Oct</td><td>0.898</td><td>0.350</td></tr><tr><td>Nov</td><td>1.054</td><td>0.440</td></tr><tr><td>Dec</td><td>1.270</td><td>0.650</td></tr><tr><td>Jan</td><td>1.578</td><td>0.800</td></tr><tr><td>Feb</td><td>1.982</td><td>0.960</td></tr><tr><td>Mar</td><td>1.847</td><td>0.900</td></tr><tr><td>Apr</td><td>1.741</td><td>0.720</td></tr><tr><td>May</td><td>1.359</td><td>0.600</td></tr><tr><td>Jun</td><td>1.112</td><td>0.450</td></tr><tr><td>Jul</td><td>0.944</td><td>0.350</td></tr><tr><td>Aug</td><td>0.850</td><td>0.250</td></tr><tr><td>Sep</td><td>0.878</td><td>0.280</td></tr></table></td><td rowspan="2">Short term: Thukela_EWR11 for TEC=C/D (Baseflows, freshets/ floods)</td></tr>
<tr><td>High flows</td><td>EWR freshets/ floods to be released from Spring Grove Dam</td><td>Freshets/ floods required for the Mooi River

Monitoring of flows at V2H004</td><td><table><tr><th></th><th>Freshet (m^3/s)</th><th>Days</th><th>Flood (m^3/s)</th><th>days</th></tr><tr><td>Nov</td><td>6</td><td>2</td><td></td><td></td></tr><tr><td>Dec</td><td>6</td><td>2</td><td>15</td><td>3</td></tr><tr><td>Jan</td><td>15</td><td>3</td><td>20</td><td>3</td></tr><tr><td>Feb</td><td>6</td><td>2</td><td>30</td><td>6</td></tr><tr><td>Mar</td><td>15</td><td>3</td><td>14</td><td>3</td></tr></table></td></tr>
<tr><td rowspan="4">Quality</td><td rowspan="2">Nutrients</td><td rowspan="2">Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the target ecological state (TEC C/D)</td><td>Ortho-phosphate as P</td><td>≤0.01 mg/L (50th percentile)</td><td rowspan="3"></td></tr>
<tr><td>Total Inorganic Nitrogen as TIN</td><td>≤0.5 mg/L (50th percentile)</td></tr>
<tr><td>Salts</td><td></td><td>Total Dissolved Solids</td><td>≤350 mg/L (95th percentile)</td></tr>
<tr><td>System variables</td><td></td><td>pH</td><td>6.5 - 9</td><td></td></tr>
<tr><td>Pathogens</td><td>The presence of pathogens should not pose a risk to human health</td><td>Escherichia coli</td><td>≤130 Colony forming counts per 100 mL</td><td>User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).</td></tr>
</table>

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Toxics		Pesticides		
	Habitat	Instream	Natural flow pattern must be maintained or improved to a C/D Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C/D) Ecological Category (55 - 70%) Riparian Integrity - Class C/D Ecological Category (55 – 70%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C/D Ecological Category.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C/D Ecological Category (55 - 70%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC C/D ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo molybdinus* (LMOL)	Ensure all flow habitat classes are present for the following species: BNAT, BANO FRAI EC: C/D (55 - 70%)	Lack of flow depth classes and flow velocity limit flow dependent spp such as *Anguilla mossambica* (AMOS), *Anguilla bengalensis* (ALAB) and *Labeo rubromaculatus* (LRUB). No previous surveys conducted in this RU, however, to achieve a MIRAI Class of a C/D, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to maintain or improved to a TEC of a C/D ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiidae Heptageniidae Hydropsychidae 2spp Elmidae	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥80 - 100 ASPT score: ≥4.5 MIRAI EC: C/D (55 – 70%)	
		Diatoms	Ecological water quality should be maintained at a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 to <40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit

*Note: *Current before Umkomaas transfer*

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
7.5 (b)** Downstream Spring Grove Dam to outlet of V20G **V20D (lower) and V20E, portion of V20G (Thukela_EWR 11)**	Quantity	Low flows	EWR maintenance low and drought flows: Mooi River at the EWR site Thukela_EWR11 (-29.116, 30.135) in V20G NMAR = 301.14 x10^6m^3 TEC=B/C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem of the Mooi River to the confluence with the Mnyamvubu River.	Maintenance and drought flows required for the Mooi River in the medium to long term when the uMWP-1 transfer to the Mooi/ Mngeni is operational Monitoring of flows at V2H004	Maintenance low flows (m^3/s) / Drought flows (m^3/s) Oct: 1.539 / 0.350 Nov: 1.835 / 0.440 Dec: 2.260 / 0.650 Jan: 2.858 / 0.800 Feb: 4.554 / 1.208 Mar: 3.379 / 0.900 Apr: 3.166 / 0.720 May: 2.433 / 0.600 Jun: 1.947 / 0.450 Jul: 1.627 / 0.350 Aug: 1.446 / 0.250 Sep: 1.494 / 0.280	Long term: Thukela_EWR11 for TEC=B/C (Baseflows, freshets/ floods)
		High Flows	EWR freshets/ floods to be released from Spring Grove Dam	Freshets/ floods required for the Mooi River Monitoring of flows at V2H004	Freshet (m^3/s) / Days / Flood (m^3/s) / Days Oct: 6 / 2 / / Nov: 6 / 2 / / Dec: 15 / 3 / 25 / 3 Jan: 21 / 3 / 25 / 3 Feb: 15 / 3 / 35 / 6 Mar: 15 / 3 / 25 / 3 Apr: 6 / 2 / /	
	Quality	Nutrients	Instream concentration of nutrients as specified must be attained to sustain aquatic ecosystem health and ensure	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)	Maintain the ecological state of a C/D category.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			the prescribed ecological category is met.			Maintain present water quality state. Prevent deterioration.
		Salts	Instream salinity levels as specified must be attained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Total Dissolved Solids	≤250 mg/L (95th percentile)	
		System variables	pH must be maintained within the prescribed range	pH	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem as the driver.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
	Habitat	Instream	Natural flow pattern must be improved to a TEC of a B/C Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class B/C) Ecological Category (75 - 85%) Riparian Integrity - Class B/C Ecological Category (75 – 85%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ B/C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI B/C Ecological Category (60 - 90%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC B/C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Anguilla mossambica* (AMOS) *Anguilla bengalensis* (ALAB) *Barbus (Enteromius) viviparus* (BVIV) *Labeo rubromaculatus* (LRUB) *Labeo molybdinus* (LMOL) *Barbus (Enteromius) pallidus* (BPAL)	Ensure all flow habitat classes are present for the following species: BNAT, BANO, BVIV, BPAL – 3 of the 4 vegetation/ cover representatives. 1 of following Anguilla mossambica (AMOS), Anguilla bengalensis (ALAB), Labeo rubromaculatus (LRUB) as flow dependent and depth class representatives. FRAI EC: B/C (75- 85%)	No previous surveys conducted in this RU, however to achieve a MIRAI Class of a B/C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to maintain or improved to a TEC of a B/C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiiidae Trichorythidae Heptageniidae Hydropsychidae 2spp Elmidae Psephenidae Perlidae Oligoneuridae	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥150 ASPT score: ≥5.5 MIRAI EC: B/C (75 - 85%)	
		Diatoms	Ecological water quality should be improved to a *good quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 15 - 17 PTV: <20%	

*Note: **long term, after Umkomaas transfer is implemented and transfers out of the system are reduced*

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
7.6 Joubertsvlei to confluence with Mooi **V20E**	Quality	Nutrients	Nutrient levels attained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.02 mg/L (50th percentile)	Maintenance of a B ecological category. No water quality monitoring data
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained to support water user requirements and sustain the ecological state	Total Dissolved Solids	≤ 195 mg/L (95th percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data. Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Biota	Diatoms	Ecological water quality should be maintained as *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 8 - 10 PTV: 40 - 60%	

6.1.8 IUA 8: Middle/ Lower Mooi River

Table 27: Resource Units delineated for IUA 8: Middle/ Lower Mooi

RU	Delineation	Catchment
8.2	Craigieburn Dam	V20F
8.3	Mnyamvubu downstream dam to confluence with Mooi	V20G
8.6	Mooi from Mnyamvubu to Thukela confluence	V20H, J

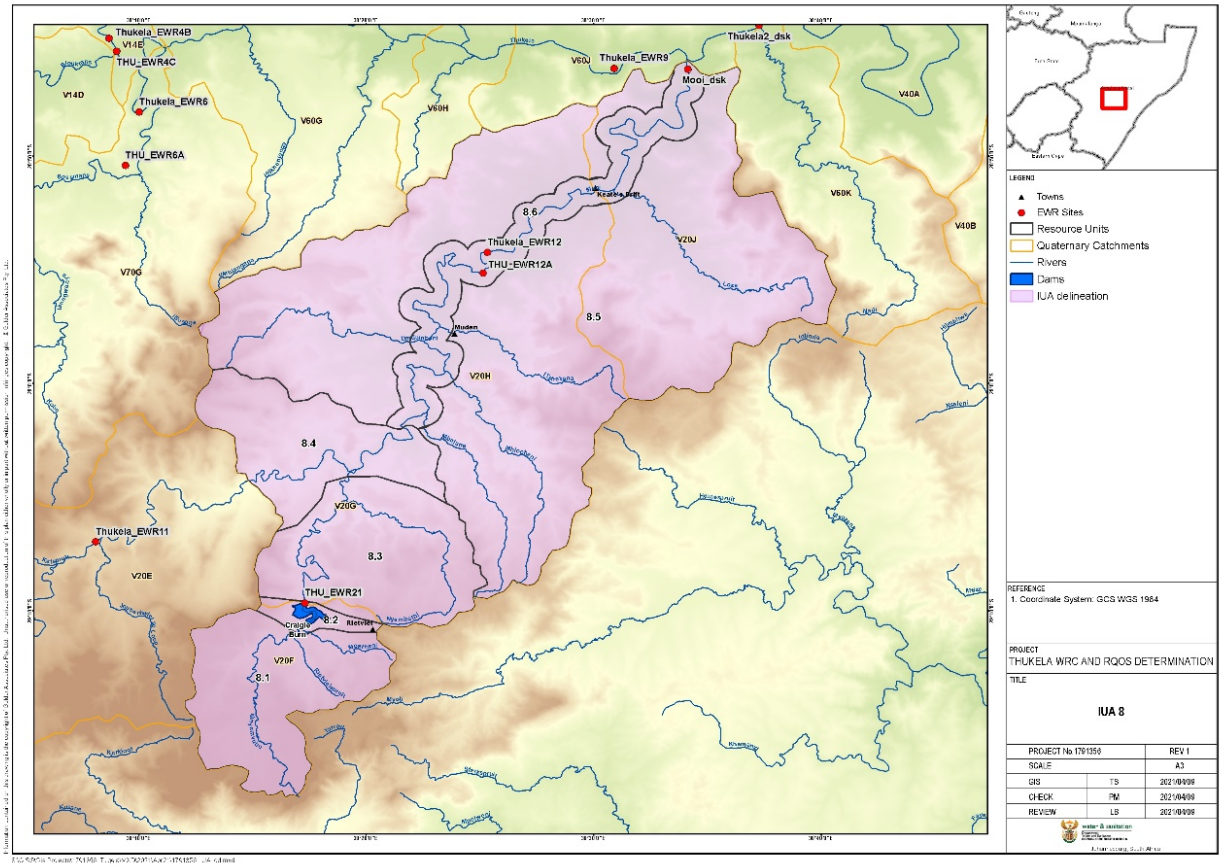

Figure 14: IUA 8 – Middle/ Lower Mooi River Resource Units

Table 28: IUA 8: Middle/ Lower Mooi River RUs description

IUA 8 – Middle/ Lower Mooi River
Resource Unit 8.2 Craigieburn Dam V20F
SWSA; water supply and irrigation; earmarked for water supply to Greytown; fully allocated.
Resource Unit 8.3 Mnyamvubu downstream dam to confluence with Mooi V20G
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); NFEPA wetlands
Resource Unit 8.6 Mooi from Mnyamvubu to Thukela confluence V20H, J
Main stem; Extensive villages and subsistence and formal agriculture along the river; PES: C except for a short reach in V20H where PES: B

Table 29: Draft RQOs for IUA 8: Middle/ Lower Mooi River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
8.2 Craigieburn Dam **V20F**	Quantity	Dam level	Update and review operating rules to sustain optimal dam levels to support users and downstream aquatic ecosystem. The dam level must be managed to protect ecosystem function as well as downstream users.	Minimal operating level required in the dam.		Operating rules
	Quality	Nutrients	The nutrients levels must be maintained to sustain ecosystem health and the water quality requirements of water users. The dam must be maintained as an oligo-mesotrophic system	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.02 mg/L (50th percentile)	Water quality status is good. Salts and nutrients are low. Ammonia levels elevated.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)	
		Salts	The salinity in the dam must be maintained to support ecosystem health and the water quality requirements of the downstream users.	Total Dissolved Solids	≤195 mg/L (95th percentile)	
		System variables	The water must be acceptable for recreational use.	pH	6.5 (5th percentile) and 9.0 (95th percentile)	Direct contact recreational use must cause minimal irritation.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Biota	Periphyton/ phytplankton	The Chl-*a* concentrations must be maintained in a mesotrophic state.	Chl *a*	11-20µg/L 50th percentile	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
8.3 Mnyamvubu downstream dam to confluence with Mooi **V20G (THU_EWR 21)**	Quantity	Low flows	EWR maintenance low and drought flows: Mnyamvubu River at the EWR site THU_EWR21 (-29.1610, 30.2884) in V20G NMAR = 31.71 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the downstream aquatic ecosystem to the Mooi River confluence.	Maintenance and drought flows required for the Mnyamvubu River downstream Craigieburn Dam Monitoring of flows at V2H016		Maintenance low flows (m^3/s)	Drought flows (m^3/s)	THU_EWR23 for TEC=C (Baseflows)
					Oct	0.101	0.052	
					Nov	0.126	0.064	
					Dec	0.15	0.075	
					Jan	0.189	0.094	
					Feb	0.224	0.111	
					Mar	0.207	0.103	
					Apr	0.178	0.089	
					May	0.116	0.06	
					Jun	0.084	0.044	
					Jul	0.07	0.037	
					Aug	0.069	0.037	
					Sep	0.085	0.045	
	Quality	Nutrients	Nutrient levels must be maintained to support aquatic ecosystem and the good water quality condition. Water quality deterioration must be prevented.	Ortho-phosphate as P	≤0.01 mg/L (50th percentile)			Maintenance of a C ecological category No water quality monitoring data. Once off sample Sept 2020– good water quality status. Based on present state
				Total Inorganic Nitrogen as TIN	≤0.5 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to sustain good water quality state and ecological condition.	Total Dissolved Solids	≤120 mg/L (95th percentile)			
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Habitat	Instream	Natural flow pattern must be maintained to a TEC of C Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C) Ecological Category (60 - 79%) Riparian Integrity - Class B Ecological Category (80 – 90%) IHAS to be *good* habitat availability (> 65%)	High silt content and lack of flows.
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Anguilla mossambica* (AMOS) *Labeo molybdinus* (LMOL) *Barbus (Enteromius) pallidus* (BPAL) TSPA	Ensure all flow habitat classes are present for the following species: BNAT, BANO, BVIV, BPAL – 3 of the 4 vegetation/ cover representatives. 1 of following *Anguilla mossambica* (AMOS), *Anguilla bengalensis (*ALAB*)*,*Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	During the survey, no fish collected although good habitat present. May be du e o operating procedures when there are periods of no flow and during the survey fish had not yet returned. Important fish refugia for Mooi River. Silt levels reduced habitat availability and smothered habitats for aquatic macroinvertebrates No previous surveys conducted in this RU, however, to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved. Current diatoms index score measured during
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained in to a TEC of a C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae >2 spp Leptophlebiiidae Trichorythidae Hydropsychidae >2spp Atydae Hydracarina	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	
		Diatoms	Ecological water quality should be improved to a *good quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 15 - 17 PTV: <20%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						the survey was in a Class B Ecological Category (SPI: 15.5 and PTV 0%) which needs to be maintained. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure					Context of the RQO and/or Numerical limit
8.6 Mooi from Mnyamvubu to Thukela confluence **V20H, J (THU_EWR 12A)**	Quantity	Low flows	EWR maintenance low and drought flows: Mooi River at the EWR site THU_EWR12A (-29.9193, 30.4189) in V20H NMAR = 361.85 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the downstream aquatic ecosystem of the Mooi River to the confluence with the Thukela River.	Maintenance and drought flows required for the Mooi River Monitoring of flows at V2H008		Maintenance		Drought		THU_EWR12A for TEC=C (Baseflows, freshets/ floods)
						Low flows (m^3/s) flows m^3/s)		Low flows (m^3/s) flows m^3/s)		
					Oct	1.647		0.849		
					Nov	2.095		0.914		
					Dec	2.586		1.287		
					Jan	3.48		1.704		
					Feb	4.196		2.046		
					Mar	3.819		1.862		
					Apr	3.266		1.607		
					May	2.233		1.122		
					Jun	1.621		0.839		
					Jul	1.351		0.711		
					Aug	1.284		0.679		
					Sep	1.503		0.784		
		High Flows	EWR freshets/ floods to be released from Spring			Freshet (m^3/s)	Days	Flood (m^3/s)	days	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure					Context of the RQO and/or Numerical limit
			Grove and Craigieburn Dams	Freshets/ floods required for the Mooi River Monitoring of flows at V2H008	Sep	6	2			
					Oct	8	2			
					Nov	8	2			
					Dec	8	2	20	3	
					Jan	15	3	33	3	
					Feb	15	2	40	6	
					Mar	15	3	20	3	
					Apr	8	2			
	Quality	Nutrients	Instream levels of nutrients must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.02 mg/L (50th percentile)					Maintenance of a C ecological category. Salinity must be improved slightly (present quality = TDS 407 mg/l) Nutrients – based on current water quality status
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)					
		Salts	Salinity concentrations must be attained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Total Dissolved Solids	≤350 mg/L (95th percentile)					
		System variables	The water must be acceptable for recreational use.	pH	6.5 (5th percentile) and 9.0 (95th percentile)					Direct contact recreational use must cause minimal irritation.
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Atrazine	≤0.078 milligrams/litre (mg/l)					Ecological specification. Ecological Reserve manual (2008). No monitoring data. Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)					
				Glyphosate	≤0.7 milligrams/litre (mg/l)					Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be improved to a TEC of C Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C) Ecological Category (60 - 79%) Riparian Integrity - Class C Ecological Category (60 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)					Currently instream Habitat Integrity Class D (58%) and Riparian habitat integrity (Class C/D) (59%) – both need to be improved to a Class C

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Labeobarbus natalensis* (BNAT) *Barbus (Enteromius) viviparus* (BVIV) *Clarias gariepinus* (CGAR) *Labeo molybdinus* (LMOL) *Barbus (Enteromius) pallidus* (BPAL) *Tilapia sparrmanii* (TSPA) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BVIV, BPAL and TSPA – 3 of the 4 vegetation/ cover representatives. 1 of following *Anguilla mossambica* (AMOS), and *Labeo molybdinus* (LMOL) as flow dependent and depth class representatives. FRAI EC: C (65 - 79%)	FRAI automated score was a D at 54%; adjusted to a C/D at 61%. Will need to improve flow depth classes, flow velocity and water quality to achieve a C class (65 – 79%) Poor water quality; high algae content, smothers the habitat SASS 5 score 124 and ASPT score 5.4 measured on survey MIRAI score Class C (65%) to be maintained. Current diatoms index score measured during the survey was in a Class C/D Ecological Category (SPI: 10 and PTV 3.8%) which needs to be improved to a Class C (SPI: 12 – 14)
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained or improved to a TEC of a C ecological category.	SASS 5 MIRAI Baetidae >2 spp Leptophlebiiidae Atydae Aeshnidae Hydropsychidae >2spp	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: 124 - 200 ASPT score: 5.4 - 7.5 MIRAI EC: C (60 – 79%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

6.1.9 IUA 9: Middle/ Lower Bushman's River

Table 30: Resource Units delineated for IUA 9: Middle/ Lower Bushman's River

RU	Delineation	Catchment
9.2	Wagendrift Dam	V70C
9.3	Little Bushmans to confluence with Bushmans	V70D
9.4	Bushmans from Wagendrift Dam to confluence with Rensburgspruit downstream of Estcourt	V70E, F, G
9.5	Bushmans from Rensburgspruit Dam to confluence with Thukela	V70F, G

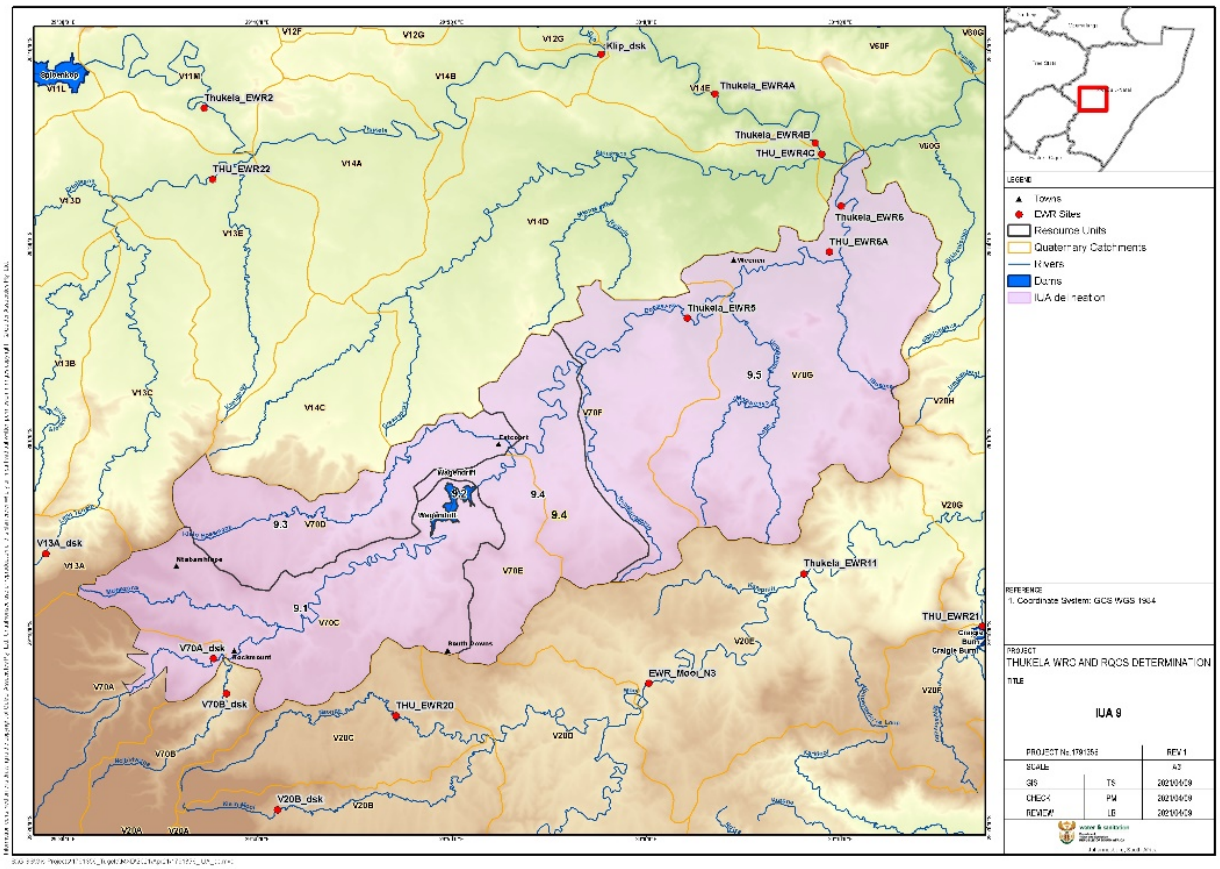

Figure 15: IUA 9 - Middle/ Lower Bushman's Resource Units

Table 31: IUA 9: Middle/ Lower Bushman's RUs description

IUA 9 – Middle/ Lower Bushman's
Resource Unit 9.2 Wagendrift Dam V70C
SWSA; water supply and irrigation. Proposed hydroelectricity plant.
Resource Unit 9.3 Little Bushmans to confluence with Bushman's 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.

