water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

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

## PROJECT STEERING COMMITTEE MEETING 5

Presented by:
Golder Associates

Date: 28 April 2021

# Purpose of the meeting

To present progress related to:

- Draft Resource Quality Objectives and Numerical Limits
  - Rivers and Dams
  - Wetlands
  - Groundwater
  - Estuary

# Study Progress

| REPORT INDEX | REPORT NUMBER | REPORT TITLE |
|---|---|---|
| 1.0 | RDM/WMA04/00/CON/ CLA/0119 | Inception Report |
| 2.0 | RDM/WMA04/00/CON/ CLA/0120 | Water Resources Information and Gap Analysis Report |
| 3.0 | RDM/WMA04/00/CON/ CLA/0220 | Specialist Workshops Report |
| 4.0 | RDM/WMA04/00/CON/ CLA/0320 | Status Quo and Integrated Unit of Analysis and Resource Units Report |
| 5.0 | RDM/WMA04/00/CON/ CLA/0420 | Report on Linking the Socio-Economic and Ecological Value and Condition of the Water Resources |
| 6.0 | RDM/WMA04/00/CON/ CLA/0520 | Preliminary Resource Units Selection and Prioritisation Report |
| 7.0 | RDM/WMA04/00/CON/ CLA/0720 | Quantification of Ecological Water Requirements Report |
| 8.0 | RDM/WMA04/00/CON/ CLA/0620 | Sub-components prioritization and indicators selection Report |
| 9.0 | RDM/WMA04/00/CON/ CLA/0121 | Scenarios Evaluation and Proposed Water Resource Classes Report |
| **10.0** | **RDM/WMA04/00/CON /CLA/0221** | **Draft RQOs and Numerical Limits Report** |

Step 1: Delineate and prioritise RUs and select study sites

Step 2: Describe status quo and delineate the study area into Integrated Units of Analysis (IUAs)

Step 3: Quantify EWR

Step 4: Identify and model scenarios within IWRM

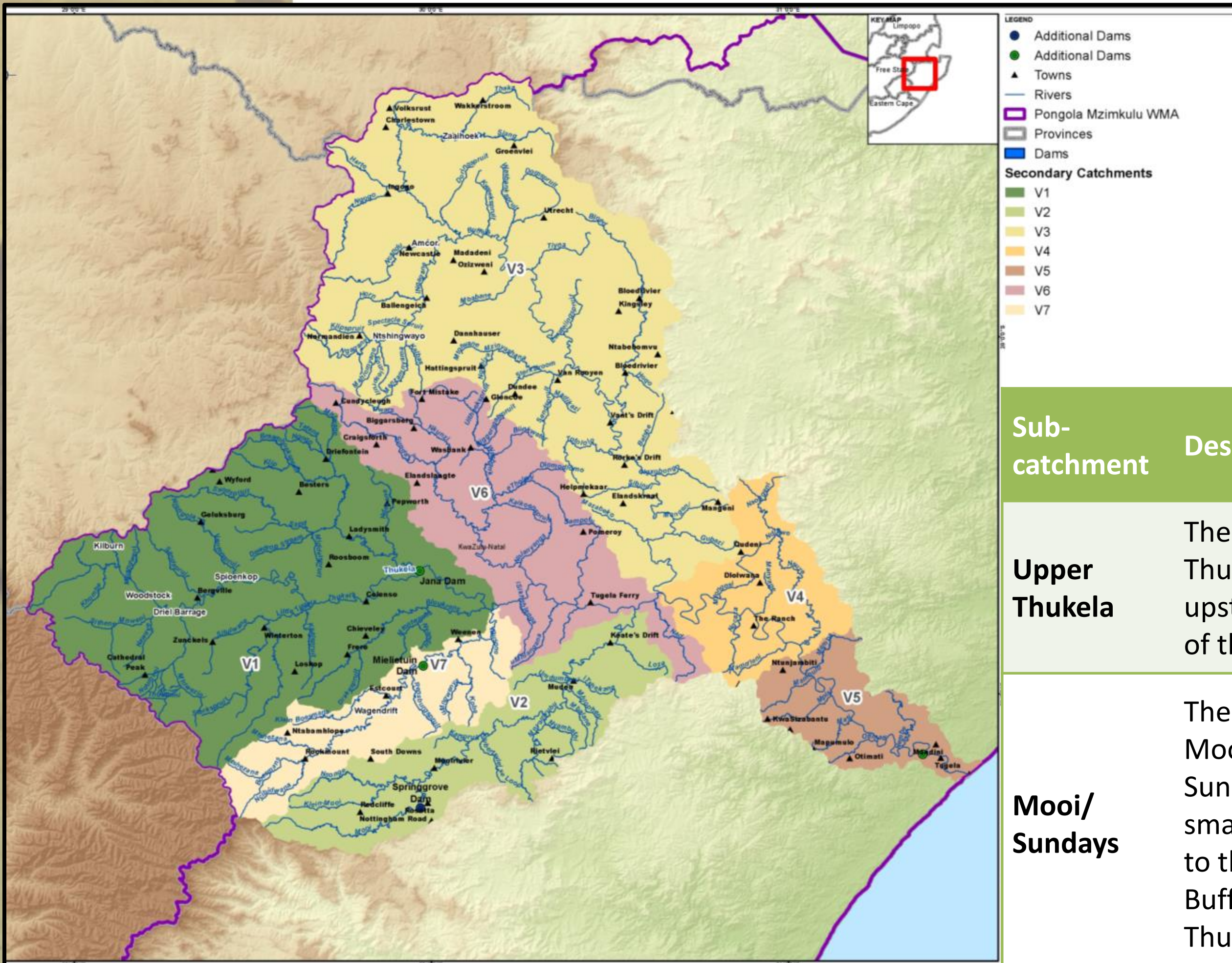
Step 5: Determine water resource class based on catchment configurations for identified scenarios