IUA 9 – Middle/ Lower Bushman's
Resource Unit 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.
Resource Unit 9.5 Bushmans from Rensburgspruit Dam to confluence with Thukela V70F, G
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. *Note: this resource Unit has been split as follows:* 9.5(a): Bushmans from Rensburgspruit confluence to outlet of V70F 9.5 (b): Bushmans from outlet of V70Fto confluence with Thukela

Table 32: Draft RQOs for IUA 9: Sundays River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
9.2 Wagendrift Dam **V70C**	Quantity	Dam level	Update and review operating rules to sustain optimal dam levels to support users and downstream aquatic ecosystem. The dam level must be managed to protect ecosystem function as well as downstream users.	Minimal operating level required in the dam.		Operating Rules
	Quality	Nutrients	Nutrients levels must be maintained to sustain ecosystem health and the water quality requirements of water users. The dam must be maintained as a mesotrophic system or better.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.01 mg/L (50th percentile)	Water quality status is good. Limits based on current status.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Biota	Periphyton/ phytplankton	The Chl-*a* concentrations must be maintained in a mesotrophic state.	Chlorophyll-*a*	11-20µg/L 50th percentile	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
9.3 Little Bushmans to confluence with Bushman' s **V70D**	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state. Improvement in levels is required.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)	Maintenance of C ecological category Salinity levels are good. (256 mg/l) – Limit based on current status Nutrient concentrations are high
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained to support aquatic ecosystem and sustain the ecological state	Total Dissolved Solids	≤300 mg/L (95th percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						Quality Guidelines (1996).
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem and user as the drivers
	Habitat	Instream	Natural flow pattern must be maintained or improved to a TEC of C Ecological Category.	IHI and IHAS	Instream and riparian Habitat Integrity to be a Class C Ecological Category (60 - 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO – 5 specimens of each. *Anguilla mossambica* (AMOS), 1 -2 specimens as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	Flow and siltation due to afforestation affecting habitat. No previous surveys conducted in this RU, however, to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained or improved to a TEC of a C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiidae Hydropsychidae 2spp Heptageniidae Elmidae	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
9.4 Bushmans from Wagendrift Dam to confluence with Rensburgspruit downstream of Estcourt **V70E, F, (Upper portion) G**	Quantity					
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state. Improvement in levels is required.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)	Maintenance of C ecological category Nutrient concentrations are high (Ammonia and phosphate). Improvement is needed.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained to support aquatic ecosystem and sustain the ecological state	Total Dissolved Solids	≤350 mg/L (95th percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem and user as the drivers
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.

				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
9.5 (a) Bushmans from Rensburgspruit Dam to outlet of V70F **V70F (lower) (Thukela_EWR 5)**	Quantity	Low flows	EWR maintenance low and drought flows: Bushmans River at the EWR site Thukela_EWR5 (-28.897, 30.035) in V70F NMAR = 281.45 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the Bushmans River downstream of Wagendrift Dam to the EWR site.	Maintenance and drought flows required for the Bushmans River	Maintenance: Low flows (m^3/s) flows m^3/s); Drought: Low flows (m^3/s) flows m^3/s) Oct: 0.959; 0.472 Nov: 1.204; 0.544 Dec: 1.496; 0.710 Jan: 1.881; 0.881 Feb: 2.315; 1.078 Mar: 2.154; 1.002 Apr: 2.006; 0.938 May: 1.495; 0.71 Jun: 1.144; 0.556 Jul: 0.895; 0.444 Aug: 0.800; 0.402 Sep: 0.849; 0.425	Thukela_EWR5 for TEC=C (Baseflows, freshets/ floods)
		High Flows	EWR freshets/ floods to be released from Wagendrift Dam (short terms and Mielietuin Dam (long term)	Freshets/ floods required for the Bushmans River Monitoring of flows at V7H020	Freshet (m^3/s) / Days / Flood (m^3/s) / days Oct: 6 / 3 / / Nov: 16 / 3 / / Dec: 18 / 4 / 20 / 4 Jan: 20 / 4 / 25 / 4 Feb: 16 / 3 / 40 / 6 Mar: 16 / 3 / 20 / 5	
	Quality	Nutrients	Nutrient levels must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)	Maintenance of C ecological category.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Total Dissolved Solids	≤350 mg/L (95th percentile)	
		System variables	pH range must be maintained within limits specified to	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem and user as the drivers

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			support the aquatic ecosystem and water user requirements.			
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be improved to a TEC of C Ecological Category.	IHI and IHAS	Instream and riparian Habitat Integrity to be maintained or improved as a Class C Ecological Category (60 - 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) **– *Barbus (Enteromius) trimaculatus*** (BTRI) ***Barbus (Enteromius) viviparus*** (BVIV) *Anguilla mossambica* (AMOS) *Labeo rubromaculatus* (LRUB) *Tilapia sparrmanii* (TSPA)	Ensure all flow habitat classes are present for the following species: BNAT, BVIV, BANO and TSPA – 3 of the 4 vegetation/ cover representatives. 1 of following *Anguilla mossambica* (AMOS), and *Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	Flows needed for flow sensitive species such as *Anguilla mossambica* (AMOS) and *Labeo rubromaculatus* (LRUB) and *macroinverbrates. No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained or improved to a TEC of a C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiidae Heptageniidae Hydropsychidae 2spp Perlidae* Elmidae* Trichorythidae*	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

<table>
<tr><th>Resource Unit</th><th>Component</th><th>Sub-component</th><th>RQO</th><th>Indicator</th><th colspan="6">Numerical Limit/ measure</th><th>Context of the RQO and/or Numerical limit</th></tr>
<tr><td rowspan="20">9.5 (b)
Bushmans from outlet of V70F to confluence with Thukela
V70G (THU_EWR 6A)</td><td rowspan="13">Quantity</td><td rowspan="12">Low flows</td><td rowspan="12">EWR maintenance low and drought flows:

Bushmans River at the EWR site THU_EWR6A (-28.8483, 30.1496) in V70G

NMAR = 298.37 x10^{6}m^3

TEC=C/D category

The maintenance low flows and drought flows must be attained to support the downstream aquatic ecosystem of the Bushmans River to the confluence with the Thukela River.</td><td rowspan="12">Maintenance and drought flows required for the lower Bushmans River</td><td></td><td colspan="2">Maintenance low flows (m^3/s)</td><td colspan="3">Drought flows (m^3/s)</td><td rowspan="13">THU_EWR6A for TEC=C/D
(Baseflows, freshets/ floods)</td></tr>
<tr><td>Oct</td><td colspan="2">1.816</td><td colspan="3">0.488</td></tr>
<tr><td>Nov</td><td colspan="2">2.246</td><td colspan="3">0.565</td></tr>
<tr><td>Dec</td><td colspan="2">2.759</td><td colspan="3">0.728</td></tr>
<tr><td>Jan</td><td colspan="2">3.473</td><td colspan="3">0.910</td></tr>
<tr><td>Feb</td><td colspan="2">4.238</td><td colspan="3">1.108</td></tr>
<tr><td>Mar</td><td colspan="2">3.931</td><td colspan="3">1.027</td></tr>
<tr><td>Apr</td><td colspan="2">3.665</td><td colspan="3">0.96</td></tr>
<tr><td>May</td><td colspan="2">2.747</td><td colspan="3">0.725</td></tr>
<tr><td>Jun</td><td colspan="2">2.121</td><td colspan="3">0.567</td></tr>
<tr><td>Jul</td><td colspan="2">1.682</td><td colspan="3">0.454</td></tr>
<tr><td>Aug</td><td colspan="2">1.519</td><td colspan="3">0.413</td></tr>
<tr><td>Sep</td><td colspan="2">1.625</td><td colspan="3">0.440</td></tr>
<tr><td rowspan="8">High Flows</td><td rowspan="8">EWR freshets/ floods to be released from Wagendrift Dam (short terms and Mielietuin Dam (long term)</td><td rowspan="8">Freshets/ floods required for the Bushmans River

Monitoring of flows at V7H020</td><td></td><td>Freshet (m^3/s)</td><td>Days</td><td>Flood (m^3/s)</td><td>days</td><td rowspan="8"></td></tr>
<tr><td>Sep</td><td>4</td><td>2</td><td></td><td></td></tr>
<tr><td>Oct</td><td>6</td><td>3</td><td></td><td></td></tr>
<tr><td>Nov</td><td>10</td><td>3</td><td></td><td></td></tr>
<tr><td>Dec</td><td>10</td><td>3</td><td>20</td><td>4</td></tr>
<tr><td>Jan</td><td>20</td><td>3</td><td>35</td><td>4</td></tr>
<tr><td>Feb</td><td>20</td><td>4</td><td>40</td><td>6</td></tr>
<tr><td rowspan="7">Quality</td><td rowspan="2">Nutrients</td><td rowspan="2">Nutrient levels must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.</td><td>Ortho-phosphate (PO_4^-) as Phosphorus</td><td colspan="6">≤0.058 mg/L (50th percentile)</td><td rowspan="2">Maintenance of C/D ecological category.</td></tr>
<tr><td>Total Inorganic Nitrogen (TIN^-) as Nitrogen</td><td colspan="6">≤2.0 mg/L (50th percentile)</td></tr>
<tr><td>Salts</td><td>Salinity concentrations must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.</td><td>Total Dissolved Solids</td><td colspan="6">≤350 mg/L (95th percentile)</td></tr>
<tr><td>System variables</td><td>pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.</td><td>pH range</td><td colspan="6">6.5 (5th percentile) and 9.0 (95th percentile)</td><td>Aquatic ecosystem and user as the drivers</td></tr>
<tr><td>Pathogens</td><td>The presence of pathogens should not pose a risk to human health</td><td>Escherichia coli</td><td colspan="6">≤130 Colony forming counts per 100 mL</td><td>User specification. Limit is the target water quality range for full</td></tr>
</table>

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Ammonia s N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be improved to a TEC of C/D Ecological Category.	IHI and IHAS	Instream Habitat Integrity (class C/D) Ecological Category (55 - 70%) Riparian Integrity - Class C/D Ecological Category (55 – 70%) IHAS to be *adequate* habitat availability (55 - 65%)	Currently instream Habitat Integrity Class D (47%) and Riparian habitat integrity (Class C/D) (45%) – both need to be improved to a Class C/D
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C/D Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C/D Ecological Category (55 - 70%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C/D ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Barbus (Enteromius) trimaculatus* (BTRI) *Barbus (Enteromius) viviparus* (BVIV) *Clarias gariepinus* (CGAR) *Labeo molybdinus* (LMOL) *Barbus (Enteromius) pallidus* (BPAL) *Tilapia sparrmanii* (TSPA) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BVIV, BPAL and TSPA – 3 of the 4 vegetation/ cover representatives. 1 of following *Anguilla mossambica* (AMOS), and *Labeo molybdinus* (LMOL) as flow dependent and depth class representatives. FRAI EC: C/D (55 - 70%)	FRAI automated score was a Class E at 35% and the adjusted a D at 56%. Will need to improve flow depth classes, flow velocity and water quality to achieve a C/D class (50 – 70%) SASS 5 score 80 and ASPT score 5.7 measured on survey to be maintained. MIRAI score Class C/D (60.9%) to be maintained. Poor water quality and high algae and silt smothering habitats for fish and invertebrates. Current diatoms index score measured during the survey was in a Class C Ecological Category (SPI: 12.8 and PTV: 0%) which needs to be maintained.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C/D ecological category.	SASS 5 MIRAI Baetidae >2 spp Leptophlebiiidae Heptageniidae Hydropsychidae 2spp	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: 80 - 180 ASPT score: 5.7 - 7.5 MIRAI EC: C/D (55 - 70%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

6.1.10 IUA 10: Upper Thukela River

Table 33: Resource Units delineated for IUA 10: Upper Thukela River

RU	Delineation	Catchment
10.1	Thukela, Putterill, Majaneni, Khombe tributary catchments	V11A (lower portion), C, D
10.3	Woodstock Dam	V11D, E
10.4	Sandspruit tributary catchment	V11F
10.8	Spioenkop Dam	V11L
10.9	Spioenkop Dam to Little Thukela confluence	V11M
10.10	Sterkspruit, Situlwane tributary catchment	V13B, D
10.11	Little Tugela from IUA14 outlet to confluence with Thukela River	V13A (lower portion), C, E
10.12	Tugela from Little Tugela confluence to proposed Jana Dam/ Klip confluence	V14A, B

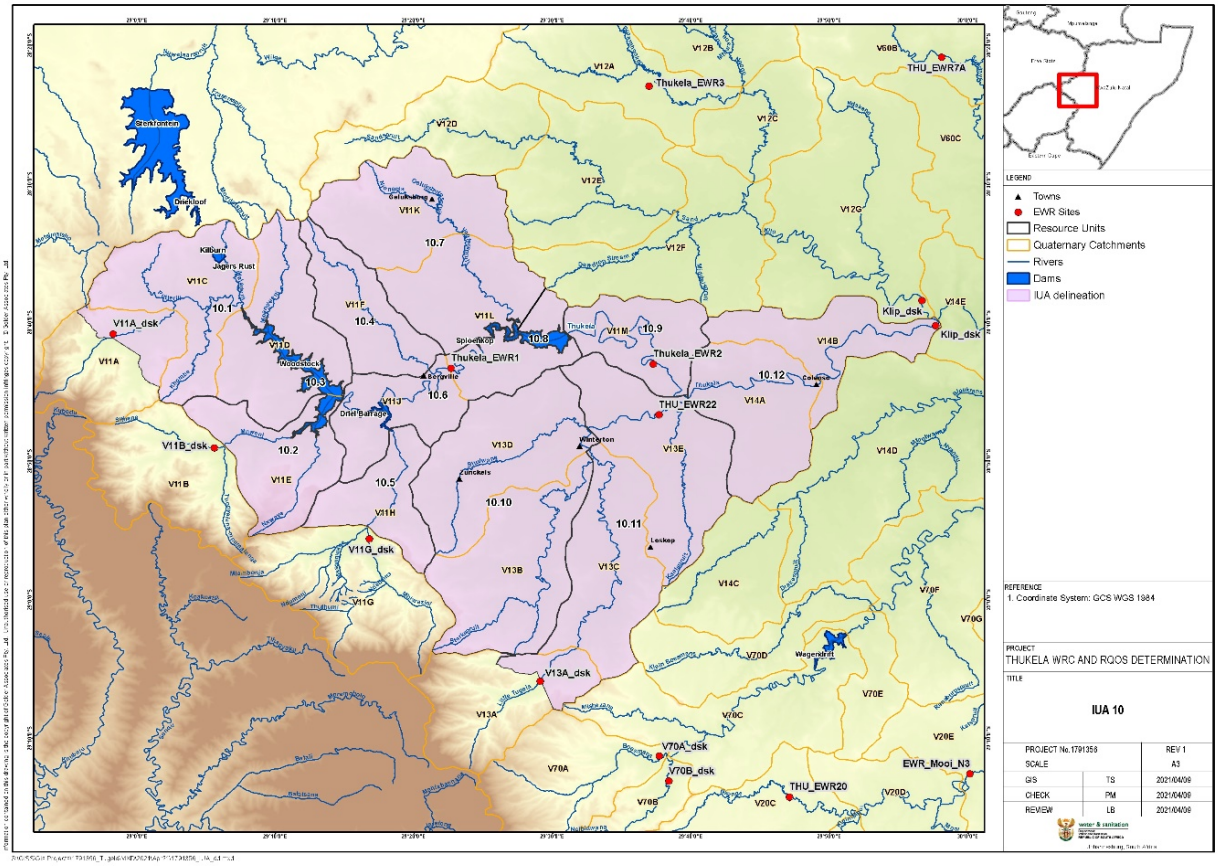

Figure 16: IUA 10 – Upper Thukela River Resource Units

Table 34: IUA 10: Upper Thukela s River RUs description

IUA 10 – Upper Thukela River
Resource Unit 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;
Resource Unit 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.
Resource Unit 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.
Resource Unit 10.8 Spioenkop Dam V11L
Spioenkop Nature Reserve; linked to Thukela-Vaal transfer; supply to Ladysmith; tourism; prioritised wetlands
Resource Unit 10.9 Spioenkop Dam to Little Thukela confluence V11M
Main stem; PES: C; irrigation along the river; priority wetlands along the river;
Resource Unit 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;
Resource Unit 10.11 Little Tugela from IUA14 outlet to confluence with Thukela River V13A (lower portion), C, E
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).
Resource Unit 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. Difficult to sample.

Table 35: Draft RQOs for IUA 10: Upper Thukela River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
10.1 Thukela, Putterill, Majaneni, Khombe tributary catchments **V11A (lower portion), C, D**	Quality	Nutrients	Nutrient levels must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.1 mg/L (50th percentile)	Maintenance of C/D ecological category. Improvement in nutrients is required – phosphate and ammonia
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)	
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem driver.
			Instream salinity levels must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Electrical Conductivity	≤ 55 milli Siemens/metre (mS/m) (95th percentile)	Ecological specification. Present ecological state must be maintained.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of B/C Ecological Category.	IHI and IHAS	Instream and riparian Habitat Integrity to be maintained or improved to Class B/C	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
					Ecological Category (75 – 85%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ B/C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI B/C Ecological Category (75 - 85%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a B/C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Amphilius natalensis* (ANAT) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo rubromaculatus* (LRUB)	Ensure all flow habitat classes are present for the following species: ANAT, BANO and BNAT – 2 of the 3 vegetation/ cover representatives. 1 of the following *Labeo molybdinus* (LMOL), mature *Labeobarbus natalensis* (BNAT) and *Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: B/C (75 - 85%)	Will need to improve flow depth classes, flow velocity and water quality to achieve a B/C class (50 – 70%) No previous surveys conducted in this RU, however, to achieve a MIRAI Class of a B/C, the SASS 5 scores and ASPT values provided must be achieved.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a B/C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiidae Heptageniidae Hydropsychidae 2spp Psephidae	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS5: ≥150 ASPT: ≥15.5 MIRAI EC: B/C (75 - 85%)	Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence. .
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
10.3 Woodstock Dam **V11D, E**	Quantity	Dam level	Update and review operating rules to sustain optimal dam levels to support users and downstream aquatic ecosystem. The dam level must be managed to protect ecosystem function as well as downstream users.	Minimal operating level required in the dam.		Operating Rules
	Quality	Nutrients	Concentration of nutrients must be maintained to sustain ecosystem health and the water quality requirements of water users.	Total Inorganic Nitrogen as TIN	≤0.7 mg/L (50th percentile))	Dam water quality status is good. Limits based on present status. (mesotrophic) Ammonia levels are elevated.
				Ortho-phosphate as P	≤0.010 mg/L (50th percentile)	
		Salts	The salinity in the dam must be maintained to support ecosystem health and the water quality requirements of the downstream users. The good water quality condition must be maintained.	Total Dissolved Solids	≤100 mg/L (95th percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Biota	Periphyton/ phytplankton	The dam must be maintained as mesotrophic system	Chlorophyll-a	11-20µg/L 50th percentile	The system must be maintained for ecological, agricultural, industrial and recreational purposes

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
10.4 Sandspruit tributary catchment **V11F**	Quality	Nutrients	Nutrient levels must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)	Maintenance of a C/D ecological category. Water quality is good, with the exception of ammonia concentrations that are high.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained to sustain aquatic ecosystem health and ensure the	Total Dissolved Solids	≤350 mg/L (95th percentile)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			prescribed ecological category is met.			
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem driver.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of C Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be maintained and/or improved in a Class C Ecological Category (60 - 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Amphilius natalensis* (ANAT) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT)	Ensure all flow habitat classes are present for the following species: ANAT, BANO and BNAT – 2 of the 3 vegetation/ cover representatives. 1 of the following *Anguilla mossambica* (AMOS) and mature BNAT as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	Will need to improve flow depth classes, flow velocity and water quality to achieve a C class (60 – 79%) No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiidae Heptageniidae Hydropsychidae 2spp Elmidae	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit	Context of the RQO and/or Numerical limit
10.8 Spioenkop Dam **V11L**	Quantity	Dam level	Update and review operating rules to sustain optimal dam levels to support users and downstream aquatic ecosystem. The dam level must be managed to protect ecosystem function as well as downstream users.	Minimal operating level required in the dam.		Operating Rules
	Quality	Nutrients	Concentration of nutrients must be maintained to sustain ecosystem health and the water quality requirements of water users. The good water condition must be protected.	Total Inornanic Nitrogen (TIN^-) as Nitrogen	≤0.7 mg/L (50^{th} percentile)	Dam is in a good state. Nutrients must be maintained as these levels.
				Ortho-phosphate (PO_4^-) as Phosphorus	≤0.01 mg/L (50^{th} percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Biota	Periphyton/ phytplankton	The dam must be maintained as mesotrophic system	Chlorophyll-a	11-20µg/L 50th percentile	The system must be maintained for ecological, agricultural, industrial and recreational purposes

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure					Context of the RQO and/or Numerical limit
10.9 Spioenkop Dam to Little Thukela confluence **V11M (EWR 2)**	Quantity	Low flows	Base flow pattern must be maintained for drought and maintenance flows	Base Flow		Maintenance		Drought		Thukela_EWR2 for TEC=C/D (Baseflows, freshets/ floods)
						Low flows (m^3/s) flows m^3/s)		Low flows (m^3/s) flows m^3/s)		
					Oct	1.800		0.560		
					Nov	2.200		0.750		
					Dec	3.200		1.000		
					Jan	3.600		1.400		
					Feb	4.200		2.000		
					Mar	4.000		1.850		
					Apr	3.800		1.600		
					May	3.000		1.200		
					Jun	2.500		0.900		
					Jul	2.000		0.650		
					Aug	1.800		0.520		
					Sep	1.800		0.510		
		High Flows	EWR freshets/ floods to be released from Spioenkop Dam	Freshets/ floods required for the Thukela River Monitoring of flows at V1H057		Freshet (m^3/s)	Days	Flood (m^3/s)	days	
					Sep	7	3			
					Oct	7	3			
					Nov	10	5			
					Dec	15	5	30	5	
					Jan	24	5	35	6	
					Feb	30	5	35	7	
					Mar	20	5	25	6	
					Apr	7	3			
	Quality	Nutrients	Nutrient levels must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.02 mg/L (50th percentile)					Maintenance of a C/D ecological category. Present state water quality is good.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)					
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)					Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)					Ecological specification. Ecological Reserve

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be improved to a TEC of C/D Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be maintained and/or improved to a Class C/D Ecological Category (55 - 70%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C/D Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C/D Ecological Category (55 - 70%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C/D ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo rubromaculatus* (LRUB) *Oreochromis mossambicus* (OMOS)	Ensure all flow habitat classes are present for the following species: BNAT, BANO and OMOS – 2 of the 3 vegetation/ cover representatives. 1 of the following *Anguilla mossambica* (AMOS), and *Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: C/D (55 - 70%)	Will need to improve flow depth classes, flow velocity and water quality to achieve a C/D class (55 – 70%) over the long run. No previous surveys conducted in this RU, however, to achieve a MIRAI Class of a C/D, the SASS 5 scores and ASPT values provided must be achieved.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be	SASS 5 (not measured within this RU but to be achieved) MIRAI	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥80 - 100 ASPT score: ≥4.5	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			maintained for a TEC of a C/D ecological category.	Baetidae 2 spp Leptophlebiiidae Heptageniidae Hydropsychidae 2spp	MIRAI EC: C/D (55 - 70%)	Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence.
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
10.10 Sterkspruit, Situlwane tributary catchment **V13B, D**	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.02 mg/L (50th percentile)	Maintenance of a C/D ecological category.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤1.0 mg/L (50th percentile)	
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of B/C Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity must be maintained and/or improved to a Class B/C Ecological Category (75 - 85%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
					IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ B/C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI B/C Ecological Category (75 - 85%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a B/C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Clarias gariepinus* (CGAR) *Labeo rubromaculatus* (LRUB) *Oreochromis mossambicus* (OMOS) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO, OMOS and ANAT – 3 of the 4 vegetation/ cover representatives. 2 of the following *Anguilla mossambica* (AMOS) , mature *Labeobarbus natalensis* (BNAT) and *Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: B/C (75 - 85%)	Will need to improve flow depth classes, flow velocity and water quality to achieve a B/C class (75 – 85%) No previous surveys conducted in this RU, however to achieve a MIRAI Class of a B/C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a B/C ecological category.	SASS 5 (not measured within this RU but to be achieved) MIRAI Baetidae >2 spp Leptophlebiiidae Heptageniidae Tricorythidae Hydropsychidae 2spp Elmidae Psepheniidae Dixidae	3 biotopes to be sampled; assemblages to be A to B abundances; SASS 5 score: ≥150 ASPT score: ≥5.5 MIRAI EC: B/C (75 - 85%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
10.11 Little Tugela from IUA14 outlet to confluence with Thukela River **V13A (lower portion), C, E (EWR 3)**	Quantity	Low flows	EWR maintenance low and drought flows: Little Thukela River at the EWR site Thukela_EWR3 (-28.383, 29.616) in V13E NMAR = 285.20 x$10^6$$m^3$ TEC=C/D category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem of the Little Thukela River.	Maintenance and drought flows required for the Little Thukela River		Maintenance low flows (m^3/s)	Drought flows (m^3/s)	Thukela_EWR3 for TEC=C/D (Baseflows)
					Oct	0.510	0.200	
					Nov	0.700	0.300	
					Dec	0.970	0.400	
					Jan	1.400	0.930	
					Feb	1.920	1.300	
					Mar	1.830	1.230	
					Apr	1.500	1.030	
					May	1.100	0.700	
					Jun	0.750	0.400	
					Jul	0.550	0.200	
					Aug	0.450	0.150	
					Sep	0.450	0.150	
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state. Deterioration must be prevented	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.0158 mg/L (50th percentile)			Maintenance of a C/D ecological category. Elevated concentrations of nutrients – phosphate and ammonia. Salinity is at tolerable levels. Some improvement is required.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Improvement in salinity levels is required.	Total Dissolved Solids	≤350 mg/L (95th percentile)			
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)			Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)			Ecological specification. Ecological Reserve manual (2008). No monitoring data.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of C/D Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be maintained and/or improved to a Class C/D) Ecological Category (55 - 70%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C/D Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C/D Ecological Category (55 - 70%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C/D ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo rubromaculatus* (LRUB) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO and ANAT – 2 of the 3 vegetation/ cover representatives. 1 of the following *Anguilla mossambica* (AMOS), mature *Labeobarbus natalensis* (BNAT) and *Labeo molybdinus* (LMOL) as flow dependent and depth class representatives. FRAI EC: C/D (55 - 70%)	Must ensure seasonal flow regime - flow depth classes, flow velocity and water quality - to maintain C/D class (55 – 70%) No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C/D, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C/D ecological category.	SASS 5 (not measured within this RU but to be achieved) MIRAI Baetidae >2 spp Leptophlebiidae Heptageniidae	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥80 - 100 ASPT score: ≥4.5 MIRAI EC: C/D (55 - 70%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
				Oligoneuridae Tricorythidae Hydropsychidae 1spp Polycentropodidae Elmidae Psephenidae		flow regimes needs to be managed to ensure indicator biota presence.
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
10.12 Tugela from Little Tugela confluence to proposed Jana Dam/ Klip confluence **V14A, B**	Quantity	Low flows	EWR maintenance low and drought flows: Thukela River at the confluence of the Klip River in V14B NMAR = 1145.20 x$10^6$$m^3$ TEC=C/D category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem to the Thukela River.	Maintenance and drought flows required for the Thukela River Monitoring of flows at V1H001		Maintenance	Drought	Thukela1_dsk for TEC=C/D (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	2.274	0.883	
					Nov	2.949	1.131	
					Dec	3.784	1.435	
					Jan	5.260	1.974	
					Feb	7.202	2.690	
					Mar	6.744	2.517	
					Apr	5.892	2.207	
					May	4.350	1.641	
					Jun	3.288	1.255	
					Jul	2.538	0.979	
					Aug	2.157	0.840	
					Sep	2.155	0.841	
	Quality	Nutrients	Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the present ecological state (PES B)	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.10 mg/L (50th percentile)			Maintenance of a C/D ecological category. Elevated concentrations of nutrients – phosphate and ammonia.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Total Dissolved Solids needs to be maintained to support aquatic ecosystem and sustain the present ecological state (PES B)	Total Dissolved Solids	≤350 mg/L (95th percentile)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Ecological specification (current levels are high – improvement required).
				Atrazine	≤0.078 milligrams/litre (mg/l)	Ecological specification. Ecological Reserve manual (2008). No monitoring data.
				Mancozeb	≤0.009 milligrams/litre (mg/l)	Human health is the driver. Australian drinking water guideline. No monitoring data. No monitoring data.
				Glyphosate	≤0.7 milligrams/litre (mg/l)	Human health is the driver. USEPA drinking water guideline
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of C/D Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be maintained and/or improved to a Class C/D) Ecological Category (55 - 70%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C/D Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C/D Ecological Category (55 - 70%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C/D ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo rubromaculatus* (LRUB) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO and ANAT – 2 of the 3 vegetation/ cover representatives. 1 of the following *Anguilla mossambica* (AMOS), mature *Labeobarbus natalensis* (BNAT) and *Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: C/D (55 - 70%)	Must ensure seasonal flow regime - flow depth classes, flow velocity and water quality - to maintain C/D class (55 – 70%) No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C/D, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C/D ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae >2 spp Leptophlebiiidae Heptageniidae Oligoneuridae Tricorythidae Hydropsychidae 1spp Polycentropodidae Elmidae Psephenidae	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥80 - 100 ASPT score: ≥4.5 MIRAI EC: C/D (55 - 70%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

6.1.11 IUA 11: Klip River

Table 36: Resource Units delineated for IUA 11: Klip River

RU	Delineation	Catchment
11.1	Sandspruit and tributaries	V12D, E and F
11.2	Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments	V12A, B, C,
11.3	Klip from Ladysmith to confluence with Thukela	V12G

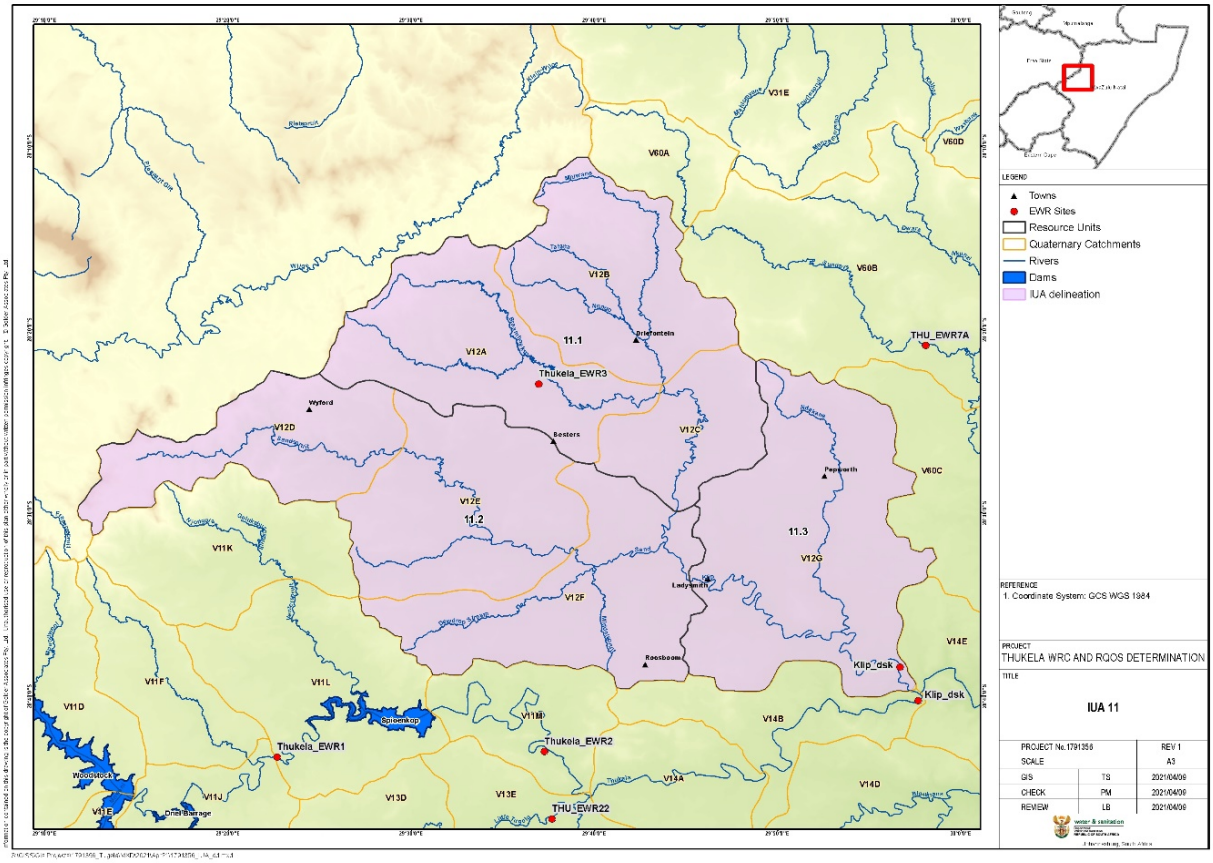

Figure 17: IUA 11 - Klip River Resource Units

Table 37: IUA 11: Klip River RUs description

IUA 11 – Klip River
Resource Unit 11.1 Sandspruit and tributaries 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.
Resource Unit 11.2 Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments V12A, B, C,
SWSA in upper reaches of the Klip and Braamhoekspruit river catchments; Ngula pump storage; 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.
Resource Unit 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.

Table 38: Draft RQOs for IUA 11: Klip River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
11.1 Sandspruit and tributaries **V12D, E and F**	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state. Deterioration must be prevented	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)	Maintenance of a C ecological category. No monitoring data.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)	
		Salts	Salinity concentrations must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Total Dissolved Solids	≤350 mg/L (95th percentile)	
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of C/D Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be maintained and/or improved to a Class C/D) Ecological Category (55 - 70%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C/D Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C/D Ecological Category (55 - 70%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C/D ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo rubromaculatus* (LRUB) *Clarias gariepinus* (CGAR) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO, CGAR (juvenile) and ANAT – 3 of the 4 vegetation/ cover representatives. 2 of the following *Anguilla mossambica* (AMOS), mature *Labeobarbus natalensis* (BNAT) and *Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: C/D (55 - 70%)	Must maintain floe regime - depth classes, flow velocity and water quality - to achieve a C/D class (55 - 70%) No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C/D, the SASS 5 scores and ASPT values provided must be achieved.

		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C/D ecological category.	SASS 5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiiidae Heptageniidae Tricorythidae Elmidae	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥80 - 100 ASPT score: ≥4.5 MIRAI EC: C/D (55 - 70%)	Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence.
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
11.2 Klip, Braamhoek, Tatana, Ngoga, Mhlwane, catchments **V12A, B, C (THU_EWR 22)**	Quantity	Low flows	EWR maintenance low and drought flows: Klip River at the EWR site THU_EWR22 (-28.3952, 29.7197) in V12A NMAR = 52.44 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream and downstream aquatic ecosystem of the Klip River.	Maintenance and drought flows required for the Klip River.		Maintenance low flows (m^3/s)	Drought flows (m^3/s)	THU_EWR22 for TEC=C (Baseflows)
					Oct	0.129	0.050	
					Nov	0.180	0.028	
					Dec	0.227	0.012	
					Jan	0.376	0.146	
					Feb	0.529	0.298	
					Mar	0.407	0.231	
					Apr	0.294	0.152	
					May	0.174	0.055	
					Jun	0.114	0.044	
					Jul	0.089	0.047	
					Aug	0.087	0.047	
					Sep	0.113	0.043	
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state. Deterioration must be prevented.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)			Maintenance of a C ecological category.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to sustain aquatic	Total Dissolved Solids	≤350 mg/L (95th percentile)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			ecosystem health and ensure the prescribed ecological category is met.			
	Habitat	Instream	Natural flow pattern must be maintained at a TEC of C Ecological Category.	IHI and IHAS	Instream Habitat Integrity to be maintained in a Class C Ecological Category (60 - 79%) Riparian Habitat Integrity to be improved to a Class C Ecological Category (60 – 79%) IHAS to be *adequate* habitat availability (55 - 65%)	Currently instream Habitat Integrity Class C (73%) and Riparian habitat integrity (Class C/D) (59%) – Riparian Habitat Integrity to be improved, Instream Habitat Integrity to be maintained.
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo rubromaculatus* (LRUB) *Clarias gariepinus* (CGAR) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, ANAT, BANO and juvenile CGAR – 3 of the 4 vegetation/ cover representatives. 2 of the following *Anguilla mossambica* (AMOS), mature *Labeobarbus natalensis* (BNAT), mature *Clarias gariepinuS* (CGAR) and *Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	FRAI automated score was a Class C at 76% and the adjusted a C at 64%. Must maintain the seasonal flow regime - flow depth classes, flow velocity and water quality - to achieve a C class (60 – 79%) SASS 5 score 213 and ASPT score 5.9 measured on survey MIRAI score Class C (77.8%) to be maintained. Poor water quality and high algae and silt smothering habitats for fish and invertebrates.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C/D ecological category.	SASS 5 MIRAI Hydracarina Perlidae Baetidae > 2 sp Heptageniidae Leptophlebiidae Aeshnidae Crambidae	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: 213 - 220 ASPT score: 5.9 - 7.5 MIRAI EC: C (60 - 79%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
				Ecnomidae Elmidae Psephenidae		Diatoms index score measured during the survey was in a Class C/D Ecological Category (SPI: 11.6 and PTV: 15.6%) which needs to be improved to a Class C.
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
11.3 Klip from Ladysmith to confluence with Thukela **V12G**	Quantity	Low flows	EWR maintenance low and drought flows: Klip River at the confluence with the Thukela River in V12G NMAR = 253.09 x$10^6$$m^3$ TEC=C category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem of the Klip River.	Maintenance and drought flows required for the Klip River.		Maintenance	Drought	Klip_dsk for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	0.623	0.240	
					Nov	0.868	0.132	
					Dec	1.103	0.078	
					Jan	1.816	0.733	
					Feb	2.534	1.384	
					Mar	1.986	1.088	
					Apr	1.435	0.736	
					May	0.844	0.270	
					Jun	0.550	0.228	
					Jul	0.430	0.228	
					Aug	0.422	0.239	
					Sep	0.547	0.207	
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state. Improvement in levels are required	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)			Maintenance of a C ecological category. Water quality status includes salinity and phosphate levels. Improvement is needed.
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met. Improvement in salinity levels required.	Total Dissolved Solids	≤500 mg/L (95th percentile)			

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)	Aquatic ecosystem driver.
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health.	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)	Strictest of ecological specifications. Ecological Reserve manual (2008), South African Water Quality Guidelines (1996) Manganese and Iron – Domestic user water quality guideline (SAWQGs, 1996). Cobalt – – Irrigation user water quality guideline (SAWQGs, 1996) Zinc - Aquatic Ecosystem water quality guideline (SAWQGs, 1996).
				Aluminium (Al)	≤ 0.105 milligrams/litre (mg/l) (95th percentile)	
				Cadmium (Cd) soft	≤ 0.0012 milligrams/litre (mg/l) (95th percentile)	
				Manganese (Mn)	≤ 0.15 milligrams/litre (mg/l) (95th percentile)	
				Iron (Fe)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
				Lead (Pb) hard	≤ 0.0095 milligrams/litre (mg/l) (95th percentile)	
				Copper (Cu) hard	≤ 0.0073 milligrams/litre (mg/l) (95th percentile)	
				Nickel (Ni)	≤ 0.07 milligrams/litre (mg/l) (95th percentile)	
				Cobalt (Co)	≤ 0.05 milligrams/litre (mg/l) (95th percentile)	
				Zinc (Zn)	≤ 0.002 milligrams/litre (mg/l) (95th percentile)	
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of C Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be maintained and/or improved in a Class C Ecological Category (60 - 79%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo rubromaculatus* (LRUB) *Clarias gariepinus* (CGAR) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BANO, ANAT and juvenile CGAR – 3 of the 4 vegetation/ cover representatives. 2of following *Anguilla mossambica* (AMOS), mature *Clarias gariepinus* (CGAR), mature *Labeobarbus natalensis* (BNAT) and *Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	Must maintain seasonal flow regime - flow depth classes, flow velocity and water quality - to achieve a C class (60 – 79%) No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiiidae Heptageniidae Hydropsychidae 2spp Elmidae	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

6.1.12 IUA 12: Middle Thukela River

Table 39: Resource Units delineated for IUA 12: Middle Thukela River

RU	Delineation	Catchment
12.2	Thukela From Klip confluence to Bushmans confluence	V14E
12.4	Thukela from Bushmans confluence to d/s Mooi confluence	V60G, H, J, K

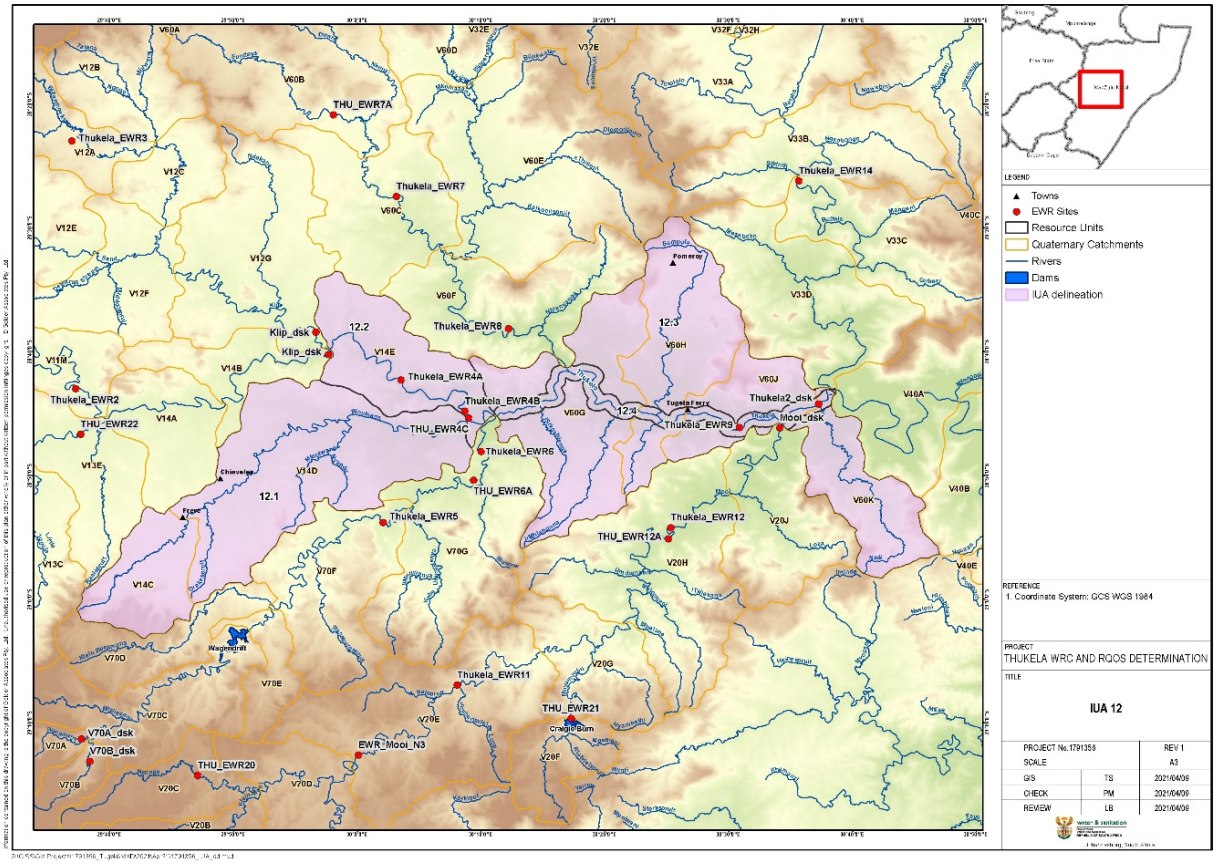

Figure 18: IUA 12 – Middle Thukela River Resource Units

Table 40: IUA 12: Middle Thukela River RUs description

IUA 12 – Middle Thukela River
Resource Unit 12.2: Thukela From Klip confluence to Bushmans confluence **V14E**
Main stem; PES: A; natural area; tourism;
Resource Unit 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.