Step 6: Determine RQOs (narrative and numerical limits) and provide implementation information

Step 7: Finalise and prepare integrated gazette template

Step 8: Gazette the Reserve (not part of the project)

# Study Overview: Thukela catchments

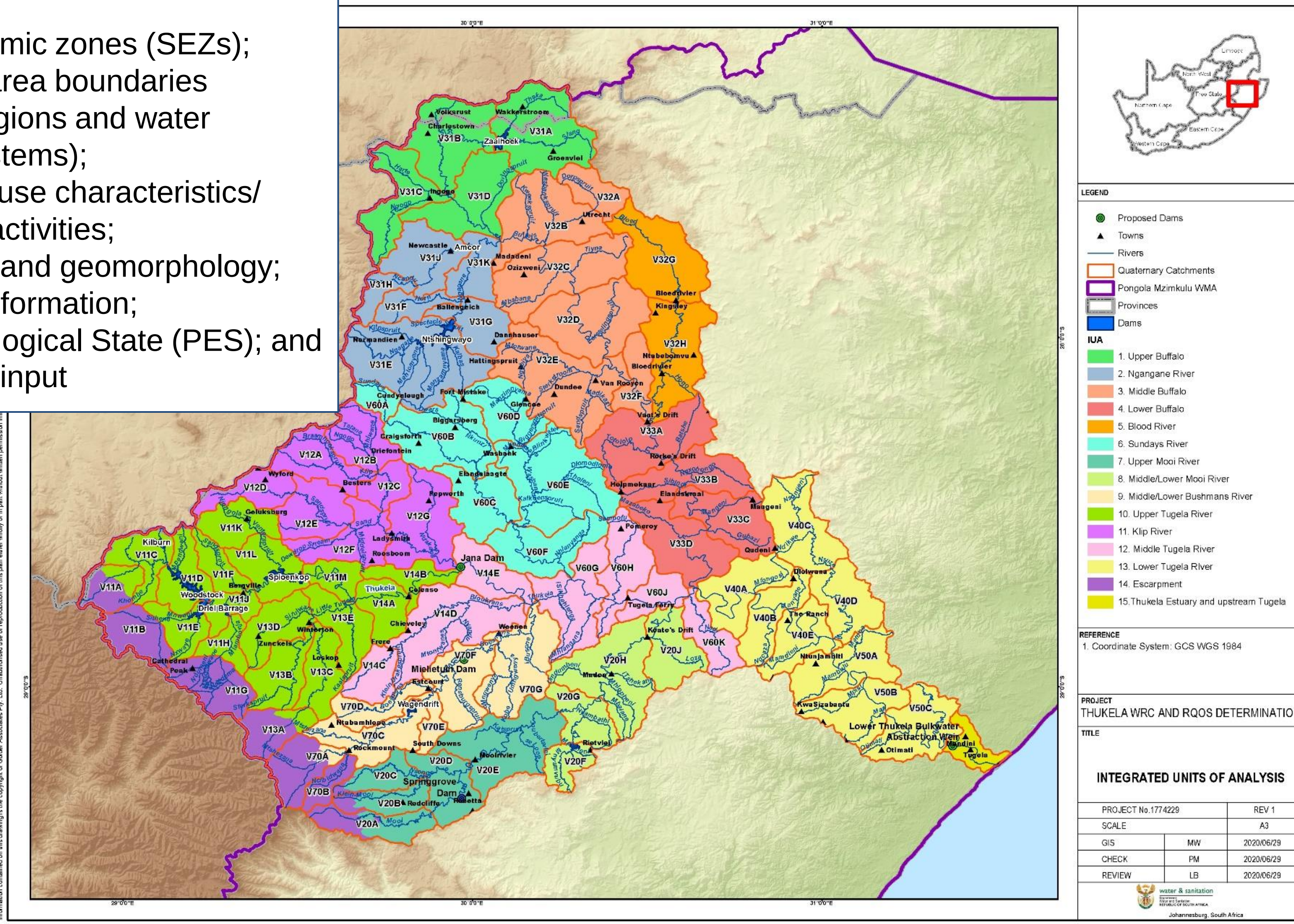



| Sub-catchment | Description | Tertiary drainage regions | Catchment area[1] ($km^2$) |
|---|---|---|---|
| **Upper Thukela** | The catchment of the Thukela River to just upstream of the confluence of the Bushmans River. | V11, V12, V13 and V14 | 7645 |
| **Mooi/ Sundays** | The catchment of the Mooi, 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 | 8496 |
| **Buffalo** | The catchment of the Buffalo River. | V31, V32 and V33 | 9803 |
| **Lower Thukela** | The catchment of the Thukela River between the confluence of the Buffalo River and the Indian ocean. | V40 and V50 | 3102 |

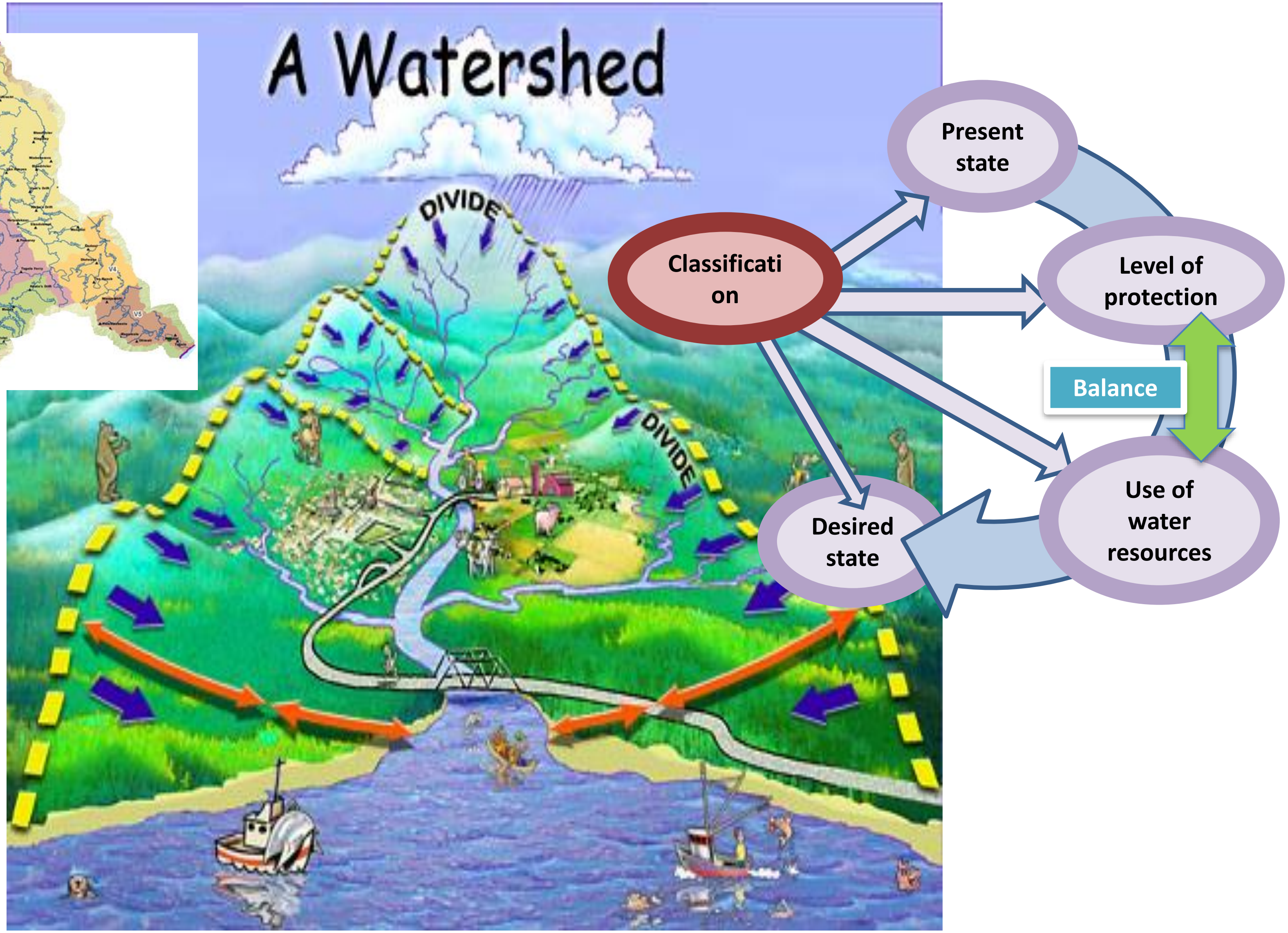
# Study Overview: Integrated Units of Analysis (IUA)