Table 41: Draft RQOs for IUA 12: Middle Thukela River Resource Units

<table>
<tr><th>Resource Unit</th><th>Component</th><th>Sub-component</th><th>RQO</th><th>Indicator</th><th colspan="6">Numerical Limit/ measure</th><th>Context of the RQO and/or Numerical limit</th></tr>
<tr><td rowspan="25">12.2
Thukela From Klip confluence to Bushmans confluence
V14E (Thukela_EWR 4B)</td><td rowspan="14">Quantity</td><td rowspan="13">Low flows</td><td rowspan="13">EWR maintenance low and drought flows:

Thukela River at the EWR site Thukela_EWR4B (-28.747, 30.145) in V14E

NMAR = 1 423.83 x10^{6}m^3

TEC=C category

The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the Thukela River downstream of Klip River to the confluence with the Bushmans River.</td><td rowspan="13">Maintenance and drought flows required for the Thukela River</td><td></td><td colspan="3">Maintenance</td><td colspan="2">Drought</td><td rowspan="13">Thukela_EWR4B for TEC=C (Baseflows, freshets/ floods)</td></tr>
<tr><td></td><td colspan="3">Low flows (m^3/s) flows m^3/s)</td><td colspan="2">Low flows (m^3/s) flows m^3/s)</td></tr>
<tr><td>Oct</td><td colspan="3">2.278</td><td colspan="2">2.100</td></tr>
<tr><td>Nov</td><td colspan="3">3.023</td><td colspan="2">2.261</td></tr>
<tr><td>Dec</td><td colspan="3">3.914</td><td colspan="2">2.065</td></tr>
<tr><td>Jan</td><td colspan="3">5.650</td><td colspan="2">4.294</td></tr>
<tr><td>Feb</td><td colspan="3">7.750</td><td colspan="2">5.842</td></tr>
<tr><td>Mar</td><td colspan="3">7.001</td><td colspan="2">5.277</td></tr>
<tr><td>Apr</td><td colspan="3">5.949</td><td colspan="2">4.518</td></tr>
<tr><td>May</td><td colspan="3">4.272</td><td colspan="2">3.292</td></tr>
<tr><td>Jun</td><td colspan="3">3.123</td><td colspan="2">2.462</td></tr>
<tr><td>Jul</td><td colspan="3">2.388</td><td colspan="2">2.000</td></tr>
<tr><td>Aug</td><td colspan="3">2.042</td><td colspan="2">2.000</td></tr>
<tr><td>Sep</td><td colspan="3">2.121</td><td colspan="2">2.000</td></tr>
<tr><td rowspan="12">High Flows</td><td rowspan="12">EWR freshets/ floods from Spioenkop Dam and Klip River in the short and medium term and to be released from Jana Dam in the long term</td><td rowspan="12">Freshets/ floods required for the Thukela River</td><td></td><td>Freshet (m^3/s)</td><td>Days</td><td>Flood (m^3/s)</td><td>Days</td><td rowspan="12"></td></tr>
<tr><td>Sep</td><td>15</td><td>4</td><td></td><td></td></tr>
<tr><td>Oct</td><td>15</td><td>4</td><td></td><td></td></tr>
<tr><td>Nov</td><td>55</td><td>4</td><td>90</td><td>6</td></tr>
<tr><td>Dec</td><td>55</td><td>4</td><td>90</td><td>6</td></tr>
<tr><td>Jan</td><td>90</td><td>6</td><td>120</td><td>7</td></tr>
<tr><td>Feb</td><td>55</td><td>4</td><td>250</td><td>8</td></tr>
<tr><td>Mar</td><td>55</td><td>4</td><td>90</td><td>6</td></tr>
<tr><td rowspan="2">Habitat</td><td>Instream</td><td>Natural flow pattern must be improved to a TEC of C Ecological Category.</td><td>IHI and IHAS</td><td colspan="6">Instream Habitat Integrity to be improved to a Class C) Ecological Category (60 - 79%)
Riparian Habitat Integrity to be maintained in a Class C Ecological Category (60 – 79%)

IHAS to be good habitat availability (>65%)</td><td rowspan="2">Currently instream Habitat Integrity Class D (56%) and Riparian habitat integrity (Class C) (68%) – Instream Habitat Integrity to be improved, Riparian Habitat Integrity to be maintained.</td></tr>
<tr><td>Riparian habitat</td><td>The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological</td><td>VEGRAI</td><td colspan="6">VEGRAI survey every 5 years.
VEGRAI C Ecological Category (60 - 79%)</td></tr>
</table>

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			Category. High erosion rate to be managed.			
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI AMOS *Amphilius natalensis* (ANAT) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo molybdinus* (LMOL) *Labeo rubromaculatus* (LRUB) *Clarias gariepinus* (CGAR) *Barbus (Enteromius) trimaculatus* (BTRI) *Barbus (Enteromius) viviparus* (BVIV) *Pseudocrenilabrus philander* (PPHI)	Ensure all flow habitat classes are present for the following species: BNAT, BVIV, BANO, BTRI and PPHI – 4 of the 5 vegetation/ cover representatives. 4 of the following *Anguilla mossambica* (AMOS), *Amphilius natalensis* (ANAT), mature *Labeobarbus natalensis* (BNAT), *Clarias gariepinus* (CGAR), *Labeo rubromaculatus* (LRUB) and *Labeo molybdinus* (LMOL) as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	FRAI automated score was a Class D at 42% and the adjusted a C at 68%. Will need to improve flow depth classes, flow velocity and water quality to achieve a C class (60 – 79%) SASS 5 score 145 and ASPT score 6.0 measured on survey Seasonal flow regimes needs to be managed to ensure indicator biota presence. MIRAI score Class C (73.7%) to be maintained. Current diatoms index score measured during the survey was in a Class B Ecological Category (SPI: 15.5 and PTV: 8.1%) which needs to be maintained.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C ecological category.	SASS 5 MIRAI Atyidae Baetidae > 2 sp Heptageniidae Leptophlebiidae Chlorocyphidae Crambidae Elmidae	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: 145 - 200 ASPT score: 6.0 – 7.6 MIRAI EC: C (60 - 79%)	
		Diatoms	Ecological water quality should be maintained as *good quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 15 - 17 PTV: < 20%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
12.4 Thukela from Bushmans confluence to d/s Mooi confluence **V60G, H, J, K (EWR 9)**	Quantity	Low flows	EWR maintenance low and drought flows: Thukela River at the EWR site Thukela_EWR9 (-28.769, 30.515) in V60J NMAR = 2 050.76 x$10^6$$m^3$ TEC=D category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the Thukela River from the Bushmans River to the Mooi River confluence.	Maintenance and drought flows required for the Thukela River Monitoring of flows at V6H002		Maintenance	Drought	Thukela_EWR9 for TEC=D (Baseflows)
						Low flows (m^3/s) flows m^3/s)	Low flows (m^3/s) flows m^3/s)	
					Oct	2.800	1.400	
					Nov	3.500	1.700	
					Dec	3.800	2.200	
					Jan	4.800	3.100	
					Feb	6.200	4.000	
					Mar	5.800	3.600	
					Apr	4.900	3.200	
					May	4.700	2.200	
					Jun	3.500	1.500	
					Jul	2.750	1.300	
					Aug	2.450	1.200	
					Sep	2.600	1 200	
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.1 mg/L (50th percentile)			Maintenance of a C/D ecological category.
				Total Inornanic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Total Dissolved Solids	≤500 mg/L (95th percentile)			
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem driver.
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)			Ecological specification. Ecological Reserve manual (2008),

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						South African Water Quality Guidelines (1996)
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of D Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be maintained and/or improved in a Class D Ecological Category (40 - 59%) IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ D Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI D Ecological Category (40 - 59%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a D ecological category.	FRAI *Anguilla mossambica* (AMOS) *Amphilius natalensis* (ANAT) *Barbus (Enteromius) anoplus* (BANO) *Labeobarbus natalensis* (BNAT) *Labeo molybdinus* (LMOL) *Clarias gariepinus* (CGAR) *Barbus (Enteromius) trimaculatus* (BTRI) *Tilapia sparrmanii* (TSPA)	Ensure all flow habitat classes are present for the following species: BNAT, BTRI, juvenile CGAR and TSPA – 3 of the 4 vegetation/ cover representatives. 1 of following *Anguilla mossambica* (AMOS), mature *Clarias gariepinus* (CGAR) and *Labeo molybdinus* (LMOL) as flow dependent and depth class representatives. FRAI EC: D (40 - 59%)	Wil need to maintain flow regime (seasonal) - flow depth classes, flow velocity and water quality to - achieve a D class (40 – 59%) in the long term. No previous surveys conducted in this RU, however, to achieve a MIRAI Class of a D, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence.
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a D ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae >2 spp Leptophlebiiidae Heptageniidae Elmidae Psephenidae	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥60 ASPT score: ≥4.0 MIRAI EC: D (40 - 59%)	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Diatoms	Ecological water quality should be maintained as *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	Current diatoms index score measured during the survey was in a Class C/D Ecological Category (SPI: 11.2 and PTV: 29.2%) which needs to be maintained.

6.1.13 UA 13: Lower Thukela River

Table 42: Resource Units delineated for IUA 13: Lower Thukela River

RU	Delineation	Catchment
13.2	Thukela from d/s Mooi confluence to Middeldrift transfer	V40A, B
13.5	Thukela from Middeldrift to Mandini Transfer (Mgeni Weir) in V50D	V40E, V50A, B, C, D (upper reach)

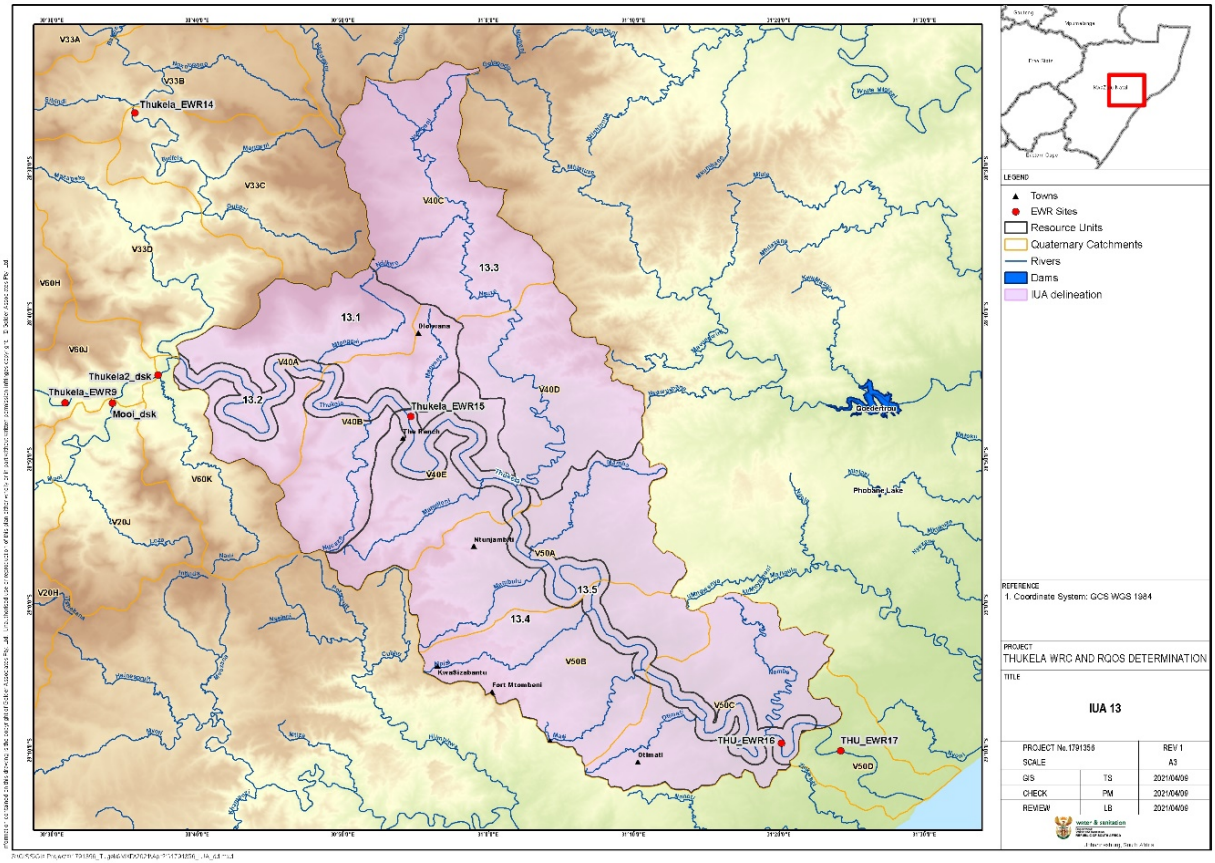

Figure 19: IUA 13 – Lower Thukela River Resource Units

Table 43: IUA 13: Lower Thukela River RUs description

IUA 13 – Lower Thukela River
Resource Unit 13.2 Thukela from downstream 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)
Resource Unit 13.5 Thukela from Middeldrift to Mandini Transfer (Mgeni Weir) in V50D: V40E, V50A, B, C, D (upper reach)
Main stem; PES: B category; smaller villages with subsistence agriculture along the river.

Table 44: Draft RQOs for IUA 13: Lower Thukela River Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
13.2 Thukela from d/s Mooi confluence to Middeldrift transfer **V40A, B (Thukela_EWR 15)**	Quantity	Low flows	Base flow pattern must be maintained for drought and maintenance flows	Base Flow		Maintenance	Drought	Thukela_EWR15 for TEC=C (Baseflows)
						Low flows (m^3/s) flows m^3/s	Low flows (m^3/s) flows m^3/s	
					Oct	9.100	3.200	
					Nov	10.500	4.500	
					Dec	14.500	5.500	
					Jan	19.000	8.500	
					Feb	25.000	10.500	
					Mar	21.500	9.200	
					Apr	19.000	8.800	
					May	14.300	6.500	
					Jun	10.400	4.200	
					Jul	8.300	3.000	
					Aug	7.400	2.000	
					Sep	8.100	2.100	
	Quality	Nutrients	Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state.	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.058 mg/L (50th percentile)			Maintenance of a C ecological category. No monitoring data. .
				Total Inorganic Nitrogen (TIN^-) as Nitrogen	≤2.0 mg/L (50th percentile)			
		Salts	Salinity concentrations must be maintained to sustain aquatic ecosystem health and ensure the prescribed ecological category is met.	Total Dissolved Solids	≤350 mg/L (95th percentile)			
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL			User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH range	6.5 (5th percentile) and 9.0 (95th percentile)			Aquatic ecosystem driver.
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health	Ammonia as N	≤ 0.0725 milligrams/litre (mg/l) (95th percentile)			Ecological specification. Ecological Reserve manual (2008), South

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
						African Water Quality Guidelines (1996)
	Habitat	Instream	Natural flow pattern must be maintained and/or improved to a TEC of C Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be maintained and/or improved in a Class C Ecological Category (60 - 79%) IHAS to be *adequate* habitat availability (55 - 65%)	Currently instream Habitat Integrity Class D (47%) and Riparian habitat integrity (Class C/D) (45%) – both need to be improved to a Class C/D
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Labeobarbus natalensis* (BNAT) *Barbus (Enteromius) trimaculatus* (BTRI) *Barbus (Enteromius) viviparus* (BVIV) *Clarias gariepinus* (CGAR) *Labeo molybdinus* (LMOL) *Tilapia sparrmanii* (TSPA) *Amphilius natalensis* (ANAT)	Ensure all flow habitat classes are present for the following species: BNAT, BVIV, juvenile CGAR, and TSPA – 3 of the 4 vegetation/ cover representatives. 1 of the following *Anguilla mossambica* (AMOS), *Clarias gariepinus* **(**CGAR**),** *Labeo molybdinus* (LMOL) as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	Important to maintain the recommended flow regime (seasonal) to maintain the flow depth classes, flow velocity and water quality to achieve a C class (60 – 79%) No previous surveys conducted in this RU, however, to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C/D ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae 2 spp Leptophlebiiidae Heptageniidae Perlidae Elmidae Psephenidae Hydropsychidae 2spp	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	

<table>
<tr><th>Resource Unit</th><th>Component</th><th>Sub-component</th><th>RQO</th><th>Indicator</th><th>Numerical Limit/ measure</th><th>Context of the RQO and/or Numerical limit</th></tr>
<tr><td rowspan="4">13.5
Thukela from Middeldrift to Mandini Transfer (Mhgeni) weir in V50D
V40E, V50A, B, C, D (uuper reach) (THU_EWR 16)</td><td rowspan="3">Quantity</td><td>Low flows</td><td>EWR maintenance low and drought flows:

Thukela River at the EWR site THU_EWR16 (-29.1603, 31.3373) in V50C

NMAR = 3 679.97 x10^{6}m^3

TEC=C category

The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the Thukela River downstream of Middledrift to the Estuary.</td><td>Maintenance and drought flows required for the Thukela River</td><td><table><tr><td></td><td>Maintenance</td><td>Drought</td></tr><tr><td></td><td>Low flows (m^3/s) flows m^3/s)</td><td>Low flows (m^3/s) flows m^3/s)</td></tr><tr><td>Oct</td><td>13.845</td><td>6.918</td></tr><tr><td>Nov</td><td>18.278</td><td>6.547</td></tr><tr><td>Dec</td><td>22.633</td><td>9.517</td></tr><tr><td>Jan</td><td>30.119</td><td>16.111</td></tr><tr><td>Feb</td><td>39.352</td><td>20.914</td></tr><tr><td>Mar</td><td>36.166</td><td>19.209</td></tr><tr><td>Apr</td><td>31.073</td><td>16.623</td></tr><tr><td>May</td><td>21.173</td><td>11.528</td></tr><tr><td>Jun</td><td>14.859</td><td>8.316</td></tr><tr><td>Jul</td><td>11.874</td><td>6.764</td></tr><tr><td>Aug</td><td>10.805</td><td>6.217</td></tr><tr><td>Sep</td><td>11.964</td><td>5.610</td></tr></table></td><td rowspan="3">THU_EWR16 for TEC=C
(Baseflows, freshets/ floods)</td></tr>
<tr><td>High Flows</td><td>EWR freshets/ floods for the lower reaches of the Thukela River</td><td>Freshets/ floods required for the Thukela River. Additional to the freshets specified in the table, large annual floods of 450m^3/s for 6 day duration in Dec, Jan and Feb are also required.</td><td><table><tr><td></td><td>Freshet (m^3/s)</td><td>Days</td><td>Flood (m^3/s)</td><td>days</td></tr><tr><td>Sep</td><td>60</td><td>5</td><td></td><td></td></tr><tr><td>Oct</td><td>60</td><td>5</td><td></td><td></td></tr><tr><td>Nov</td><td>60</td><td>5</td><td>250</td><td>8</td></tr><tr><td>Dec</td><td>60</td><td>5</td><td>120</td><td>5</td></tr><tr><td>Jan</td><td>60</td><td>5</td><td>250</td><td>8</td></tr><tr><td>Feb</td><td>60</td><td>5</td><td>250</td><td>8</td></tr><tr><td>Mar</td><td>60</td><td>5</td><td>250</td><td>8</td></tr><tr><td>Apr</td><td>60</td><td>5</td><td></td><td></td></tr></table></td></tr>
<tr><td>Quality</td><td>Salts</td><td>Salinity concentrations must be maintained to sustain aquatic ecosystem health and user requirements and ensure the prescribed ecological category is met.</td><td>Total Dissolved Solids</td><td>≤350 mg/L (95th percentile)</td><td>Maintenance of a C ecological category.

No monitoring data.

.</td></tr>
<tr><td rowspan="2">Habitat</td><td>Instream</td><td>Natural flow pattern must be maintained and/or improved to a TEC of C Ecological Category.</td><td>IHI and IHAS</td><td>Instream and Riparian Habitat Integrity to be maintained and/or improved in a Class C Ecological Category (60 - 79%)

IHAS to be adequate habitat availability (55 - 65%)</td><td rowspan="2"></td></tr>
<tr><td>Riparian habitat</td><td>The riparian vegetation must be improved and/or</td><td>VEGRAI</td><td>VEGRAI survey every 5 years.</td></tr>
</table>

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.		VEGRAI C Ecological Category (60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained and/or improved to a TEC of a C ecological category.	FRAI *Anguilla mossambica* (AMOS) *Labeobarbus natalensis* (BNAT) *Barbus (Enteromius) trimaculatus* (BTRI) *Clarias gariepinus* (CGAR) *Labeo molybdinus* (LMOL) *Labeo rubromaculatus* (LRUB)	Ensure all flow habitat classes are present for the following species: BNAT, BTRI and juvenile CGAR – 2 of the 3 vegetation/ cover representatives. 2of the following *Anguilla mossambica* (AMOS), *Labeo molybdinus* (LMOL) *and Labeo rubromaculatus* (LRUB) as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	Must maintain the seasonal recommended flow regime to ensure flow depth classes, flow velocity and water quality to achieve a C class (60 – 79%) No previous surveys conducted in this RU, however to achieve a MIRAI Class of a C, the SASS 5 scores and ASPT values provided must be achieved. Poor water quality and seasonal flow regimes needs to be managed to ensure indicator biota presence
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C/D ecological category.	SASS5 (not measured within this RU but to be achieved) MIRAI Baetidae >2 spp Heptageniidae Perlidae Oligoneuridae Tricorythidae Prosopistomatidae Elmidae Hydropsychidae 2spp	At least 2 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: ≥120 ASPT score: ≥4.8 MIRAI EC: C (60 - 79%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

6.1.14 IUA 14: Escarpment

Table 45: Resource Units delineated for IUA 14: Escarpment

RU	Delineation	Catchment
14.1	Upper reaches of Thukela River	V11A
14.2	Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River)	V11B
14.4	Upper reaches of Little Thukela River	V13A
14.5	Upper reaches of Boesmans River	V70A
14.7	Upper reaches of Mooi River	V20A

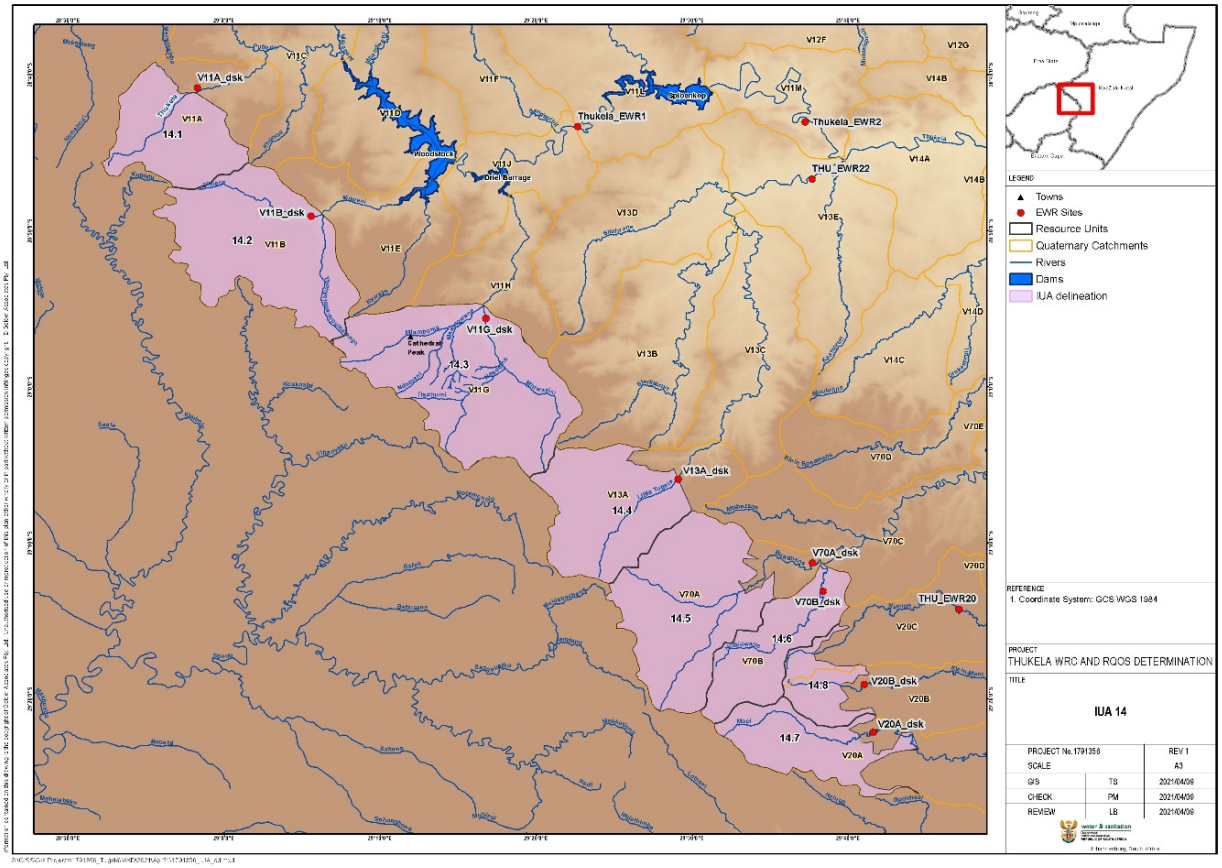

Figure 20: IUA 14 – Escarpment River Resource Units

Table 46: IUA 14: Escarpment River RUs description

IUA 14 – Escarpment
Resource Unit 14.1: Upper reaches of Thukela River **V11A**
Main stem; SWSA; Royal Natal National Park; tourism; PES: B
Resource Unit 14.2: Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River) **V11B**

IUA 14 – Escarpment
SWSA; Rivers are in PES: B; tourism.
Resource Unit 14.4: Upper reaches of Little Thukela River **V13A**
SWSA; Giants Castle Game Reserve; tourism; PES: C
Resource Unit 14.5: Upper reaches of Boesmans River **V70A**
SWSA; Giants Castle Game Reserve; PES: A/B
Resource Unit 14.7: Upper reaches of Mooi River **V20A**
Main stem; SWSA; Ukhahlamba Drakensberg World Heritage Site; tourism; PES: C category

The river biota habitat in the IUA is sensitive due to the steep slopes (high erodibility) and impacts from alien invasive vegetation. In the areas just east of the Biosphere Reserve, the impacts of settlements in the valleys show negative impacts which include over grazing, trampling of stream banks, some alien invasive vegetation and pollution related to organic inflows (siltation and algal growth). Another threat to the sensitive biota (fish and water quality and flow sensitive macroinvertebrates) is the presence of exotic fish introduced as sport angling fish and include Rainbow Trout (*Oncorhynchus mykiss)*, Spotted Bass (*Micropterus punctulatus)* and Brown Trout (*Salmo trutta)*. These are ferocious predators that have a large impact on the indigenous fish and macroinvertebrate communities and their presence can result in localised extinctions of fish populations instreams.