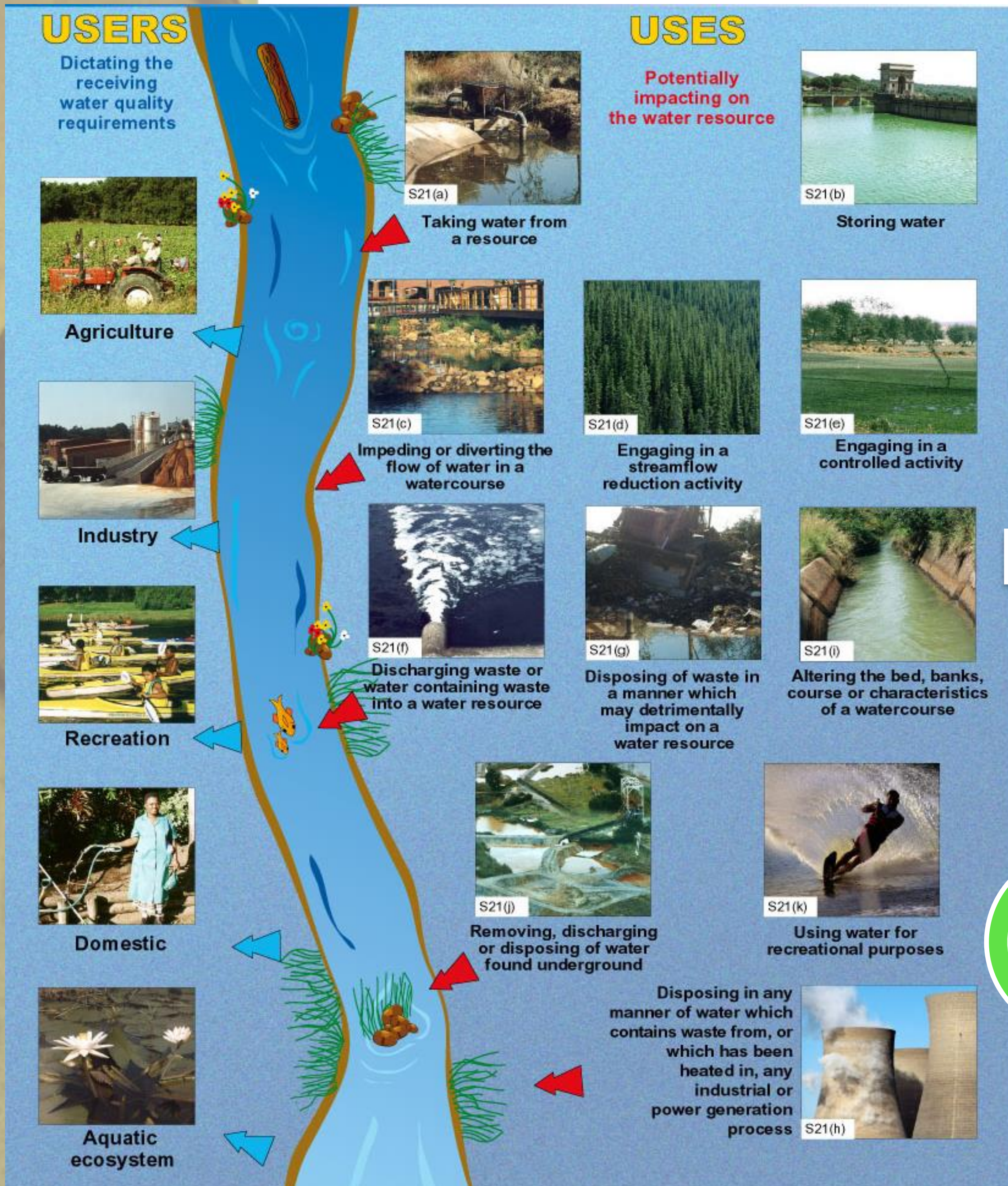
Divided the area into ***15*** Integrated Units of Analysis (IUA) based on:

- Socio-economic zones (SEZs);
- Catchment area boundaries (drainage regions and water resource systems);
- Similar land use characteristics/ land-based activities;
- Eco-regions and geomorphology;
- Ecological information;
- Present Ecological State (PES); and
- Stakeholder input



# Classification of Water Resources



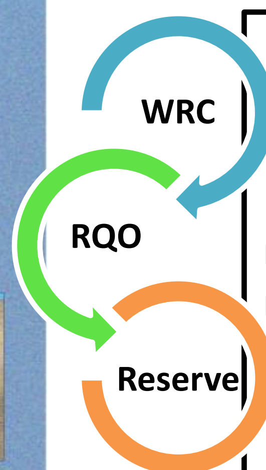



# We all live downstream

## Resource Management

**Source Control**

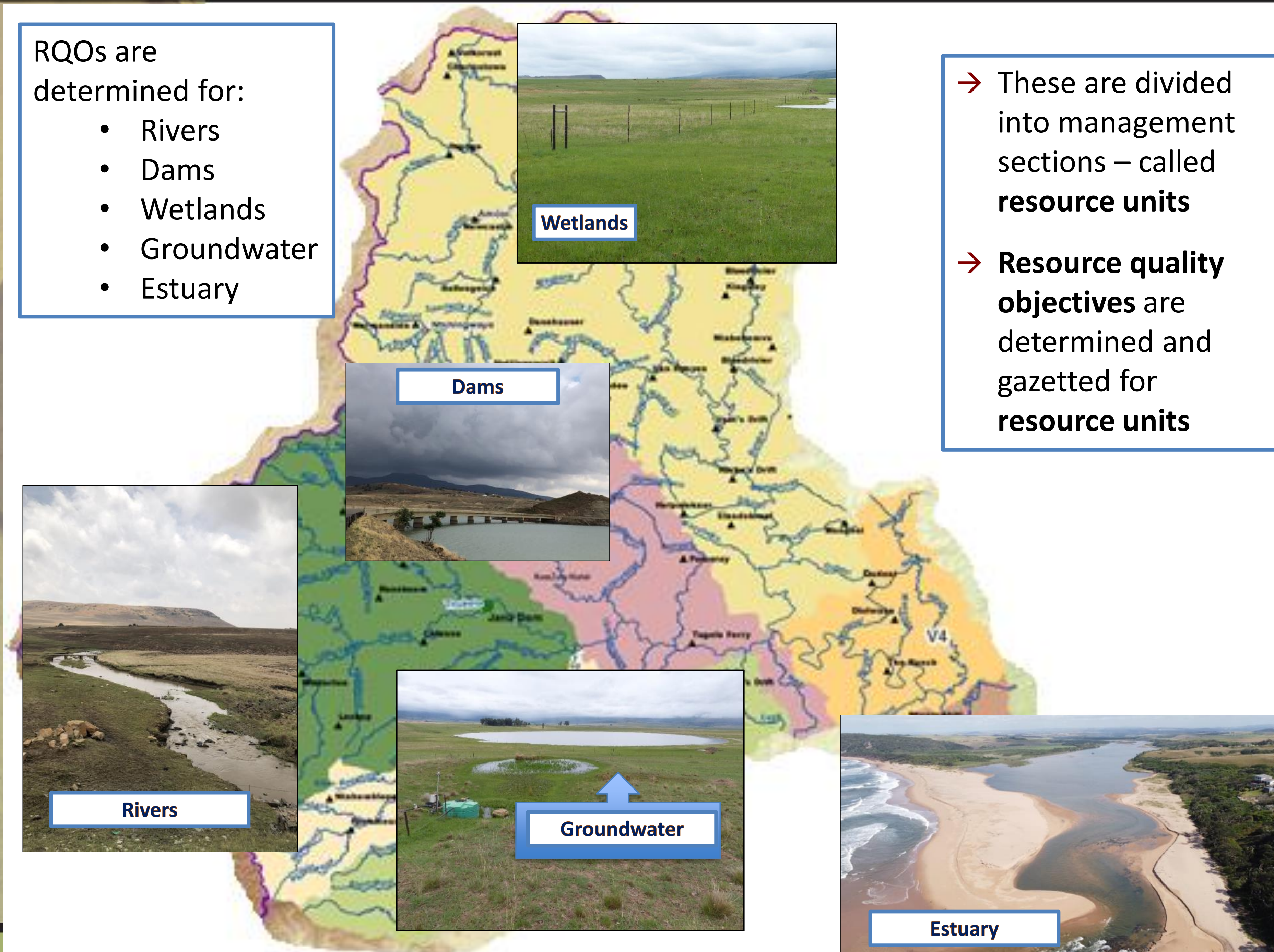
**Resource Protection**




- Setting requirements in water resources – Water Resource Class
- Resource Requirements:
  - Human Needs
  - Aquatic System Health (Ecospecs)
  - Resource Quality Objectives

RQOs are determined for:

- Rivers
- Dams
- Wetlands
- Groundwater
- Estuary



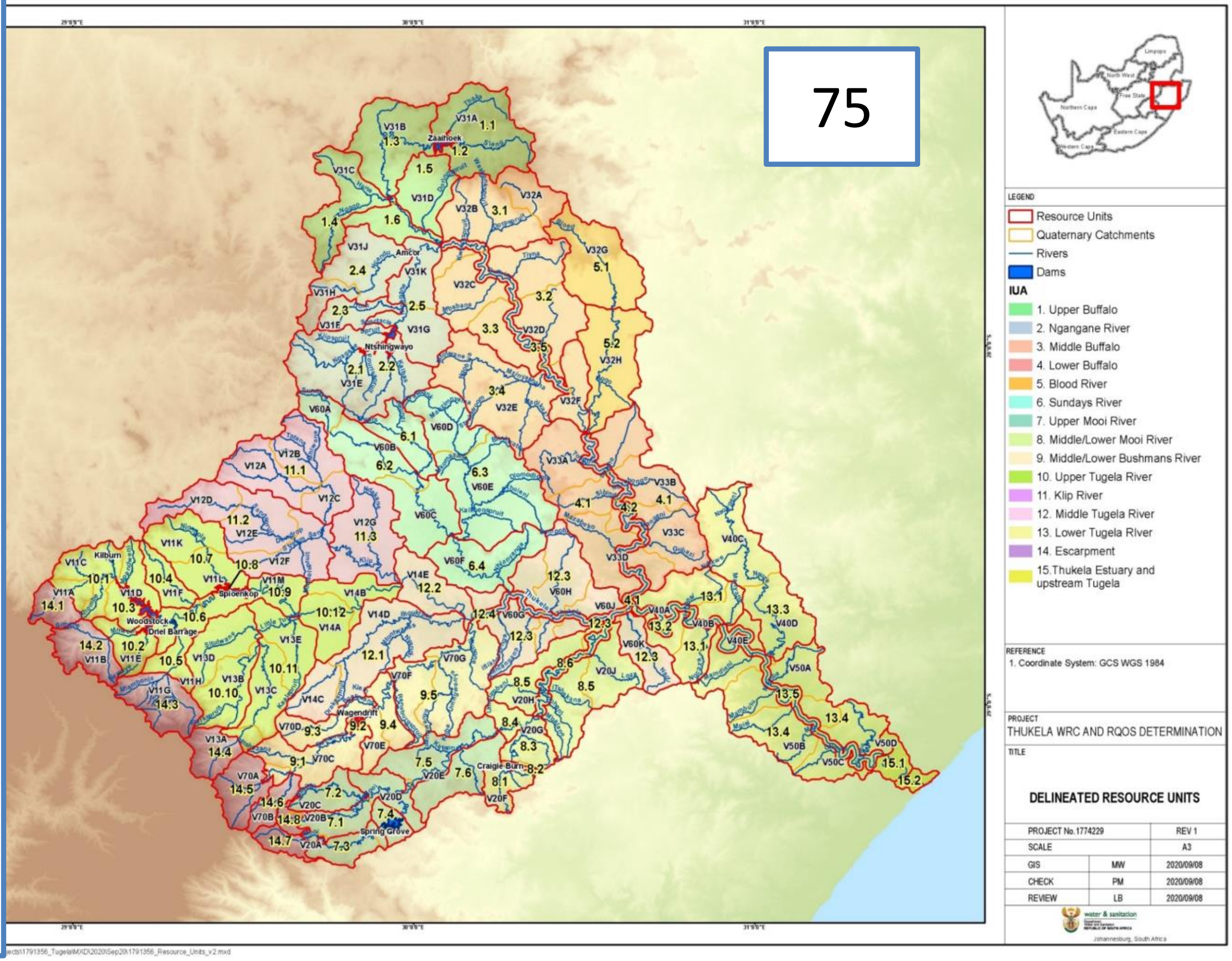

→ These are divided into management sections – called **resource units**

→ **Resource quality objectives** are determined and gazetted for **resource units**

# Resource Units

The Resource Unit Prioritisation Tool used for prioritisation, incorporates a multi criteria decision analyses approach 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.