As the area falls within a “Strategic Water Source Area”, it is important to ensure that the areas within this IUA are managed and/or protected, to ensure good water quality will flow to the lower reaches of the various rivers and outlet of this IUA. Limited abstraction occurs and can have negative impacts on the ecosystems, as the small mountain streams are sensitive to flow modification (loss of riparian vegetation and channel modifications).

Table 47: Draft RQOs for Escarpment Resource Units

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
14.1 Upper reaches of Thukela River **V11A**	Quantity	Low flows, freshets and floods	EWR maintenance low and drought flows: Little Thukela River in V13A NMAR = 82.32 x10⁶m³ TEC=B category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the upper Little Thukela River	Maintenance and drought flows required for the Little Thukela River. The natural flooding regime should be maintained as the upstream river is part of the SWSA		Maintenance Low flows (m³/s)	Drought Low flows (m³/s)	Thukela: V11A_dsk for TEC=B (Baseflows)
					Oct	0.345	0.109	
					Nov	0.451	0.144	
					Dec	0.574	0.159	
					Jan	0.786	0.239	
					Feb	1.076	0.321	
					Mar	1.013	0.302	
					Apr	0.901	0.272	
					May	0.719	0.221	
					Jun	0.565	0.180	
					Jul	0.426	0.141	
					Aug	0.345	0.119	
					Sep	0.33	0.116	
14.2 Thukela from source to confluence of Sithene and Thonyelana Rivers (Sithene River; Thonyelana-mpumalanga River) **V11B**	Quantity	Low flows, freshets and floods	EWR maintenance low and drought flows: Mnweni River in V11B NMAR = 142.69 x10⁶m³ TEC=B category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the Mnweni River	Maintenance and drought flows required for the Mnweni River. The natural flooding regime should be maintained as the upstream river is part of the SWSA		Maintenance Low flows (m³/s	Drought Low flows (m³/s)	Mnweni: V11B_dsk for TEC=B (Baseflows)
					Oct	0.736	0.233	
					Nov	0.962	0.307	
					Dec	1.224	0.340	
					Jan	1.676	0.511	
					Feb	2.294	0.685	
					Mar	2.162	0.643	
					Apr	1.922	0.580	
					May	1.534	0.472	
					Jun	1.206	0.384	
					Jul	0.908	0.301	
					Aug	0.737	0.254	
					Sep	0.703	0.247	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
14.3 Source to confluence of Mlambonja and Mhlwazini Rivers (Mlambonja River (upper); Mhlwazini River; Ndedema River; Ndumeni River; Thuthumi River) **V11G**	Quantity	Low flows, freshets and floods	EWR maintenance low and drought flows: Mlambonja River in V11G NMAR = 191.99 x10⁶m³ TEC=B category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the upper Mlambonja River	Maintenance and drought flows required for the Mlambonja River. The natural flooding regime should be maintained as the upstream river is part of the SWSA		Maintenance Low flows (m^3/s	Drought Low flows (m^3/s)	Mlambonja: V11G_dsk for TEC=B (Baseflows)
					Oct	0.944	0.316	
					Nov	1.287	0.313	
					Dec	1.684	0.319	
					Jan	2.260	0.687	
					Feb	3.052	0.911	
					Mar	2.928	0.87	
					Apr	2.625	0.789	
					May	2.043	0.628	
					Jun	1.541	0.492	
					Jul	1.134	0.378	
					Aug	0.926	0.321	
					Sep	0.890	0.313	
14.4 Upper reaches of Little Thukela River **V11B**	Quantity	Low flows, freshets and floods	EWR maintenance low and drought flows: Little Thukela River in V13A NMAR = 82.32 x10⁶m³ TEC=B category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the upper Little Thukela River	Maintenance and drought flows required for the Little Thukela River. The natural flooding regime should be maintained as the upstream river is part of the SWSA		Maintenance Low flows (m^3/s	Drought Low flows (m^3/s)	Little Thukela: V13A_dsk for TEC=B (Baseflows)
					Oct	0.323	0.119	
					Nov	0.449	0.115	
					Dec	0.628	0.115	
					Jan	0.910	0.318	
					Feb	1.288	0.442	
					Mar	1.240	0.423	
					Apr	1.048	0.363	
					May	0.705	0.252	
					Jun	0.487	0.183	
					Jul	0.361	0.142	
					Aug	0.301	0.123	
					Sep	0.299	0.123	
14.5 Upper reaches of Boesmans River	Quantity	Low flows, freshets and floods	EWR maintenance low and drought flows: Bushmans River in V70A	Maintenance and drought flows required for the Bushmans River. The natural flooding regime		Maintenance Low flows (m^3/s	Drought Low flows (m^3/s)	Bushmans: V70A_dsk for TEC=B (Baseflows)
					Oct	0.591	0.171	
					Nov	0.778	0.206	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
			NMAR = 113.46 x10^{6}m^3 TEC=B category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the upper Bushmans River	should be maintained as the upstream river is part of the SWSA	Dec	0.994	0.34	
					Jan	1.258	0.419	
					Feb	1.562	0.515	
					Mar	1.461	0.480	
					Apr	1.355	0.450	
					May	0.987	0.337	
					Jun	0.724	0.26	
					Jul	0.547	0.205	
					Aug	0.477	0.184	
					Sep	0.504	0.194	
14.6 Ncibidwana source to outlet of V70B **V70B**	Quantity	Low flows, freshets and floods	EWR maintenance low and drought flows: Ncibidwana River in V70B NMAR = 44.16 x10^{6}m^3 TEC=B category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the upper Ncibidwana River	Maintenance and drought flows required for the Ncibidwana River. The natural flooding regime should be maintained as the upstream river is part of the SWSA		Maintenance Low flows (m^3/s	Drought Low flows (m^3/s)	Ncibidwana: V70B_dsk for TEC=B (Baseflows)
					Oct	0.230	0.066	
					Nov	0.303	0.080	
					Dec	0.387	0.132	
					Jan	0.490	0.163	
					Feb	0.608	0.200	
					Mar	0.569	0.187	
					Apr	0.527	0.175	
					May	0.384	0.131	
					Jun	0.282	0.101	
					Jul	0.213	0.080	
					Aug	0.186	0.072	
					Sep	0.196	0.075	
14.7 Upper reaches of Mooi River **V20A**	Quantity	Low flows, freshets and floods	EWR maintenance low and drought flows: Mooi River in V20A NMAR = 42.90 x10^{6}m^3 TEC=B category The maintenance low flows and drought flows must be	Maintenance and drought flows required for the Mooi River. The natural flooding regime should be maintained as the upstream river is part of the SWSA		Maintenance Low flows (m^3/s	Drought Low flows (m^3/s)	Mooi: V20A_dsk for TEC=B (Baseflows)
					Oct	0.203	0.079	
					Nov	0.283	0.087	
					Dec	0.368	0.132	
					Jan	0.492	0.172	
					Feb	0.603	0.209	
					Mar	0.559	0.193	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure			Context of the RQO and/or Numerical limit
			attained to support the aquatic ecosystem of the upper Mooi River		Apr	0.48	0.168	
					May	0.298	0.109	
					Jun	0.196	0.077	
					Jul	0.157	0.064	
					Aug	0.149	0.062	
					Sep	0.169	0.068	
14.8 Upper reaches of Little Mooi River **V20B**	Quantity	Low flows, freshets and floods	EWR maintenance low and drought flows: Little Mooi River in V20B NMAR = 10.32 x$10^6$$m^3$ TEC=B/C category The maintenance low flows and drought flows must be attained to support the aquatic ecosystem of the upper Little Mooi River	Maintenance and drought flows required for the Little Mooi River. The natural flooding regime should be maintained as the upstream river is part of the SWSA		Maintenance Low flows (m^3/s	Drought Low flows (m^3/s)	Little Mooi: V20B_dsk for TEC=B/C (Baseflows)
					Oct	0.041	0.019	
					Nov	0.056	0.025	
					Dec	0.071	0.031	
					Jan	0.096	0.041	
					Feb	0.115	0.048	
					Mar	0.103	0.043	
					Apr	0.083	0.036	
					May	0.059	0.026	
					Jun	0.044	0.02	
					Jul	0.037	0.017	
					Aug	0.034	0.016	
					Sep	0.038	0.018	

7. WETLANDS RESOURCE QUALITY OBJECTIVES

Table 48 sets out the draft RQOs for the wetlands in the study area.

Table 48: Wetland Resource Quality Objectives: Wakkerstroom

<table>
<tr><th>IUA</th><th>Wetland/Site</th><th>Wetland Type (main system)</th><th>Desktop PES Category</th><th>Desktop IS Category</th><th>REC</th><th>Likely BAS</th><th>Component prioritised</th><th>RQO</th><th>Indicator</th><th>Numerical Criteria</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Wakkerstroom</td><td rowspan="3">Unchannelled valley bottom (Peatland)</td><td rowspan="3">B adjusted to C based on Ezemvelo KZN Report, 2012</td><td rowspan="3">Very High</td><td rowspan="3">B</td><td rowspan="3">C</td><td rowspan="2">Quantity</td><td><u>River RQO applies</u>

EWR maintenance low and drought flows:
Slang River at V3R003 in V31A
NMAR = 97.065 x10⁶m3
TEC=B category
The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.

A constant baseflow must be maintained that ensures that the system remains perennial and the peatland is permanently saturated.</td><td>Maintenance and drought flows - specifically required for wetlands upstream of the Zaaihoek Dam (V3R003).
Monitoring of flows at V3R003.</td><td>
<table>
<tr><th></th><th>Maintenance</th><th>Drought</th></tr>
<tr><td></td><td>Low flows (m^3/s) flows m^3/s)</td><td>Low flows (m^3/s) flows m^3/s)</td></tr>
<tr><td>Oct</td><td>0.221</td><td>0.007</td></tr>
<tr><td>Nov</td><td>0.418</td><td>0.081</td></tr>
<tr><td>Dec</td><td>0.610</td><td>0.075</td></tr>
<tr><td>Jan</td><td>0.83</td><td>0.180</td></tr>
<tr><td>Feb</td><td>1.069</td><td>0.231</td></tr>
<tr><td>Mar</td><td>0.812</td><td>0.176</td></tr>
<tr><td>Apr</td><td>0.576</td><td>0.127</td></tr>
<tr><td>May</td><td>0.319</td><td>0.004</td></tr>
<tr><td>Jun</td><td>0.185</td><td>0.039</td></tr>
<tr><td>Jul</td><td>0.142</td><td>0.036</td></tr>
<tr><td>Aug</td><td>0.121</td><td>0.032</td></tr>
<tr><td>Sep</td><td>0.137</td><td>0.035</td></tr>
</table>
</td></tr>
<tr><td>Maintain a minimum water level to ensure the peat remains saturated.</td><td>Water level.</td><td>Peat must remain fully saturated.</td></tr>
<tr><td>Quality</td><td><u>River RQO applies</u>

Nutrient levels should not</td><td>Ortho-phosphate as P</td><td>≤0.01 mg/L (50th percentile)</td></tr>
</table>

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
								deteriorate and should support aquatic ecosystem and sustain the present ecological state (PES B). Total Dissolved Solids needs to be maintained to support aquatic ecosystem and sustain the present ecological state (PES B). The presence of pathogens should not pose a risk to human health.	Total Inorganic Nitrogen (TIN) Total Dissolved Solids *Escherichia coli*	≤0.5 mg/L (50th percentile) ≤120 mg/L (95th percentile) ≤130 Colony forming counts per 100 mL
							Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is	PES score above 70%

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
									available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	
								Peat depth and humification should be constant over time.	Peat depth and humification – determine using an appropriate sampling and analysis method at selected points in the wetland to determine depth and humification of the peat. Determine baseline and repeat every 5 years.	Less than 10% reduction in peat profile depth and quality/humification from the baseline measurements at each sampling site.
							Biota	Overall diversity and populations of aquatic/wetland dependent bird species must be maintained.	SABAP 2 reporting rates for aquatic/wetland dependent Red Data bird species: • White-Winged Flufftail • Grey Crowned Crane • African Marsh Harrier • African Grass Owl • Blue Crane • Maccoa Duck • Greater Flamingo • Lesser Flamingo • Half-Collared Kingfisher • Greater Painted Snipe Verify from monitoring records and recorded sightings from available avifaunal reporting data. Report on this every year.	Over the next 5 years the reporting rate for each species must not decline from the SABAP2 reporting rates (as at 15 April 2021): • White-Winged Flufftail (~0.3%) • Grey Crowned Crane (~59.6%) • African Marsh Harrier (~49.1%) • African Grass Owl (~0.5%) • Blue Crane (~12.2%) • Maccoa Duck (~1.6%) • Greater Flamingo (~1.1%) • Lesser Flamingo (~0.3%) • Half-Collared Kingfisher (~4.5%) • Greater Painted Snipe (~0.1%)

Table 49: Wetland Resource Quality Objectives: Groenvlei

<table>
<tr><th>IUA</th><th>Wetland/Site</th><th>Wetland Type (main system)</th><th>Desktop PES Category</th><th>Desktop IS Category</th><th>REC</th><th>Likely BAS</th><th>Component prioritised</th><th>RQO</th><th>Indicator</th><th>Numerical Criteria</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Groenvlei</td><td rowspan="2">Channelled valley bottom and Floodplain</td><td rowspan="2">C</td><td rowspan="2">High</td><td rowspan="2">B/C</td><td rowspan="2">C</td><td>Quantity</td><td>The relationship between the extent, depth and frequency of flooding to rainfall in the catchment must be maintained.</td><td>Floods are necessary to inundate the floodplain thereby providing the wetting regime and sediment required for supporting the floodplain morphology and ecosystem, including vegetation.

Measure water level at selected points in the floodplain to monitor frequency, depth and extent of flooding. Establish/determine a historical relationship between rainfall and flooding extent by using suitable remote imagery coinciding with larger rainfall events. Compare the ratio of rainfall to flooding going forward against the historical relationship.

Repeat annually.</td><td>The relationship between the extent, depth and frequency of flooding to rainfall in the catchment must not on average indicate a negative trend (reduction in flooding extent in relation to rainfall events).</td></tr>
<tr><td></td><td><u>River RQO applies</u>

EWR maintenance low and drought flows:
Slang River at V3R003 in V31A
NMAR = 97.065 x10⁶m3
TEC=B category

The maintenance low flows and drought flows must be</td><td>Maintenance and drought flows - specifically required for wetlands upstream of the Zaaihoek Dam (V3R003). Monitoring of flows at V3R003.</td><td>
<table>
<tr><th></th><th>Maintenance</th><th>Drought</th></tr>
<tr><td></td><td>Low flows (m^3/s) flows m^3/s)</td><td>Low flows (m^3/s) flows m^3/s)</td></tr>
<tr><td>Oct</td><td>0.221</td><td>0.007</td></tr>
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<tr><td>Mar</td><td>0.812</td><td>0.176</td></tr>
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<tr><td>Aug</td><td>0.121</td><td>0.032</td></tr>
<tr><td>Sep</td><td>0.137</td><td>0.035</td></tr>
</table>
</td></tr>
</table>

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
								attained to support the upstream aquatic ecosystem.		
							Quality	River RQO applies Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the present ecological state (PES B). Total Dissolved Solids needs to be maintained to support aquatic ecosystem and sustain the present ecological state (PES B). The presence of pathogens should not pose a risk to human health.	Ortho-phosphate as P Total Inorganic Nitrogen (TIN) Total Dissolved Solids *Escherichia coli*	≤0.01 mg/L (50th percentile) ≤0.5 mg/L (50th percentile) ≤120 mg/L (95th percentile) ≤130 Colony forming counts per 100 mL
							Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest	PES score above 70%

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
									available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	

Table 50: Wetland Resource Quality Objectives: Boschoffsvlei

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
3	Boschoffsvlei	Floodplain	B/C (adjusted down from B)	High	B	B/C	Quantity	The relationship between the extent, depth and frequency of flooding to rainfall in the catchment must be maintained.	Floods are necessary to inundate the floodplain thereby providing the wetting regime and sediment required for supporting the floodplain morphology and ecosystem, including vegetation. Measure water level at selected points in the floodplain to monitor frequency, depth and extent of flooding. Establish/determine a historical relationship between rainfall and flooding extent by using suitable remote imagery coinciding with larger rainfall events. Compare the ratio of rainfall to flooding going forward against the historical relationship. Repeat annually.	The relationship between the extent, depth and frequency of flooding to rainfall in the catchment must not on average indicate a negative trend (reduction in flooding extent in relation to rainfall events).

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
							Quality	River RQO applies Nutrient levels should not deteriorate and should support aquatic ecosystem and sustain the ecological state (B ecological category). Salinity levels must be maintained to support aquatic ecosystem and sustain the ecological state (B ecological category). The presence of pathogens should not pose a risk to human health.	Ortho-phosphate (PO_4^-) as Phosphorus Total Inorganic Nitrogen (TIN^-) as Nitrogen Total Dissolved Solids *Escherichia coli*	≤ 0.02 mg/L (50th percentile) ≤ 1.0 mg/L (50th percentile) ≤200 mg/L (95th percentile) ≤130 Colony forming counts per 100 mL (95th percentile)
							Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 75%

Table 51: Wetland Resource Quality Objectives: Boschoffsvlei Pan Complex

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
3	Boschoffsvlei pan complex	Depressions / Pans and Seeps	A & B	Very High	A	A & B	Quantity	The relationship between the extent, depth and frequency of inundation to local rainfall must be maintained.	Water quantity impacts must be managed so as not to undermine the ecological value of the pans. In particular, abstraction or artificial water inputs should be limited in the pans so that the depth and duration of inundation is maintained within the normal range for high, average and low rainfall years. Map the inundation extent at the end of the summer season (end of April) to establish/determine a relationship between antecedent summer rainfall (September to April) and inundation extent using suitable remote imagery. Compare the ratio of rainfall to inundation extent going forward. Repeat annually.	The relationship between the extent, depth and frequency of inundation to local rainfall must not on average indicate a negative trend (reduction in inundation extent in relation to antecedent summer rainfall [September to April]).
							Quality	Water quality impacts to the pan systems must be restricted to ensure that the water and sediment chemistry remain within an acceptable normal range (anion and cation concentration to pan volume relationship) for the particular water chemistry pan type applicable to each pan.	pH, Electrical Conductivity, TDS, Total Alkalinity as CaCO3, Sodium, Calcium, Magnesium, Sulphate, Iron, Chloride, Potassium, Magnesium, Manganese, Aluminium, Phosphorous, Silica, Fluoride Ammonia, Nitrate and Fluoride. Sample February every year and February and July every 3 years.	Maintain the water chemistry pan type applicable for each pan.
							Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within	PES score above 85% for each pan.

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
									the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	

Table 52: Wetland Resource Quality Objectives: Upper Blood River

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
5	Upper Blood River	Seeps, Channelled and Unchannelled valley bottoms	A & B	High	A & A/B	A & B	Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken of latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 90% for the northern cluster and above 80% for the southern cluster.

Table 53: Wetland Resource Quality Objectives: Blood River

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
5	Blood River	Unchannelled valley bottom and Floodplain	C	Very High	B	C	Quantity	Existing water inputs to the wetland from its catchment must be maintained, with no increase in direct abstraction from the wetland.	Extent of dams and Surface Flow Reduction (SFR) activities (e.g. irrigated cultivation, plantations, etc.).	No increase from current extent of dams and SFR activities within the catchment.
								The relationship between the extent, depth and frequency of flooding to rainfall in the catchment must be maintained.	Floods are necessary to inundate the floodplain thereby providing the wetting regime and sediment required for supporting the floodplain morphology and ecosystem, including vegetation. Measure water level at selected points in the floodplain to monitor frequency, depth and extent of flooding. Establish/determine a historical relationship between rainfall and flooding extent by using suitable remote imagery coinciding with larger rainfall events. Compare the ratio of rainfall to flooding going forward against the historical relationship. Repeat annually.	The relationship between the extent, depth and frequency of flooding to rainfall in the catchment must not on average indicate a negative trend (reduction in flooding extent in relation to rainfall events).
							Quality	<u>River RQO applies</u> Nutrient levels must be maintained to support aquatic ecosystem and sustain the present ecological state (B ecological category). Salinity concentrations must be maintained to support aquatic ecosystem and sustain the present	Ortho-phosphate (PO_4^-) as Phosphorus Total Inorganic Nitrogen (TIN-) as Nitrogen Total Dissolved Solids	≤0.02 mg/L (50th percentile) ≤1.0 mg/L (50th percentile) ≤200 mg/L (95th percentile)

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
								ecological state (B ecological category).		
							Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 70% north of R34 crossing and PES score above 55% south of R34 crossing.

Table 54: Wetland Resource Quality Objectives: Paddavlei

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
6	Paddavlei	Unchannelled and Channelled valley bottom	B adjusted to C based on Ezemvelo KZN Report, 2012	High	B/C	C	Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 70%

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
							Biota	Maintain a presence of Wattled Crane in the wetland.	Presence of Critically Endangered Wattled Crane.	Continued presence of Wattled Crane.

Table 55: Wetland Resource Quality Objectives: Boschberg

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
6	Boschberg	Floodplain	B/C (adjusted down from B)	High	B	B/C	Quantity	The relationship between the extent, depth and frequency of flooding to rainfall in the catchment must be maintained.	Floods are necessary to inundate the floodplain thereby providing the wetting regime and sediment required for supporting the floodplain morphology and ecosystem, including vegetation. Measure water level at selected points in the floodplain to monitor frequency, depth and extent of flooding. Establish/determine a historical relationship between rainfall and flooding extent by using suitable remote imagery coinciding with larger rainfall events. Compare the ratio of rainfall to flooding going forward against the historical relationship. Repeat annually.	The relationship between the extent, depth and frequency of flooding to rainfall in the catchment must not on average indicate a negative trend (reduction in flooding extent in relation to rainfall events).
								<u>River RQO applies</u> EWR maintenance low	Maintenance and drought flows required for the Sundays River.	<table><tr><td></td><td>Maintenance</td><td>Drought</td></tr><tr><td></td><td>Low flows (m^3/s) flows m^3/s)</td><td>Low flows (m^3/s) flows m^3/s)</td></tr><tr><td>Oct</td><td>0.180</td><td>0.120</td></tr></table>

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
								and drought flows: Sundays River at the EWR site Thukela_EWR7 (-28.458, 30.053) in V60C NMAR = 90.26 x10^{6}m^3 TEC=C/D category The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem.	Monitoring of flows at V6H004.	Nov 0.240 0.140 Dec 0.350 0.105 Jan 0.500 0.220 Feb 0.700 0.280 Mar 0.520 0.240 Apr 0.350 0.210 May 0.260 0.160 Jun 0.200 0.140 Jul 0.160 0.120 Aug 0.150 0.120 Sep 0.160 0.110
							Quality	<u>River RQO applies</u> Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state. Salinity concentrations must be maintained to support aquatic ecosystem and sustain the ecological state. The presence of pathogens should	Ortho-phosphate (PO_4^-) as Phosphorus Total Inorganic Nitrogen (TIN^-) as Nitrogen Total Dissolved Solids *Escherichia coli* pH range Turbidity	≤0.058 mg/L (50th percentile) ≤1.0 mg/L (50th percentile) ≤200 mg/L (95th percentile) ≤130 Colony forming counts per 100 mL 6.5 (5th percentile) and 9.0 (95th percentile) A 10% variation from background concentration. Limits must be determined.