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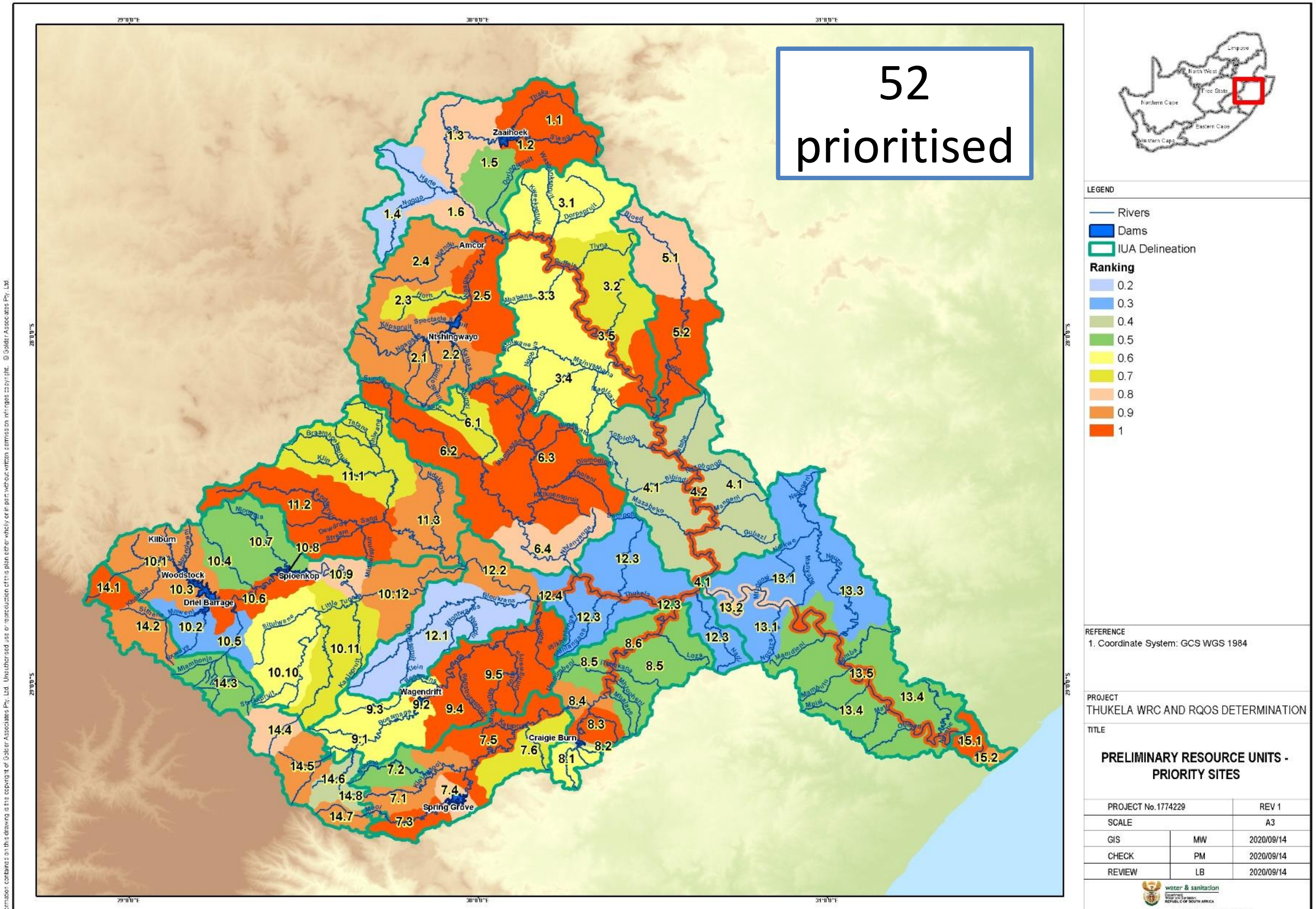
# Determination of Resource Quality Objectives

- 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.