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
								not pose a risk to human health. pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements. Baseline clarity must be maintained.		
							Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there	PES score above 75%

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
									have been any changes in the state of the system.	

Table 56: Wetland Resource Quality Objectives: Hlatikulu

<table>
<tr><th>IUA</th><th>Wetland/Site</th><th>Wetland Type (main system)</th><th>Desktop PES Category</th><th>Desktop IS Category</th><th>REC</th><th>Likely BAS</th><th>Component prioritised</th><th>RQO</th><th>Indicator</th><th>Numerical Criteria</th></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Hlatikulu</td><td rowspan="2">Channelled and Unchannelled valley bottom</td><td rowspan="2">C</td><td rowspan="2">Very High</td><td rowspan="2">B</td><td rowspan="2">C</td><td rowspan="2">Quantity</td><td>Existing water inputs to the wetland from its catchment must be maintained, with no increase in direct abstraction from the wetland.</td><td>Extent of dams and Surface Flow Reduction (SFR) activities (e.g. irrigated cultivation, plantations, etc.).</td><td>No increase from current extent of dams and SFR activities within the catchment.</td></tr>
<tr><td><u>River RQO applies</u>

EWR maintenance low and drought flows:
Nsonge River at the EWR site THU_EWR20 (-29.2377, 29.7853) in V20C
NMAR = 27.136 x10^{6}m^3
TEC=B/C category

The maintenance low flows and drought flows must be attained to support the</td><td>Maintenance and drought flows required for the Nsonge River.

Monitoring of flows at V2H007.</td><td>
<table>
<tr><th></th><th>Maintenance</th><th>Drought</th></tr>
<tr><th></th><th>Low flows (m^3/s) flows m^3/s)</th><th>Low flows (m^3/s) flows m^3/s)</th></tr>
<tr><td>Oct</td><td>0.109</td><td>0.063</td></tr>
<tr><td>Nov</td><td>0.148</td><td>0.082</td></tr>
<tr><td>Dec</td><td>0.188</td><td>0.102</td></tr>
<tr><td>Jan</td><td>0.253</td><td>0.134</td></tr>
<tr><td>Feb</td><td>0.302</td><td>0.159</td></tr>
<tr><td>Mar</td><td>0.271</td><td>0.143</td></tr>
<tr><td>Apr</td><td>0.219</td><td>0.118</td></tr>
<tr><td>May</td><td>0.155</td><td>0.086</td></tr>
<tr><td>Jun</td><td>0.115</td><td>0.066</td></tr>
<tr><td>Jul</td><td>0.097</td><td>0.057</td></tr>
<tr><td>Aug</td><td>0.090</td><td>0.054</td></tr>
<tr><td>Sep</td><td>0.101</td><td>0.060</td></tr>
</table>
</td></tr>
</table>

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
								upstream aquatic ecosystem.		
							Quality	<u>River RQO applies</u> Nutrient levels must be maintained to support aquatic ecosystem and good water quality condition. Salinity concentrations must be maintained to sustain good water quality state and ecological condition. pH must be maintained within the prescribed range. The presence of pathogens should not pose a risk to human health. The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Ortho-phosphate (PO4-) as Phosphorus Total Inorganic Nitrogen (TIN-) as Nitrogen Total Dissolved Solids pH Escherichia coli Ammonia as N Atrazine Mancozeb Glyphosate	≤0.01 mg/L (50th percentile) ≤0.5 mg/L (50th percentile) ≤120 mg/L (95th percentile) 6.5 (5th percentile) and 9.0 (95th percentile) ≤130 Colony forming counts per 100 mL ≤ 0.0725 milligrams/litre (mg/l) (95th percentile) ≤0.078 milligrams/litre (mg/l) ≤0.009 milligrams/litre (mg/l) ≤0.7 milligrams/litre (mg/l)

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
							Habitat	Maintain or improve current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 65%
							Biota	Overall diversity and populations of aquatic/wetland dependent bird species must be maintained.	SABAP 2 reporting rates for aquatic/wetland dependent Red Data bird species: • Wattled Crane • Grey Crowned Crane • African Marsh Harrier • African Grass Owl • Blue Crane • Half-Collared Kingfisher	Over the next 5 years the reporting rate for each species must not decline from the SABAP2 reporting rates (as at 15 April 2021): • Wattled Crane (~19.6%) • Grey Crowned Crane (~43.5%) • African Marsh Harrier (~15.2%) • African Grass Owl (~2.2%) • Blue Crane (~21.7%) • Half-Collared Kingfisher (~13.0%).

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
									Verify from monitoring records and recorded sightings from available avifaunal reporting data. Report on this every year.	

Table 57: Wetland Resource Quality Objectives: Stillerust

<table>
<tr><th>IUA</th><th>Wetland/Site</th><th>Wetland Type (main system)</th><th>Desktop PES Category</th><th>Desktop IS Category</th><th>REC</th><th>Likely BAS</th><th>Component prioritised</th><th>RQO</th><th>Indicator</th><th>Numerical Criteria</th></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Stillerust</td><td rowspan="2">Channelled valley bottom and Floodplain</td><td rowspan="2">A</td><td rowspan="2">Very High</td><td rowspan="2">A</td><td rowspan="2">A</td><td>Quantity</td><td><u>River RQO applies</u>

EWR maintenance low and drought flows: Mooi River upstream of Spring Grove Dam in V20D
NMAR = 92.98 x10⁶m³
TEC=C category

The maintenance low flows and drought flows must be attained to support the upstream aquatic ecosystem of the Mooi River.</td><td>Maintenance and drought flows required for the Mooi River.

Monitoring of flows at V2H005.</td><td>
<table>
<tr><td></td><td>Maintenance</td><td>Drought</td></tr>
<tr><td></td><td>Low flows (m³/s) flows m³/s)</td><td>Low flows (m³/s) flows m³/s)</td></tr>
<tr><td>Oct</td><td>0.265</td><td>0.227</td></tr>
<tr><td>Nov</td><td>0.361</td><td>0.188</td></tr>
<tr><td>Dec</td><td>0.461</td><td>0.329</td></tr>
<tr><td>Jan</td><td>0.609</td><td>0.496</td></tr>
<tr><td>Feb</td><td>0.743</td><td>0.602</td></tr>
<tr><td>Mar</td><td>0.689</td><td>0.558</td></tr>
<tr><td>Apr</td><td>0.595</td><td>0.486</td></tr>
<tr><td>May</td><td>0.378</td><td>0.315</td></tr>
<tr><td>Jun</td><td>0.258</td><td>0.216</td></tr>
<tr><td>Jul</td><td>0.211</td><td>0.14</td></tr>
<tr><td>Aug</td><td>0.201</td><td>0.134</td></tr>
<tr><td>Sep</td><td>0.225</td><td>0.173</td></tr>
</table>
</td></tr>
<tr><td>Quality</td><td><u>River RQO applies</u>

Nutrient levels must be maintained to</td><td>Ortho-phosphate (PO4-) as Phosphorus
Total Inorganic Nitrogen (TIN-) as Nitrogen</td><td>≤0.01 mg/L (50th percentile)
≤0.5 mg/L (50th percentile)</td></tr>
</table>

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
								support aquatic ecosystem and good water quality condition Salinity concentrations must be maintained to sustain good water quality state and ecological condition The presence of pathogens should not pose a risk to human health The concentrations of toxicants must pose no risk to aquatic organisms and to human health.	Total Dissolved Solids Escherichia coli Ammonia as N Atrazine Mancozeb Glyphosate	≤120 mg/L (95th percentile) ≤130 Colony forming counts per 100 mL ≤ 0.0725 milligrams/litre (mg/l) (95th percentile) ≤0.078 milligrams/litre (mg/l) ≤0.009 milligrams/litre (mg/l) ≤0.7 milligrams/litre (mg/l)
							Habitat	Maintain the current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest	PES score above 90%

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
									available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	
							Biota	Overall diversity and populations of aquatic/wetland dependent bird species must be maintained.	SABAP 2 reporting rates for aquatic/wetland dependent Red Data bird species: • Wattled Crane • Grey Crowned Crane • African Marsh Harrier • Blue Crane Verify from monitoring records and recorded sightings from available avifaunal reporting data. Report on this every year.	Over the next 5 years the reporting rate for each species must not decline from the SABAP2 reporting rates (as at 15 April 2021): • Wattled Crane (~27.6%) • Grey Crowned Crane (~37.9%) • African Marsh Harrier (~6.9%) • Blue Crane (~3.4%).
								The continued presence of at least 1 breeding pair of Wattled Cranes must be maintained.	The continued presence of breeding Wattled Cranes. Wattled Crane monitoring, including breeding success monitoring.	At least 1 breeding pair of Wattled cranes.

Table 58: Wetland Resource Quality Objectives: Melmoth

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
8	Melmoth	Channelled valley bottom	A	Very High	A	A	Habitat	Maintain the current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 90%
							Biota	Overall diversity and populations of aquatic/wetland dependent bird species must be maintained.	SABAP 2 reporting rates for aquatic/wetland dependent Red Data bird species: • Wattled Crane • Grey Crowned Crane • African Marsh Harrier • Blue Crane Verify from monitoring records and recorded sightings from available avifaunal reporting data. Report on this every year.	Over the next 5 years the reporting rate for each species must not decline from the SABAP2 reporting rates (as at 15 April 2021): • Wattled Crane (~21.1%) • Grey Crowned Crane (~28.9%) • African Marsh Harrier (~7.9%) • Blue Crane (~34.2%).

Table 59: Wetland Resource Quality Objectives: Dartmoor

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
8	Dartmoor	Unchannelled and Channelled valley bottom	A	Very High	A	A	Habitat	Maintain the current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 90%
							Biota	Overall diversity and populations of aquatic/wetland dependent bird species must be maintained.	SABAP 2 reporting rates for aquatic/wetland dependent Red Data bird species: • Wattled Crane • Grey Crowned Crane • African Marsh Harrier • Blue Crane Verify from monitoring records and recorded sightings from available avifaunal reporting data. Report on this every year.	Over the next 5 years the reporting rate for each species must not decline from the SABAP2 reporting rates (as at 15 April 2021): • Wattled Crane (~21.1%) • Grey Crowned Crane (~28.9%) • African Marsh Harrier (~7.9%) • Blue Crane (~34.2%).

Table 60: Wetland Resource Quality Objectives: Scawby

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
8	Scawby	Channelled and Unchannelled valley bottom	B/C	Very High	A/B	B/C	Quantity	Existing water inputs to the wetland from its catchment must be maintained, with no increase in direct abstraction from the wetland.	Extent of dams and Surface Flow Reduction (SFR) activities (e.g. irrigated cultivation, plantations, etc.)	No increase from current extent of dams and SFR activities within the catchment.
							Habitat	Maintain the current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 75%
							Biota	Overall diversity and populations of aquatic/wetland dependent bird species must be maintained.	SABAP 2 reporting rates for aquatic/wetland dependent Red Data bird species: • Wattled Crane • Grey Crowned Crane • African Marsh Harrier • Blue Crane Verify from monitoring records and recorded sightings from available avifaunal reporting data. Report on this every year.	Over the next 5 years the reporting rate for each species must not decline from the SABAP2 reporting rates (as at 15 April 2021): • Wattled Crane (~21.1%) • Grey Crowned Crane (~28.9%) • African Marsh Harrier (~7.9%)

										• Blue Crane (~34.2%).

Table 61: Wetland Resource Quality Objectives: Ntbamhlope

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
9	Ntabamhlope	Floodplain, Channelled and Unchannelled valley bottom	C (Ezemvelo KZN 2012)	Very High	B	C	Quantity	Existing water inputs to the wetland from its catchment must be maintained, with no increase in direct abstraction from the wetland.	Extent of dams and Surface Flow Reduction (SFR) activities (e.g. irrigated cultivation, plantations, etc.).	No increase from current extent of dams and SFR activities within the catchment.
							Quality	<u>River RQO applies</u> Nutrient levels must be maintained to the support aquatic ecosystem and sustain the ecological state. Improvement in levels is required. Salinity concentrations must be maintained to support aquatic ecosystem and sustain the ecological state. The presence of pathogens should not pose a risk to human health. pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	Ortho-phosphate (PO4-) as Phosphorus Total Inorganic Nitrogen (TIN-) as Nitrogen Total Dissolved Solids Escherichia coli pH range	≤0.058 mg/L (50th percentile) ≤2.0 mg/L (50th percentile) ≤300 mg/L (95th percentile) ≤130 Colony forming counts per 100 mL 6.5 (5th percentile) and 9.0 (95th percentile)

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
							Habitat	Maintain the current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 70%

Table 62: Wetland Resource Quality Objectives: Highmoor

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
14	Highmoor	Channelled and Unchannelled valley bottom	A & C	High	A & B/C	A & B/C	Habitat	Maintain or improve the current PES category.	PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	PES score above 90% for southern cluster and PES score above 75% for northern cluster.

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
							Biota	Overall diversity and populations of aquatic/wetland dependent bird species must be maintained.	SABAP 2 reporting rates for aquatic/wetland dependent Red Data bird species: • Wattled Crane • Grey Crowned Crane • African Marsh Harrier • Blue Crane Verify from monitoring records and recorded sightings from available avifaunal reporting data. Report on this every year.	Over the next 5 years the reporting rate for each species must not decline from the SABAP2 reporting rates (as at 15 April 2021): • Wattled Crane (~17.9%) • Grey Crowned Crane (~10.7%) • African Marsh Harrier (~3.69%) • Blue Crane (~10.7%).

Table 63: Wetland Resource Quality Objectives: Drakensburg

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
14	Natal Drakensberg Park	Seeps, Channelled and Unchannelled valley bottom	To be determined.	To be determined.	To be determined.	To be determined.	Habitat	Maintain the current PES category.	Desktop PES Category – Compile a wetland inventory for the Ramsar site through desktop identification and mapping of wetlands. Select a representative sample of wetlands to undertake PES assessments and monitoring. PES Category - As a minimum undertake a WET-Health Level 1a PES assessment (as per the method described by Macfarlane *et al*., 2020). For the PES assessment the latest available National or Provincial Land Cover datasets should be utilised for the wetland catchment, while detailed manual digitising of land cover within the wetland should be undertaken off latest available	Maintain current PES for selected representative wetlands. PES to be determined.

IUA	Wetland/Site	Wetland Type (main system)	Desktop PES Category	Desktop IS Category	REC	Likely BAS	Component prioritised	RQO	Indicator	Numerical Criteria
									aerial imagery and supplemented through field verification by an experienced wetland specialist. Repeat as soon as new National or Provincial land cover data is available but at least every 5 years if possible and report on this with a view to assess if there have been any changes in the state of the system.	

8. GROUNDWATER RESOURCE QUALITY OBJECTIVES

A summary of the groundwater resource quality objectives is listed in Table 64. Groundwater resources occur over most of the Thukela Catchment and represents an "insignificant" (Borehole Yield Classification (BYC) ≤0.05 L/s) to "minor" (BYC = 0.5 to 2 L/s), with a few areas where the BYC is regarded as "moderate" (BYC = 2 to 5 L/s) and "significant" (BYC ≥ 5 L/s). Therefore, all the integrated units of assessment are included in this assessment. As mentioned above, where specific "Hotspots" are present, they are highlighted in Table 64.

Specific aspects to be noted in terms of the groundwater Resource Quality Objectives are as follow:

- Groundwater use in the catchment is a concern. Stress Factor values for all quaternary catchments are based on outdated/ incomplete water use datasets and, therefore, the "**Level of Confidence**" for the SI indexes in this RQO assessment is regarded as "moderate", i.e., <75%.
- Aquifer saturation levels: a management option is to allow water levels to drop during dry periods, but never allow water level to reach the main water strike as this could impact on economical and construction maintenance of abstraction boreholes. Therefore, a numerical limit of ~1 m/a during drier seasons is proposed as a protection/management protocol for boreholes where annual abstractions are greater than 25% of annual recharge (i.e., SI percentages >25%).
- If the water levels do not recover (viz., rebound due to rainfall recharge) to long-term average levels after a wet period, production borehole abstraction rates should be lowered (as a start by 25%. As long as water levels recover after wet period(s) the system is considered sustainable (DWS, 2009), however, aquifer balances should be administered.
- In the case of stressed areas, viz., Hotspots, short-term (at least quarterly) water level trends should be used to identify individual boreholes to be managed accordingly.
- The Thukela Catchment is known for several small-scale springs which could be regarded as "sole water supplies" for domestic and stock watering in the rural areas. These springs are classified as "hot" or "cold" discharge systems mainly driven by groundwater and therefore need to be protected to sustain long-term discharge. It is, therefore, required that a limit be placed on the drilling of abstraction boreholes within a radius of 1 km from the spring – same limit counts for possible pollution sources in the catchment area of a spring. This limit is to secure that drawdown cones of nearby production boreholes do not interfere with the discharge areas of the spring – specific spring catchment boundary zones should be mapped.
- The Thukela wetland study data/information should be used to identify groundwater driven wetlands in the Thukela Catchment. A method to address the groundwater impacts on wetlands is included in the 2009 Reserve Determination Study and should be used for setting specific quantity and quality based RQOs.
- The geothermal gradient for groundwater; that is, the rate of increase in temperature with depth, is about or 1o C per 30 m depth (Van Tonder, 2003), although there are exceptions to this rule. The capture area for a cold-water spring can be determined by

standard methods. A minimum distance for any potentially harmful activities (boreholes, possible pollution sources) must be allocated outside the minimum distance.

Table 64: Summary of the Groundwater RQOs per Resource Unit

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA1: Upper Buffalo River	**GRU-1**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be ~51% (2021 SI plus 50%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 34%** Only 50% of 2021 Gwater allocation allowed = ~33Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly "rest" water level depth in "metre below collar level". Water table conditions at main wetland site (Wakkerstroom Wetland).	Annual water level depletion should not drop to 5 m above the "main water strike" depth in wellfield production boreholes. Wetlands: annual water level depths at control monitoring sites in main wetland area should not drop >0.5 m.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS in QC V31B and should be regarded as local "Hotspot" areas. Wetlands: Controlled groundwater abstraction (Schedule 1 use only) only allowed inside the buffer zone of the Wakkerstroom Wetland (in middle-lower Thaka River valley).
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤ 450mgTDS/L pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Ca/Mg/**Na**-**HCO_3** Long-term TDS trend should not approach +10%(∴~500 mg/L).
				Macro element concentrations: Sodium; TAL; Chloride; and Sulphate.	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <65 mgNa/L. Long-term trend should not approach +10% (∴72 mg/L) TAL: dominant anion hydrochemical constituent – should remain <300 mgHCO_3/L. Chloride: <90 mgCl/L. Long-term trend should not approach+10% (∴100 mg/l). Sulphate: <180 mgSO_4/L. Long-term trend should not approach+10% (∴200mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria, however, due to specific geological formations, the background Na-Cl concentrations could breach this limit and is therefore a characteristic of the groundwater quality in specific areas (a natural phenomenon).
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈8 mbgl) - Water level recession rate must be less than 0.5 m/a. If negative trend is observed, abstraction yield (L/s) should be decreased by 25%. Dedicated Gwater monitoring programme required for main Wakkerstroom Wetland.	Water level trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5-yr cycle) increases should not approach +50%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	
IUA2. Ngagane River	**GRU-2**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be ~45% (2021 SI plus 55%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 29%** Only 55% of 2021 Gwater allocation allowed = ~39Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤ 450mgTDS/L. Note: Hotspots with TDS ~2 400 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Ca/**Na**-**HCO_3** Long-term TDS trend should not approach +10% (∴~500 mg/L).
				Macro element concentrations: Sodium; Total Alkalinity; Chloride; and Sulphate.	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <65 mgNa/L. Long-term trend should not approach +10% (∴72 mg/L) TAL: dominant anion hydrochemical constituent – should remain <300 mgHCO_3/L. Chloride: <100 mgCl/L. Long-term trend should not approach+10% (∴110 mg/l). Sulphate: <200 mgSO_4/L. Long-term trend should not approach+10% (∴220mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria, however, due to specific geological formations, the background Na-Cl concentrations could breach this limit and is therefore a characteristic of the groundwater quality in specific areas.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈8 mbgl) - Water level in wellfield area(s) should remain +5 m above the main water strike (MWS). Note: Scattered areas where water level is <1 m above MWS If negative trend is observed, abstraction yield (L/s) should be decreased by 25%.	Trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5-yr cycle) increases should not approach +50%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation. In **mining/industrial/high level agricultural zones**, the following 3-Tier water quality criteria should apply: T1–Site area of activities, allow up to 95th Percentile driven by impact: pH: 3.0 to 11.0 NO_3–N: 40 mg/l; Salinity TDS: 3 400 mg/L; Sodium: 1 000 mg/L Chloride: 1 200 mg/l; Sulphates: 1 000 mg/l; and Fluoride: 3.5 mg/l. T2–Buffer Area: Allow up to 75th Percentile supported by buffer area background signatures: pH: 5.0 to 9.5; NO_3–N: 10 mg/l; Salinity TDS: 1 000 mg/L; Sodium: 200 mg/L Chloride: 200 mg/l; Sulphates: 400 mg/l; and Fluoride: 1.0 mg/l. T3–Background or Reference Area: Allow up to MEDIAN - value +10% in key CoCs as indicated above (Quality).
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA3: Middle Buffalo River	**GRU-3**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be ~47% (2021 SI plus 50%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 31%** Only 50% of 2021 Gwater allocation allowed = ~37Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Aquifers: Annual water level depletion should not drop to 5 m above the "main water strike" depth. Wetlands: Annual water level depths at control monitoring sites in main wetland area should not drop >0.5 m.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m and ~3 m above MWS in the northern ½ and southern ½ respectively. Wetlands; Boshoffsvlei Wetland and Pans could be partially groundwater driven systems – controlled groundwater abstraction (Schedule 1 use only) only allowed inside the buffer zone of the wetland's buffer zone.
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤ 900mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: **Na**-HCO_3/SO_4. Long-term TDS trend should not approach +10%(∴~1 000 mg/L).
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <58 mgNa/L. Long-term trend should not approach +10% (∴64 mg/L) TAL: dominant anion hydrochemical constituent – should remain <100 mgHCO_3/L. Chloride: <90 mgCl/L. Long-term trend should not approach+10% (∴100 mg/l). Sulphate: <180 mgSO_4/L. Long-term trend should not approach+10% (∴200mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria, however, due to specific geological formations, the background Na-Cl concentrations could breach this limit and is therefore a characteristic of the groundwater quality in specific areas. Sulphate concentrations are indicators of mining/industrial pollution and should be regarded as critical water quality indicators.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈13 mbgl) - Water level recession rate must be less than 1.0 m/a. Note: Scattered areas where water level is <1 m and ~3 m above MWS in the northern ½ and southern ½ respectively. If negative trend is observed, abstraction yield (L/s) should be decreased by 25%.	Trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5-yr cycle) increases should not approach +10%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation. In **mining/industrial/high level agricultural zones**, the following 3-Tier water quality criteria should apply: T1–Site area of activities, allow up to 95th Percentile driven by impact: pH: 3.0 to 11.0; NO_3–N: 40 mg/l; Salinity TDS: 3 400 mg/L; Sodium: 1 000 mg/L Chloride: 1 200 mg/l; Sulphates: 1 000 mg/l; and Fluoride: 3.5 mg/l. T2–Buffer Area: Allow up to 75th Percentile supported by buffer area background signatures: pH: 5.0 to 9.5; NO_3–N: 10 mg/l; Salinity TDS: 1 000 mg/L; Sodium: 200 mg/L Chloride: 200 mg/l; Sulphates: 400 mg/l; and Fluoride: 1.0 mg/l. T3–Background or Reference Area: Allow up to MEDIAN -value +10% in key CoCs as indicated above (Quality).
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA4: Lower Buffalo	**GRU-4**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be ~55% (2021 SI plus 25%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 44%** Only 25% of 2021 Gwater allocation allowed = ~8Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS (main water strike) specifically in QC V32A and should be regarded as a "Hotspot" site.
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤ 600mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Ca/Na–HCO_3/Cl Long-term TDS trend should not approach +10%(∴~660 mg/L).
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <63 mgNa/L. Long-term trend should not approach +10% (∴70 mg/L) TAL: dominant anion hydrochemical constituent – should remain <300 mgHCO_3/L. Chloride: <90 mgCl/L. Long-term trend should not approach+10% (∴100 mg/l). Sulphate: <180 mgSO_4/L. Long-term trend should not approach+10% (∴200mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria, however, due to specific geological formations, the background Na-Cl concentrations could breach this limit and it therefore a characteristic of the groundwater quality in specific areas.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈8 mbgl) - Water level recession rate must be less than 1.0 m/a. Note: Scattered areas where water level is <1 m above MWS (main water strike) specifically in QC V32A and should be regarded as a "Hotspot" site. If negative trend is observed, abstraction yield (L/s) should be decreased by 25%.	Trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5-yr cycle) increases should not approach 45%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA5: Blood River	**GRU-5**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be ~38% (2021 SI plus 50%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 25%** Only 50% of 2021 Gwater allocation allowed = ~15Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth. Wetlands: Water level recession should be limited to 0.5 m in the surrounding wetlands buffer zone.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS (main water strike). Wetland: Limited Gwater driven – probably [partly] interflow from valley faces.
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤ 600mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Na–**HCO_3**/Cl Long-term TDS trend should not approach +10% (∴~660 mg/L).
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <60 mgNa/L. Long-term trend should not approach +10% (∴66 mg/L) TAL: dominant anion hydrochemical constituent – should remain <400 mgHCO_3/L. Chloride: <90 mgCl/L. Long-term trend should not approach+10% (∴100 mg/l). Sulphate: <180 mgSO_4/L. Long-term trend should not approach+10% (∴200mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria, however, due to specific geological formations, the background Na-Cl concentrations could breach this limit and it therefore a characteristic of the groundwater quality in specific areas.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈6 mbgl) - Water level recession rate must be less than 1.0 m/a. If negative trend is observed, abstraction yield (L/s) should be decreased by 25%.	Trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5-yr cycle) increases should not approach 45%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA6: Sundays River	**GRU-6**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 65% (2021 SI plus 50%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 43%** Only 50% of 2021 Gwater allocation allowed = ~27Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth. Wetlands: Water level recession should be limited to 0.5 m in the surrounding wetlands buffer zone.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS (main water strike), but slightly higher (~3 m above the MWS) in QC V60D. Wetlands: Paddavlei and Boschbergvlei not regarded as Gwater driven.
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤ 500 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Ca/Na–**HCO_3.** Long-term trend should not approach ~550 mgTDS/L. "Hotspots" present in V60F QC (>2 400 mgTDS/L).