# Resource Unit Prioritisation

52 prioritised



# Determination of Resource Quality Objectives

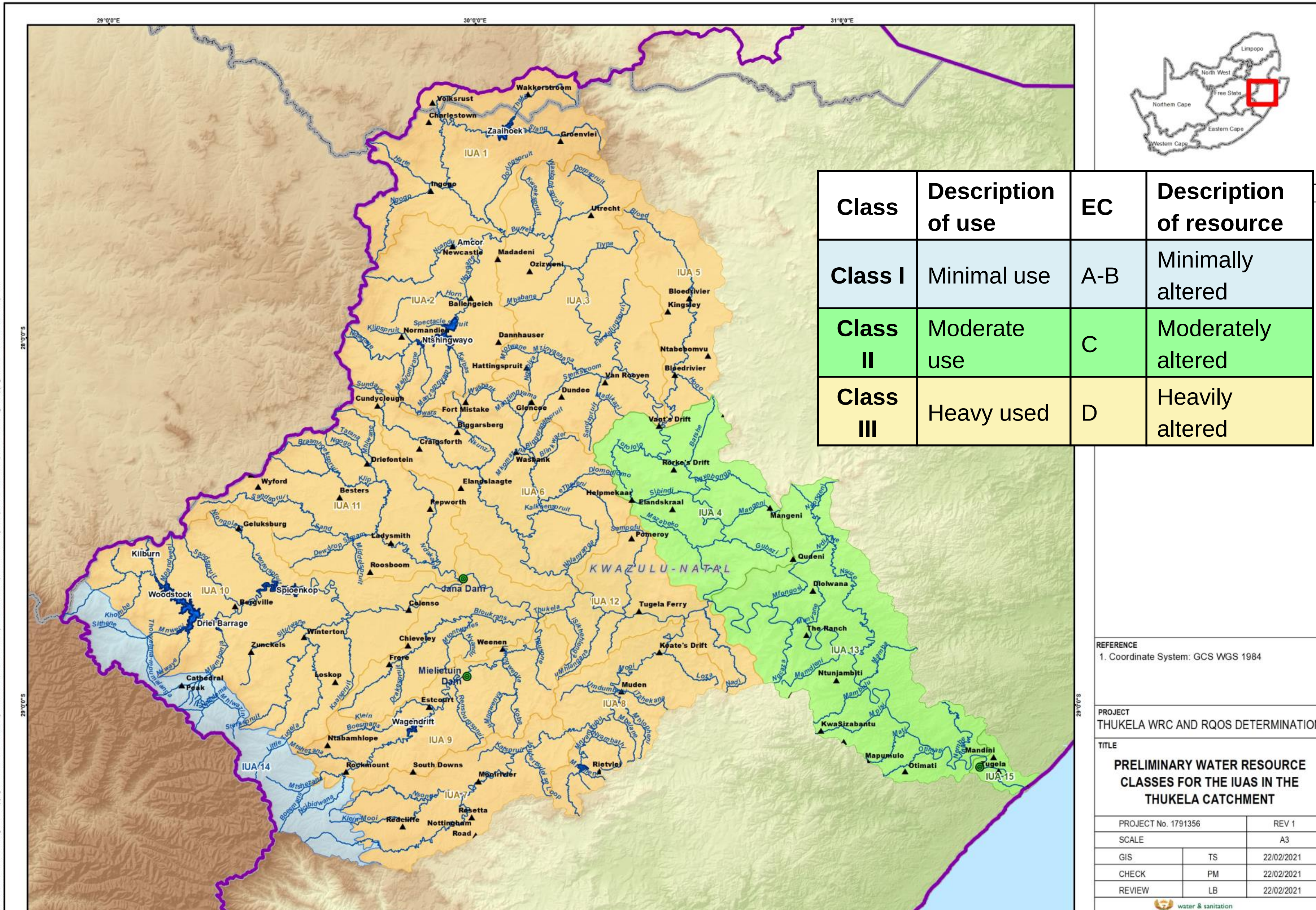
***RQOs encompass the following four components of the resource:***

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

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.

# Study Overview: Proposed Water Resource Classes




| Class | Description of use | EC | Description of resource |
|---|---|---|---|
| **Class I** | Minimal use | A-B | Minimally altered |
| **Class II** | Moderate use | C | Moderately altered |
| **Class III** | Heavy used | D | Heavily altered |