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <58 mgNa/L. Long-term trend should not approach +10% (∴64 mg/L) TAL: dominant anion hydrochemical constituent – should remain <400 mgHCO_3/L. Chloride: <180 mgCl/L. Long-term trend should not approach+10% (∴200 mg/l). Sulphate: <360 mgSO_4/L. Long-term trend should not approach+10% (∴400mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria, however, due to specific geological formations, the background Na-Cl concentrations could breach this limit and it therefore a characteristic of the groundwater quality in specific areas. Sulphate concentrations are indicators of mining/industrial pollution and should be regarded as critical water quality indicators.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈10 mbgl) - Water level recession rate must be less than 1.0 m/a. If negative trend is observed, abstraction yield (L/s) should be decreased by 35%.	Trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5-yr cycle) increases should not approach 50% (limited datasets).	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation. In **mining/industrial/high level agricultural zones**, the following 3-Tier water quality criteria should apply: T1–Site area of activities, allow up to 95th Percentile driven by impact: pH: 3.0 to 11.0; NO_3–N: 40 mg/l; Salinity TDS: 3 400 mg/L; Sodium: 1 000 mg/L Chloride: 1 200 mg/l; Sulphates: 1 000 mg/l; and Fluoride: 3.5 mg/l.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
						T2–Buffer Area: Allow up to 75th Percentile supported by buffer area background signatures: pH: 5.0 to 9.5; NO_3–N: 10 mg/l; Salinity TDS: 1 000 mg/L; Sodium: 200 mg/L Chloride: 200 mg/l; Sulphates: 400 mg/l; and Fluoride: 1.0 mg/l. T3–Background or Reference Area: Allow up to MEDIAN -value +10% in key CoCs as indicated above (Quality).

UA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA7: Upper Mooi River	**GRU-7**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 45% (2021 SI plus 50%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 30%** Only 50% of 2021 Gwater allocation allowed = ~45Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth. Wetlands: Water level recession should be limited to 0.5 m in the surrounding wetlands buffer zone.	Use "depth to MWS" as borehole depth -6m. Note: Limited data available, request implementation of a Gwater monitoring programme. Wetlands: Hlatikulu (V20C) and Stillerus (V20A) wetlands not regarded as preliminary Gwater driven (viz., mainly seasonal interflows).
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤ 900 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Limited hydrochemical data. Long-term trend should not approach ~1 000 mgTDS/L.
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Note: Limited data to perform a hydrochemical assessment (apply Class 0 criteria as baseline) Sodium: <100 mgNa/L; TAL: <250 mgHCO_3/L; Chloride: <100 mgCl/L; and	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria.

UA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
					Sulphate: <200 mgSO_4/L.	
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈5 mbgl) - Water level recession rate must be less than 1.0 m/a. If negative trend remains, abstraction yield (L/s) should be decreased by 50%.	Water level trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5-yr cycle) increases should not approach 10%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA8: Middle/ Lower Mooi River	**GRU-8**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 45% (2021 SI plus 50%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 30%** Only 50% of 2021 Gwater allocation allowed = ~36Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Aquifers: Annual water level depletion should not drop to 5 m above the "main water strike" depth. Wetlands: Water level recession should be limited to 0.5 m in the surrounding wetlands buffer zone.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS. Wetlands: Melmoth, Scawby and Myamvubu (Dartmor) Vlei Systems (V20F) – wetlands not

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
						regarded as preliminary Gwater driven systems (viz., mainly seasonal interflows).
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L): and pH Value.	TDS (salinity): Concentration should be limit to ≤ 2 160 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Ca/Na–HCO_3/Cl/SO_4 Long-term trend should not approach ~2 400 mgTDS/L.
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <230 mgNa/L. Long-term trend should not approach +10% (∴250 mg/L) TAL: dominant anion hydrochemical constituent – should remain <370 mgHCO_3/L. Long-term trend should not approach 390 mgHCO_3/L. Chloride: <200 mgCl/L. Long-term trend should not approach+10% (∴220 mg/l). Sulphate: < 200mgSO_4/L. Long-term trend should not approach+10% (∴220 mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria, however, due to specific geological formations, the **background Na-Cl concentrations** could breach this limit and is therefore a characteristic of the groundwater quality in specific areas.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈9 mbgl) - Water level recession rate must be less than 1.0 m/a. If negative trend remains, abstraction yield (L/s) should be decreased by 25%.	Water level trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5-yr cycle) increases should not approach 5%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA9: Middle/ Lower Bushman's River	**GRU-9**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 59% (2021 SI plus 10%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 54%** Only 10% of 2021 Gwater allocation allowed = ~2.6Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth. Wetlands: Water level recession should be limited to 0.5 m in the surrounding wetlands buffer zone.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS. Wetlands: Ntabamhlope wetland not regarded as preliminary Gwater driven systems (viz., mainly seasonal interflows).
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Values.	TDS (salinity): Concentration should be limit to ≤1 000mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: No hydrochemical dataset available. Long-term trend should not approach ~1 100 mgTDS/L.
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <130 mgNa/L. Long-term trend should not approach +10% (∴145 mg/L) TAL: dominant anion hydrochemical constituent – should remain <310 mgHCO_3/L. Long-term trend should not approach 340 mgHCO_3/L. Chloride: <120 mgCl/L. Long-term trend should not approach+10% (∴130 mg/l). Sulphate: <56 mgSO_4/L. Long-term trend should not approach+10% (∴61 mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈6 mbgl) - Water level recession rate must be less than 1.0 m/a. If negative trend remains, abstraction yield (L/s) should be decreased by 25%.	Water level trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5yr cycle) increases should not approach 5%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA10: Upper Thukela River	**GRU-10**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 59% (2021 SI plus 27%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 47%** Only 27% of 2021 Gwater allocation allowed = ~22Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS in QCs V11M, V13E and V14A – these areas should be regarded as "Hotspot" sites.
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤900 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Ca/**Na**–**HCO_3**/Cl/SO_4 Long-term trend should not approach ~1 000 mgTDS/L.
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <180 mgNa/L. Long-term trend should not approach +10% (∴200 mg/L) TAL: dominant anion hydrochemical constituent – should remain	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria. Due to specific geological formations, the **background Na-Cl concentrations** could breach the Class 1 limit and is therefore a characteristic of the groundwater quality in specific areas.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
					<300 mgHCO_3/L. Long-term trend should not approach 330 mgHCO_3/L. Chloride: <180 mgCl/L. Long-term trend should not approach+10% (∴200 mg/l). Sulphate: <300 mgSO_4/L. Long-term trend should not approach+10% (∴330 mg/l).	Sulphate concentrations are indicators of mining/industrial pollution and should be regarded as critical water quality indicators.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈3 mbgl) - Water level recession rate must be less than 1.0 m/a. If negative trend remains, abstraction yield (L/s) should be decreased by 25%.	Water level trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5yr cycle) increases should not approach 10%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation. In **mining/industrial/high level agricultural zones**, the following 3-Tier water quality criteria should apply: T1–Site area of activities, allow up to 95th Percentile driven by impact: pH: 3.0 to 11.0; NO_3–N: 40 mg/l; Salinity TDS: 3 400 mg/L; Sodium: 1 000 mg/L Chloride: 1 200 mg/l; Sulphates: 1 000 mg/l; and Fluoride: 3.5 mg/l. T2–Buffer Area: Allow up to 75th Percentile supported by buffer area background signatures: pH: 5.0 to 9.5; NO_3–N: 10 mg/l; Salinity TDS: 1 000 mg/L; Sodium: 200 mg/L Chloride: 200 mg/l;
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
						Sulphates: 400 mg/l; and Fluoride: 1.0 mg/l. T3–Background or Reference Area: Allow up to MEDIAN -value +10% in key CoCs as indicated above (Quality).

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA11: Klip River	**GRU-11**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 45% (2021 SI plus 32%).	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 34%** Only 32% of 2021 Gwater allocation allowed = ~21Mm^3 in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth. Wetlands: Water level recession should be limited to 0.5 m in the surrounding wetlands buffer zone.	Use "depth to MWS" as borehole depth -6m. Wetlands: Unknown wetland along the Klip River: not regarded as preliminary Gwater driven systems (viz., mainly seasonal interflows from highlands area in the east).
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤1 000mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Ca/**Na**–**HCO_3**/Cl/SO_4 Long-term trend should not approach ~1 000 mgTDS/L.
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <53 mgNa/L. Long-term trend should not approach +10% (∴60 mg/L) TAL: dominant anion hydrochemical constituent – should remain <300 mgHCO_3/L. Long-term trend should not approach 330 mgHCO_3/L. Chloride: <180 mgCl/L. Long-term trend should not approach+10% (∴200 mg/l). Sulphate: <360 mgSO_4/L. Long-term trend should not approach+10% (∴400 mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria. Due to specific geological formations, the **background Na-Cl concentrations** could breach the Class 1 limit and is therefore a characteristic of the groundwater quality in specific areas. Sulphate concentrations are indicators of mining/industrial pollution and should be regarded as critical water quality indicators.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 10 mgNO_3-N/L; Fluoride: <1.0 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈5 mbgl) - Water level recession rate must be less than 1.0 m/a.	Water level trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5yr cycle) increases should not approach 10%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation. In **mining/industrial/high level agricultural zones**, the following 3-Tier water quality criteria should apply: T1–Site area of activities, allow up to 95th Percentile driven by impact: pH: 3.0 to 11.0; NO_3–N: 40 mg/l; Salinity TDS: 3 400 mg/L; Sodium: 1 000 mg/L Chloride: 1 200 mg/l; Sulphates: 1 000 mg/l; and Fluoride: 3.5 mg/l. T2–Buffer Area: Allow up to 75th Percentile supported by buffer area background signatures: pH: 5.0 to 9.5; NO_3–N: 10 mg/l; Salinity TDS: 1 000 mg/L; Sodium: 200 mg/L Chloride: 200 mg/l; Sulphates: 400 mg/l; and Fluoride: 1.0 mg/l. T3–Background or Reference Area: Allow up to MEDIAN -value +10% in key CoCs as indicated above (Quality).
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA12: Middle Tugela River	**GRU-12**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 65%. New water use allocations should be limited.	From SI=65% the aquifer system becomes vulnerable when prolonged drier climate occurs – therefore the water balance requires advanced management through updates on actual Gwater use figures. **Current SI = 72%** No new Gwater allocations should be allowed in future without detailed assessment of water use figures in the RU.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth.	Use "depth to MWS" as borehole depth -6m. Note: Scattered areas where water level is <1 m above MWS in QC V14E, V60H and V60J (Tugela Ferry) and should be regarded as "Hotspot" sites.
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤770 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Ca/**Na**–**HCO_3**/Cl/SO_4 Long-term trend should not approach 1 000 mgTDS/L.
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <73 mgNa/L. Long-term trend should not approach +10% (∴85 mg/L) TAL: dominant anion hydrochemical constituent – should remain <300 mgHCO_3/L. Long-term trend should not approach 330 mgHCO_3/L. Chloride: <180 mgCl/L. Long-term trend should not approach+10% (∴200 mg/l). Sulphate: <200 mgSO_4/L. Long-term trend should not approach+10% (∴220 mg/l).	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria. Due to specific geological formations, the **background Na-Cl concentrations** could breach the Class 1 limit and is therefore a characteristic of the groundwater quality in specific areas. Sulphate concentrations are indicators of mining/industrial pollution and should be regarded as critical water quality indicators.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml). Nitrate: Less than 9.0 mg/l. Long-term trend should not approach +10% (~10.0 mg/l). Fluoride: Less than 0.9 mg/L. Long-term trend should not approach +10% (∴~1.0 mg/l). Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈8 mbgl) - Water level recession rate must be less than 1.0 m/a.	Water level trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5yr cycle) increases should not approach 15%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA13: Lower Tugela River	**GRU-13**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 65%. New water use allocations should be limited.	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 97%** No new Gwater allocations should be allowed in future without detailed re-assessment of water use figures in the RU.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth.	Use "depth to MWS" as borehole depth -6m. Note: Several sites are present in this RU where water levels are <1 m above the MWS and should be regarded as "Hotspot" sites, i.e., QCs V40C, V40D, V50A, V50B and V50C.
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤900 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: : Ca//Mg/**N**a–**HCO_3.** Long-term trend should not approach ~1 000 mgTDS/L.
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Sodium: <83 mgNa/L. Long-term trend should not approach +10% (∴91 mg/L) TAL: dominant anion hydrochemical constituent – should remain <300 mgHCO_3/L. Long-term trend should not approach 330 mgHCO_3/L.	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 1 criteria. Due to specific geological formations, the **background Na-Cl concentrations** could breach the Class 1 limit and is therefore a characteristic of the groundwater quality in specific areas.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
					Chloride: <100 mgCl/L. Long-term trend should not approach+10% (∴110 mg/l). Sulphate: <100 mgSO_4/L. Long-term trend should not approach+10% (∴110 mg/l).	
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml). Nitrate: Less than 9.0 mg/l. Long-term trend should not approach +10% (~10.0 mg/l). Fluoride: Less than 0.9 mg/L. Long-term trend should not approach +10% (∴~1.0 mg/l). Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈8 mbgl) - Water level recession rate must be less than 1.0 m/a.	Water level trend should be stable over time (1x Hydrological Cycle); If trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5yr cycle) increases should not approach 10%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
IUA14: Escarpment	**GRU-14**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit to be 65%. Wetlands: Groundwater abstraction from all wetlands terrains should be limited to Schedule 1 water use category.	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. **Current SI = 95%** No new Gwater allocations should be allowed in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth. Wetlands: Water level recession should be limited to 0.5 m in the surrounding wetlands buffer zone.	Use "depth to MWS" as borehole depth -6m. Wetlands: Various isolated wetlands – not regarded as preliminary Gwater driven systems (viz., mainly seasonal interflows).

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit	Context
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤450 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Natural water quality: No dataset available. Long-term trend should not approach ~500 mgTDS/L.
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Note: No water quality dataset to perform a hydrochemical assessment (apply Class 0 criteria as baseline) Sodium: <100 mgNa/L; TAL: <250 mgHCO_3/L; Chloride: <100 mgCl/L; and Sulphate: <200 mgSO_4/L.	Pristine groundwater conditions should prevail in this RU – high recharge area of the local downstream areas in the Thukela WMA. COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 0 criteria.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 6.0 mgNO_3-N/L; Fluoride: <0.7 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈4 mbgl) - Water level recession rate must be less than 1.0 m/a.	Water level trend should be stable over time (1x Hydrological Cycle). Seasonal oscillations due to the run of wet/dry cycles could cause temporary rise/fall of the water table which could be several metres (±5 m). If the annual water level trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5yr cycle) increases should not approach 10%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation.
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit/	Context o/t RQO / Narrative
IUA15: Thukela Estuary and upstream Tugela	**GRU-15**	**Quantity**	Sustainable Use:	Annual calculation of Stress Index (Aquifer Unit Use divided by Aquifer Unit Recharge) expressed as a percentage.	Annual abstraction should not be larger than 65% of average annual recharge (i.e., SI of 0.65 as upper limit). ∴ Upper SI limit should <65%.	At 100% all recharge is abstracted from the aquifer system leaving no balance for periods with "below average" annual recharge. New water use allocations not allowed. **Current SI = 72%** No new Gwater allocations should be allowed in future.
			Aquifer water level (table) depth.	Quarterly water level depth in "metre below collar level".	Annual water level depletion should not drop to 5 m above the "main water strike" depth.	Use "depth to MWS" as borehole depth -6m.
		Quality	Constituents of Concern.	Monthly salinity measurements: (TDS), mg/L); and pH Value.	TDS (salinity): Concentration should be limit to ≤900 mgTDS/L. pH Value: >5.5 to <9.5 pH units.	Natural water quality signature: Natural water quality: No dataset available. Long-term trend should not approach ~1 000 mgTDS/L. Note: Expecting high industrial risks on local groundwater (probably with surface water interaction in the Mandini area).
				Macro element concentrations: Sodium: TAL: Chloride: Sulphate:	Quarterly analyses required and individual concentrations should be limit to a Class 1 (Good) water quality criteria: Note: No water quality dataset to perform a hydrochemical assessment (apply Class 0 criteria as baseline) Sodium: <100 mgNa/L♦; TAL: <250 mgHCO_3/L; Chloride: <100 mgCl/L♦; and Sulphate: <200 mgSO_4/L♦.	COCs has an impact of the Health and Aesthetic criteria of the water. The upper limit should be a Class 0 criteria. Expect to intercept saline groundwater towards the coastal terrains due to airborne sea salt deposits and subterranean seawater inflows where high groundwater abstraction takes place.
				Microbiological status (Total coliform counts) Nutrients Nitrate: NO_3, mgN/L; Toxin– Fluoride: F, mgF/L; Toxin– Arsenic: As, mgAs/L; and Diss. metals: Iron and Manganese (mgFe-Mn/L).	Total coliform counts: <10 counts/100 ml) Nitrate: Less than 6.0 mgNO_3-N/L; Fluoride: <0.7 mgF/L; Arsenic: <0.05 mgAs/L; Iron-Manganese: <0.2 mgFe/L and <0.4 mgMn/L.	Total coliform counts and nitrate/nitrite concentrations are indicators of domestic pollution and should be regarded as critical water quality indicators – annual trends are therefore required through specific monitoring programmes.

IUA	GMU	Sub-component	Resource Quality Objective	Indicator(s)	Measure/Numerical Limit/	Context o/t RQO / Narrative
		Protection Criteria	Aquifer water level trend	Annual positive or negative water level trend (time series dataset) – water level recession rate (M/a)	(Wl≈7 mbgl) - Water level recession rate must be less than 1.0 m/a.	Water level trend should be stable over time (1x Hydrological Cycle). If the annual water level trend remains negative (+1½-yrs) , a special investigation is required to identify and address the cause of the water level recession.
			Hydrochemical trends:	Time series trends of TDS obtained from quarterly water quality analyses.	Medium-term trend (5yr cycle) increases should not approach 10%.	Quality trend(s) should stay within natural annual oscillation (annual recharge freshening). Medium-term (18 to 24 months) negative trend must be investigated (source identification). The critical constituent for the area is nitrate due to industrial and domestic waste generation. Note: In **mining/industrial/**, the following 3-Tier water quality criteria should apply: T1–Site area of activities, allow up to 95th Percentile driven by impact: pH: 3.0 to 11.0; NO_3–N: 40 mg/l; Salinity TDS: 3 400 mg/L; Sodium: 1 000 mg/L Chloride: 1 200 mg/l; Sulphates: 1 000 mg/l; and Fluoride: 3.5 mg/l. T2–Buffer Area: Allow up to 75th Percentile supported by buffer area background signatures: pH: 5.0 to 9.5; NO_3–N: 10 mg/l; Salinity TDS: 1 000 mg/L; Sodium: 200 mg/L Chloride: 200 mg/l; Sulphates: 400 mg/l; and Fluoride: 1.0 mg/l. T3–Background or Reference Area: Allow up to MEDIAN -value +10% in key CoCs as indicated above (Quality).
				Time series trends of nutrients and toxic dissolved elements.	Nitrate: Long-term trend should not approach + 10% (∴>10 mgN/L). Fluoride; Long-term trend should not approach +10% (∴1.1 mg/l).	

9. ESTUARY RESOURCE QUALITY OBJECTIVES

9.1 IUA 15: Thukela Estuary

Table 65: Resource Units delineated for IUA 15: Thukela Estuary

RU	Delineation	Catchment
15.1	Thukela reach upstream Estuary to Mngeni transfer	V50D (upper portion)
15.2	Estuary (8.5 km upstream)	V50D

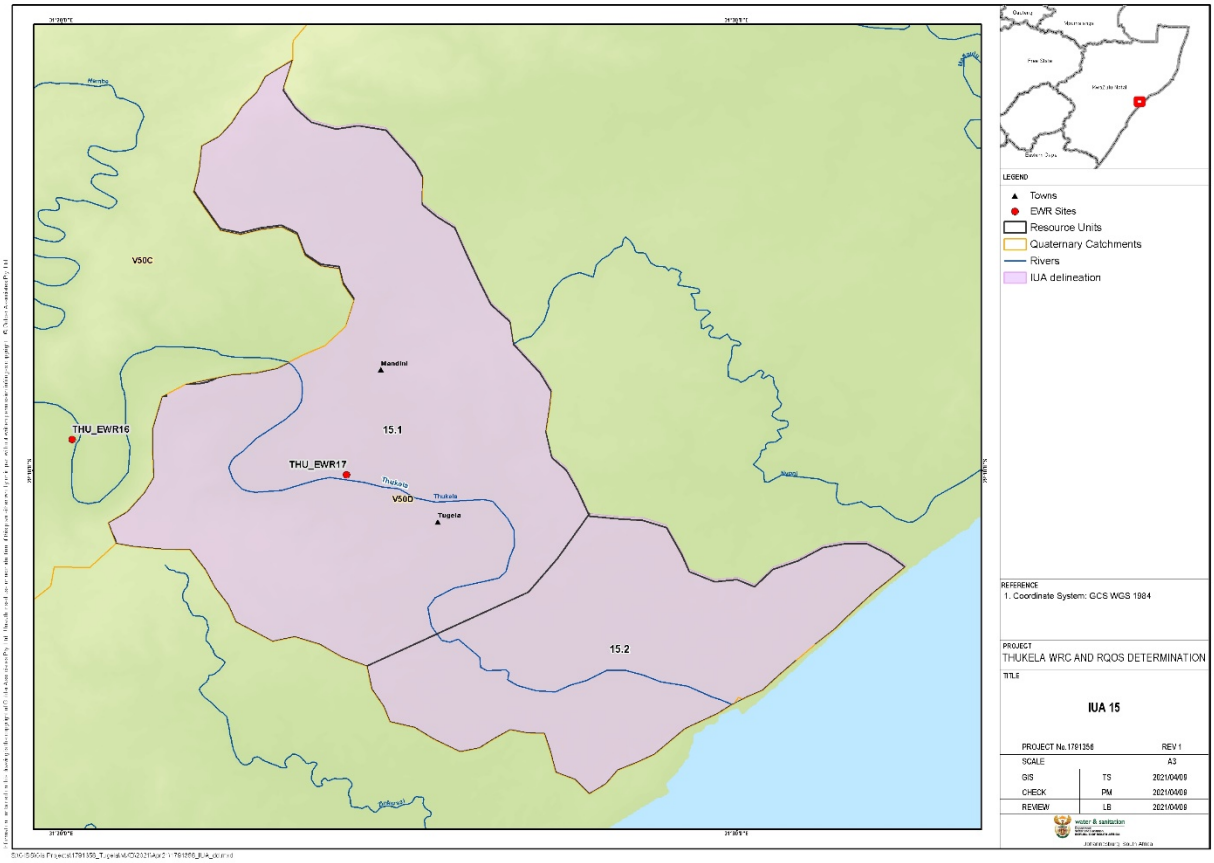

Figure 21: IUA 15 – Estuary Resource Units

Table 66: IUA 15: Thukela Estuary RUs description

IUA 15 –Thukela Estuary
Resource Unit 15.1: Thukela from Mandini Transfer (Mngeni) weir to upstream Estuary, including Mandini Stream
Main stem. Town of Mandeni – urban areas; PES: B; Mgeni transfer station; Industrial area; Sappi Mandeni Mill; tourism. *Note: this upper portion is still the Thukela River and not yet estuarine.*
Resource Unit 15.2: Estuary (8.5 km upstream)
Main stem. Protected Area; PES: C; Harold Johnson Nature Reserve; urban areas; tourism.

Table 67: Draft RQOs for IUA 15: Thukela Estuary Resource Unit

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
15.1 Thukela from Mandini Transfer (Mngeni) weir to upstream Estuary, including Mandini Stream **V50D (Upper Portions) (EWR 16)**	Quality	Nutrients	Nutrient levels must be maintained to the support estuarine ecosystem and sustain the ecological state	Ortho-phosphate (PO_4^-) as Phosphorus	≤0.1 mg/L (50th percentile) *Thukela River*	Maintenance of a C ecological category
					≤0.1 mg/L (50th percentile) *Mandini Stream*	
				Total Inorganic Nitrogen (TIN) as Nitrogen	≤2.0 mg/L (50th percentile)	Mandini stream – poor water quality: salinity and ammonia, phosphate levels are high.
		Salts	Salinity concentrations must be maintained to sustain estuarine ecosystem and ensure the prescribed ecological category is met.	Total Dissolved Solids	≤500 mg/L (95th percentile)	
				Chloride	≤175 mg/L (95th percentile) *Mandini Stream*	
				Sodium	≤115 mg/L (95th percentile) *Mandini Stream*	Stringent source control is required to improve the quality of the stream
		Pathogens	The presence of pathogens should not pose a risk to human health	*Escherichia coli*	≤130 Colony forming counts per 100 mL	User specification. Limit is the target water quality range for full contact recreational use – South African Water Quality Guidelines (1996).
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH	6.5 – 8.5	
			Water clarity to be maintained to support the estuarine ecosystem.	Turbidity	Turbidity should be < 20 NTU or >25cm	
			Temperature ranges must be maintained to support aquatic biota	Temperature	17°C (10th percentile) and 30°C (90th percentile) with <5% of measurements outside of this range within a given year	Water temperature, based on the January 1997 to October 2001 dataset (DWAF 2004) and subsequent Sappi reports, shows a very strong seasonal pattern with temperatures reaching a maximum of 30°C during summer and 17°C in winter
			Dissolved oxygen concentration must be maintained to support the aquatic and estuarine ecosystem	Dissolved oxygen	≥ 6mg/l	Ecological specification. Ecological Reserve manual (2008).

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
		Toxics	The concentrations of toxicants must not pose a risk to aquatic organisms and to human health	Ammonia as N	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	Ecological specification. Ecological Reserve manual (2008), South African Water Quality Guidelines (1996)
				Aluminium (Al)	≤ 0.105 milligrams/litre (mg/l) (95th percentile)	
				Manganese (Mn)	≤ 0.15 milligrams/litre (mg/l) (95th percentile)	
				Iron (Fe)	≤ 0.1 milligrams/litre (mg/l) (95th percentile)	
				Lead (Pb) hard	≤ 0.0095 milligrams/litre (mg/l) (95th percentile)	
				Copper (Cu) hard	≤ 0.0073 milligrams/litre (mg/l) (95th percentile)	
				Nickel (Ni)	≤ 0.07 milligrams/litre (mg/l) (95th percentile)	
				Cobalt (Co)	≤ 0.05 milligrams/litre (mg/l) (95th percentile)	
				Zinc (Zn)	≤ 0.002 milligrams/litre (mg/l) (95th percentile)	
	Habitat	Instream	Natural flow pattern must be improved and/or maintained at a TEC of C Ecological Category.	IHI and IHAS	Instream and Riparian Habitat Integrity to be improved and/or maintained in a Class C Ecological Category (60 - 79%) Riparian Habitat Integrity IHAS to be *adequate* habitat availability (55 - 65%)	
		Riparian habitat	The riparian vegetation must be improved and/or maintained at VEGRAI ≥ C Ecological Category. High erosion rate to be managed.	VEGRAI	VEGRAI survey every 5 years. VEGRAI C Ecological Category (60 - 79%)	
	Biota	Fish	Flow and water quality sensitive Fish species to be maintained	FRAI *Anguilla spp.*	Two distinct areas in this reach – the upper more freshwater dominated, the	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/or Numerical limit
			and/or improved to a TEC of a C ecological category.	*Glossogobius spp.* *Awaous aeneofuscus* (AAEN) *Barbus (Enteromius) trimaculatus (*BTRI) *Labeobarbus natalensis (*BNAT) *Labeo molybdinus* (LMOL) *Labeo rubromaculatus* (LRUB) *Oreochromis mossambicus (*OMOS)	lower more an estuarine habitat where marine spp. can be present. Ensure all flow habitat classes are present for the following species: *Glossogobius spp.,* BNAT, BTRI and juvenile OMOS – 3 of the 4 vegetation/ cover representatives. 2 of the following *Anguilla spp.* (elvers), mature BNAT, LMOL and LRUB as flow dependent and depth class representatives. FRAI EC: C (60 - 79%)	FRAI score (2019) was a Class C to D/E (39% to 70%). Seasonal flow regimes must be maintained, including flow depth classes, flow velocity and water quality - to achieve a TEC of a C class (60 – 75%) Previous studies (2008 – 2018)(Wade 2019) SASS 5 scores at sites EWR17 and EWR18 ranged from 89 – 105 and ASPT scores ranged from 5.5 – 6.3 (to achieve the TEC of a C). Poor water quality, silt and high turbidity providing poor habitat availability for fish and invertebrates, which needs to be improved
		Aquatic invertebrates	Flow and water quality sensitive macroinvertebrate assemblages to be maintained. Macroinvertebrate assemblages to be maintained for a TEC of a C ecological category.	SASS 5 MIRAI Perlidae Baetidae > 2 sp Heptageniidae Leptophlebiidae Oligoneuridae Prosopistomatidae Elmidae Hydropsychidae 2spp	3 biotopes sampled; assemblages to be A to B abundances; SASS 5 score: 100 - 120 ASPT score: 5.5 - 6.5 MIRAI EC: C (60 - 79%)	
		Diatoms	Ecological water quality should be improved to a *moderate quality*	Specific Pollution Sensitivity Index (SPI) Percentage pollution tolerant values (%PTV)	SPI: 12 - 14 PTV: 20 - < 40%	

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
15.2 Thukela Estuary (8.5 km upstream) **V50D**	Quantity	Low Flows	Flows must be met to maintain the open mouth of the estuary.	Base flows	Must exceed 5m³/s + LTBWSS abstraction (0.64 m³/s during Phase 1 and 1.27 m³/s during Phase 2) at Mandini Weir, V2H005	A flow measurement in the river will provide an indication if the required maintenance flows are being met. [NB. Must consider the abstraction from the Lower Thukela Bulk Water Supply Scheme.]
		High Flows (floods)	Floods are necessary to scour the estuary of accumulated sediments and organic matter, which are then transported to the coastal zone (Thukela Banks) and support crustacean and line fish fisheries.	Sediment composition (sediment particle size, organic content), Bathymetry	Maintain TEC: High flows within 8% of reference	Dams in the catchment had decreased flood peaks by an estimated 8% (DWAF 2004).
	Hydrodynamics	Mouth Condition	The mouth needs to be open to maintain river, estuary and KwaZulu-Natal Bight interlinkages	Mouth condition – Open	Water level within tidal range (Exceeds 2.5 m when closed)	Tidal variation could fall within 0.3 m (neap) and 1.5 m (spring) range, exposing intertidal sediments. When closed, water backfloods and level can exceed 2.5 m above MSL. [Note: tidal gauge V5T003 data – 1999 to 2018 – indicated tidal range of 0 – >1.7 m; no indication of closure.]
		Abiotic states	The longitudinal salinity profile to be maintained to protect the estuarine ecosystem	River discharge Longitudinal salinity profile	Open estuary, with flows exceeding 5 m^3/s, will have full salinity gradient; euhaline (>30) at mouth to oligohaline (0.5-5) up to 6 km upstream of mouth. Estuary becomes fully fresh at flow >30 m^3/s (low tide) and when mouth has closed for extended period (weeks to months).	Longitudinal (mouth to head of estuary) and vertical (surface to bottom waters) salinity gradients develop in the estuary as less dense fresh river water mixes with saline marine water. The intrusion of saline water into the estuary increases as tidal height increases, particularly during spring high tides, and as river flow decreases. Mixing occurs outside of the estuary mouth, in the coastal zone, during large flood events.
	Quality	Salinity	Instream salinity levels as specified must be maintained to	Salinity	Saline water (range <0.5 to 35 Practical Salinity Units or	The vertical and longitudinal salinity gradients provide a

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			protect the aquatic ecosystem health and ensure the prescribed ecological category is met.		conductivity of <1 to 53 mS/cm) within TEC category (C) may penetrate up to 6 km from the mouth at river flows close to 5 m^3/s.	broad range of habits from euhaline to oligohaline.
		Dissolved inorganic nitrogen	Instream concentration of nutrients as specified maintained to protect the aquatic ecosystem health and ensure the prescribed ecological category is met.	Total Oxidised Nitrogen (Nitrate + nitrite; TON) plus ammonium = Dissolved Inorganic Nitrogen (DIN)	TON can range from < 0.05 (marine) to 1.40 mg-N/L (fresh) along salinity gradients. NH_{4^+} < 0.05 mg-N/L throughout	Marine water at the mouth of the estuary is typically low in TON (< 0.05 mg-N/L) and elevated in inflowing river water (up to 1.4 mg-N/L have been measured), creating longitudinal and vertical gradients (inversely correlated to salinity).
		Dissolved inorganic phosphorus		Orthophosphate; Dissolved Inorganic Phosphorus (DIP)	DIP < 0.05 (marine) to 0.20 mg-P/L (fresh) along salinity gradients.)	Marine water at the mouth of the estuary is typically low in DIP (< 0.05 mg-N/L) and elevated in inflowing river water (up to 0.2 mg-P/L have been measured), creating longitudinal and vertical gradients (inversely correlated to salinity).
		Nutrients		DIN + DIP	TON < 0.05 (marine) to 1.40 mg-N/L (fresh) along salinity gradients. NH_{4^+} < 0.05 mg-N/L throughout. DIP can range from < 0.05 (marine) to 0.20 mg-P/L (fresh) along salinity gradients.	Cultural eutrophication is the result of abnormally high loads of dissolved inorganic nutrients (DIN + DIP) entering aquatic environments. This supports rapid growth of primary producers (microalgae and macrophytes), build-up of organic matter, and high demand for oxygen through bacterial decomposition of this organic matter.
		Water Clarity	The river and estuary are naturally turbid, so it is necessary to maintain the turbidity within a range that is suitable for the TEC. A moderate change from natural with temporary high sediment	Total Suspended Solids (TSS), Secchi depth, and/ or Turbidimeter		Turbidity in water is caused by colloidal suspension of fine particles such as clays, silt and organic material, usually introduced through river run-off. The resuspension

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
			loads and turbidity during runoff events.			of debris occurs during turbulent conditions, usually caused by strong wind, wave action and strong river flow. Colloidally suspended particles and humic substances coagulate at the interface between fresh and estuarine waters, causing the material to flocculate, precipitate and settle out of the water column. This interface is often referred to as the turbidity maximum zone.
		System variables	pH range must be maintained within limits specified to support the aquatic ecosystem and water user requirements.	pH	7.0 to 8.5 range, with <5% falling outside of this range during a given year.	
		Dissolved Oxygen	Estuary should be well-oxygenated throughout	Dissolved oxygen (mg/L)	Dissolved Oxygen > 4 mg/L.	Dissolved oxygen is an essential for most aquatic life. Anthropogenic sources that may influence dissolved oxygen concentration are those with high oxygen demand such as high organic content, biochemical oxygen demand or chemical oxygen demand. These include stormwater run-off, sewage discharge and certain industrial wastes. A frequently used threshold of hypoxia proposed in the literature is 4 mg-O_2/litre. Hypoxia can lead to biodiversity loss and affect surviving organisms through sublethal stresses. These include constrained growth and reproduction, physiologic stress, forced migration, loss of suitable habitat, increased

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
						vulnerability to predation, and disruption of life cycles.
		Toxic substances		Organic and inorganic constituents, and pathogens.	Toxic substances in water and sediments not to exceed target values as per SA Water Quality Guidelines and Western Indian Ocean Regional guidelines, respectively. Provided pH remains within 7.0-8.5 range within estuary, then ammonia should be present in its non-toxic, ionised form (NH_{4^+}).	Various water quality constituents can stimulate algal growth or affect biological health. These are classified into organic and inorganic constituents, and pathogens. Organic: Organotins, total petroleum hydrocarbons, algal toxins, tainting substances, polycyclic aromatics, halogenated aliphatics and ethers, monocyclic aromatics, nitrosamines, biocides, resin acids, and surfactants. Inorganic: ammonia, cyanide, fluoride, chlorine, hydrogen sulfide, arsenic, cadmium, chromium, copper, lead mercury, nickel, silver, tin, zinc, and other metals.
		Pathogens		*Escherichia coli*	Enterococci < 185 counts per 100 ml (90^{th} percentile) *Escherichia coli* < 500 counts per 100 ml (90^{th} percentile)	For recreational use in estuaries (based on DEA, 2012). Faecal *Streptococcus* can provide a more direct measure of human-sourced wastewater effluent.
	Physical Habitat	Intertidal habitat		Area of tidally exposed sediments (GIS mapping)	Tidal exchange present: Tidal range 0.3 m (neap) - 1.5 m (spring) above MSL. Intertidal area estimated at 20.55 ha.	Tidal variation creates an intertidal habitat that is suitable for colonisation or feeding by certain taxa. These can include intertidal benthic microalgae, macrophytes (no saltmarsh present in Thukela Estuary), macroinvertebrates, macrocrustacea, and birds.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Subtidal habitat		Area of permanently inundated sediments (GIS mapping)	Subtidal area estimated at 72.47 ha.	Permanently inundated, the water provides habitat for microalgae (phytoplankton and subtidal benthic microalgae), submerged macrophytes and macroalgae, zooplankton, macroinvertebrates, macrocrustacea, fish and birds.
		Substrate type	Sediment must be dominated by sand throughout the estuary except in deposition areas where silt/ mud can dominate.	Sediment particle size Ash-free dry weight Water content	Sediment dominated by sand (>90%) throughout the estuary except in deposition areas, within 0.5 km to 1.5 km of mouth, where fines (silt and clay) can exceed 80%; deposition of fines most likely during periods of low flow.	Sediment deposition along the Thukela River channel is greater than under natural conditions, a result of increased erosion and reduced flow competence to entrain sediment to the coast. Being a river-dominated system, the Thukela Estuary is dominated by coarse and medium sand, and acts as a conduit for sediment and organic material to the coastal zone. Fine sediments and organic matter are deposited during periods of low flows and scoured out during flood events.
	Biota	Microalgae	Low phytoplankton biomass must be maintained	Biomass using chlorophyll-*a* as an index. Community structure using phytoplankton groups and benthic diatoms.	Maintain low phytoplankton biomass (average chl a < 20 µg/ℓ or median chl a < 3.5 µg/ℓ) and diversity of phytoplankton groups (cyanobacteria present but not dominant) associated with TEC. Diatoms and flagellated phytoplankton dominate the mid to lower reaches of the estuary, euglenids, chlorophytes and cyanophytes (in low abundance) present in the fresh upper reaches.	Microalgae are an important C source for zooplankton and benthic invertebrates. Diversity and abundance typically highest in fresh upper reaches of estuary. Reduced flow and greater salinity intrusion increase microalgal biomass and diversity. Extended mouth closure likely to result in loss in diversity and phytoplankton biomass and increase in benthic microalgal biomass.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
					Maintain median subtidal and intertidal benthic chl-a < 42 mg/m^2.	Phytoplankton chl-a > 20 µg/L represents blooms and should not occur in this system.
		Macrophytes	Distribution of plant communities to be maintained in relevant proportions and alien species to be limited.	Community structure using botanical survey and mapping (including alien invasive species).	Maintain diversity of macrophyte habitats based on TEC. Approximately 40 ha of common reed (*Phragmites australis*), sedge (*Schoenoplectus scirpoides*) and swamp forest (*Barringtonia racemosa* and *Hibiscus tiliaceus*) present in 2001. An increase in reeds and sedge into the main channel, and the presence of water hyacinth (*Eicchornia crassipes*) and bulrush (*Typha* spp.) indicate fresher, more stable and nutrient-rich conditions. Mangroves are not present due to the estuary being a river-dominated system.	The distribution of plant communities is sensitive to changes in salinity and nutrient concentrations. Additional pressures include harvesting, grazing, loss of land within the estuarine functional zone and competition with invasive alien species.
		Invertebrates	Invertebrate community structure to be maintained.	Community structure. Macrobenthos: Eckman sediment grab sampling and sieving. Zooplankton: Night collection using Bongo nets. Macrocrustacea: Beam trawls and prawn traps.	Maintain present relatively low diversity and low abundance invertebrate community as per TEC) physico-chemical conditions, sediment composition and estuary morphology. Macrobenthos: State 3 will have species-rich community associated with saline intrusion. Mid to upper reaches dominated by polychaetes, and establishment of gastropods and bivalves. Switch to State 2 will see a peak in abundance, as upper and lower reaches are colonised.	Macrobenthos communities are influenced by salinity gradients, shelter from wave action, fluctuations in temperature and dissolved oxygen, nature of the substratum, and input of detritus. Estuaries support a variety of marine, estuarine and freshwater holo- and meroplanktonic zooplankton, dominance of which depends on estuarine characteristics (including abiotic states). Macrocrustacea use estuaries for shelter and

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
					During low flows, open mouth, fauna typically dominated by estuarine and marine spp.; polychaetes, amphipods, isopods, Tanaidacea, gastropods and bivalves. Zooplankton (estuarine): High diversity, low abundance during State 3 will switch to low diversity, high abundance during State 2. Macrocrustacea: Paneid post-larvae need access to estuary in spring, and *Varuna litterata* need to access marine environment in late Autumn. *Macrobrachium* requires salinity gradient (States 2 & 3) for larval development and is sensitive to sediment deposition and habitat shrinkage.	nursery grounds. River flow and water quality threaten this use and the link between fresh and marine environments. Mouth closure is biggest threat.
		Fish	Estuaries to be maintained as nursery areas for estuary-dependent fish, habitat for stenohaline marine and euryhaline freshwater fish, and conduits for Anguillid eel larvae.	Fish Recruitment Index (FRI) Community structure (seine net collection)	Maintain diversity and abundance that is consistent with TEC. 40 fish spp. from 20 families are present when a full salinity gradient is present. Six species dependent on estuary for breeding purposes, 25 marine spp. with a gradient of dependence on the estuary as a nursery habitat (very dependent to not at all). Only one freshwater species regularly recorded in the estuary. Six species are endemic to southern Africa. Anguillid eels make extensive use of the estuary when migrating between the marine environment and river catchment.	Mouth condition, river flow, food availability (e.g. detritus and invertebrates), and habitat diversity affect community structure.

Resource Unit	Component	Sub-component	RQO	Indicator	Numerical Limit/ measure	Context of the RQO and/ or Numerical limit
		Birds	Three major groups of estuarine dependent birds to be maintained; summer (incl. palaearctic migrants) and winter fauna that use the estuary for feeding, and birds that use the estuary to roost and mostly feed offshore.	Winter and summer bird counts	Maintain an avifaunal community that is consistent with TEC; representatives of all three groups. 64 bird spp. recorded from estuary. Three groups; summer (incl. Palaearctic migrants) winter that use the estuary for feeding, and species that roost in the estuary and feed offshore (dominated by gulls and terns). Average monthly average of species is 26, exceeding 4000 individuals during summer months (Nov-Mar). No endemic species have been recorded.	Changes in habitat, food availability and human disturbance affect community composition and species abundance.

8 CONCLUSIONS

The RQOs proposed in the above sections provide a set of objectives that are based on available data, information, previous studies, the Water Resource Classification component and inputs from external specialists and stakeholders.

These proposed RQOs and associated numerical limits have been taken through various stakeholder consultation processes and are based on guidance received and best available information sources at the time of development.

The Implementation Plan to follow will be developed around the inputs received and will aim to put forward a plan that will enable the Department of Water and Sanitation to work in collaboration with the various relevant Government Departments and external organisations in the Thukela catchment, to work towards the achievement of the RQOs, and fill gaps that may still exist.

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