# Sub-components considered

**Rivers and dams:**

- **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

**Wetlands:**

- Quality
- Quantity and
- Habitat
- Biota

**Estuary:**

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

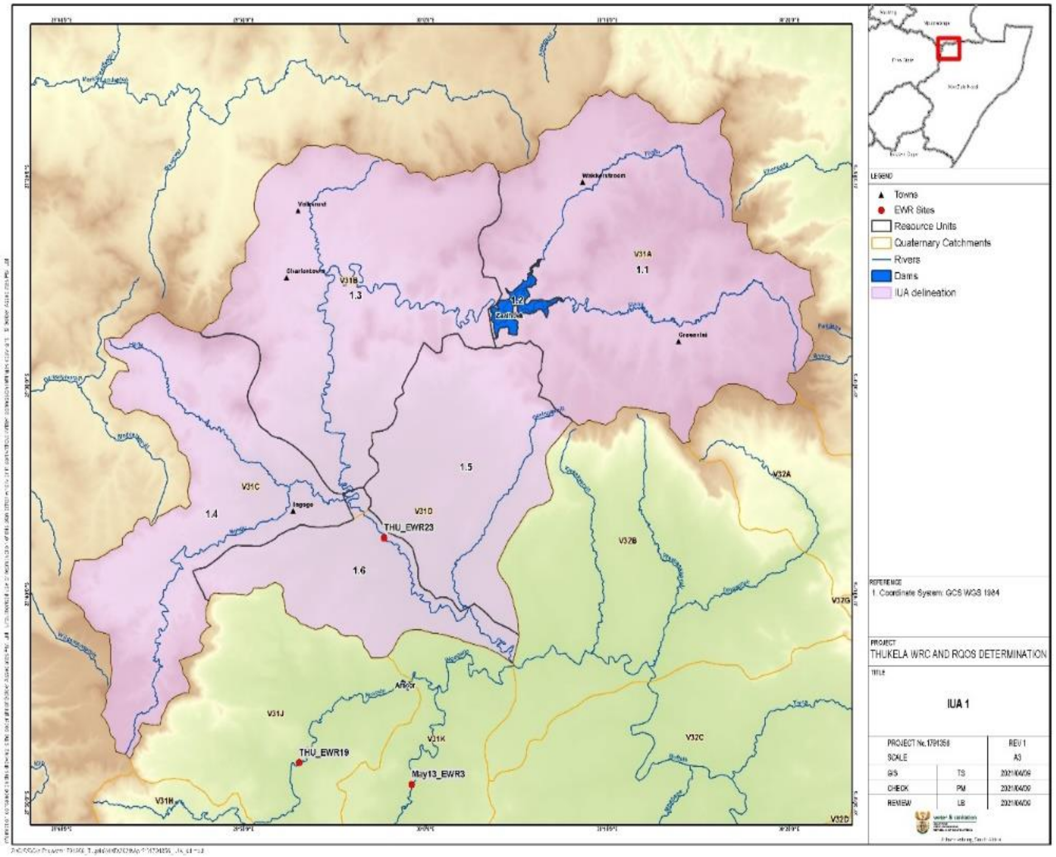
**Groundwater:**

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

RESOURCE QUALITY OBJECTIVES

# Rivers and Dams (Example)

# 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.<br><br>*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. |

# 2.5

## Ngagane from Ntshingwayo Dam to confluence with Buffalo

## V31G, K (May 13_EWR 3)

| Component | Sub-component | RQO | Indicator | Numerical Limit/ measure | | | Context of the RQO and/or Numerical limit |
|---|---|---|---|---|---|---|---|
| Quantity | Low flows | EWR maintenance low and drought flows:<br>Ngagane River at the EWR site May13_EWR3 (-27.819, 29.987) in V31K<br>NMAR = 160.12 $x10^6 m^3$<br>TEC=C/D category<br>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<br>(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 | |

# 2.5

## Ngagane from Ntshingwayo Dam to confluence with Buffalo

## V31G, K (May 13_EWR 3)

| Sub-component | RQO | Indicator | Numerical Limit/ measure | Context of the RQO and/or Numerical limit |
|---|---|---|---|---|
| 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. |
| | | Nitrate ($NO_3^-$) 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 Check with RO |
| 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 (95th percentile) | Human Health |

| 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.<br><br>Confirm pesticides, hydrocarbons | 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)<br><br>Manganese and Iron – Domestic user water quality guideline (SAWQGs, 1996).<br><br>Cobalt – – Irrigation user water quality guideline (SAWQGs, 1996)<br><br>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 drinking water guideline. |
| | | Glyphosate | ≤0.7 milligrams/litre (mg/l) | Human health is the driver. USEPA drinking water guideline |
| | | Endosulfan | ≤0.13 micrograms/litre (ug/l) | Ecological specification. Ecological Reserve manual (2008). No monitoring data. |
| | | 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) |

# 2.5
## Ngagane from Ntshingwayo Dam to confluence with Buffalo
## V31G, K (May 13_EWR 3)C

| Component | Sub-component | RQO | Indicator | Numerical Limit/ measure |
|---|---|---|---|---|
| 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%)<br>Riparian Integrity - Class ≥B Ecological Category (80 – 90%)<br>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.<br>VEGRAI ≥C Ecological Category (>60%) |
| Biota | Fish | Flow and water quality sensitive Fish species to be maintained or improved to a PES C/D ecological category. | FRAI<br><br>Amphilius natalensis (ANAT)<br>Barbus (Enteromius) paludinosus (BPAU)<br>Labeobarbus natalensis (BNAT)<br>Barbus (Enteromius) pallidus (BPAL)<br>Barbus (Enteromius) anoplus (BANO) | During survey in all flow habitat classes all species present.<br>BNAT, BPAL and BANO – 2 of 3 spp present as habitat indicators; and ANAT ≥ 3 individuals per species<br><br>FRAI EC: C/D (60 - 79%) |
| | Aquatic invertebrates | Flow and water quality sensitive macroinvertebrate assemblages to be maintained.<br>Macroinvertebrate assemblages must be maintained within a C/D ecological category or improved upon. | SASS 5<br>MIRAI<br><br>Baetidae >2 spp<br>Heptageniidae<br>Leptophlebiidae<br>Tricorythidae<br>Leptoceridae<br>Hydropsychidae >1spp<br>Elmidae<br>Economidae | 3 biotopes sampled; assemblages to be ≥ B abundances;<br><br>SASS 5 scores: ≥213<br>ASPT score: ≥7.2<br><br>MIRAI EC: C/D (50 – 79%) |
| | Diatoms | Ecological water quality should be maintained as moderate quality | Specific Pollution Sensitivity Index (SPI)<br>Percentage pollution tolerant values (%PTV) | SPI: 12 - 14<br>PTV: 20 to <40% |

## 1.2

Zaaihoek Dam

**V31A**

| Component | Sub-component | RQO | Indicator | Numerical Limit | Context of the RQO and/or Numerical limit |
|---|---|---|---|---|---|
| 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) | |
| | | | Nitrate ($NO_3^-$) 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 QUALITY OBJECTIVES

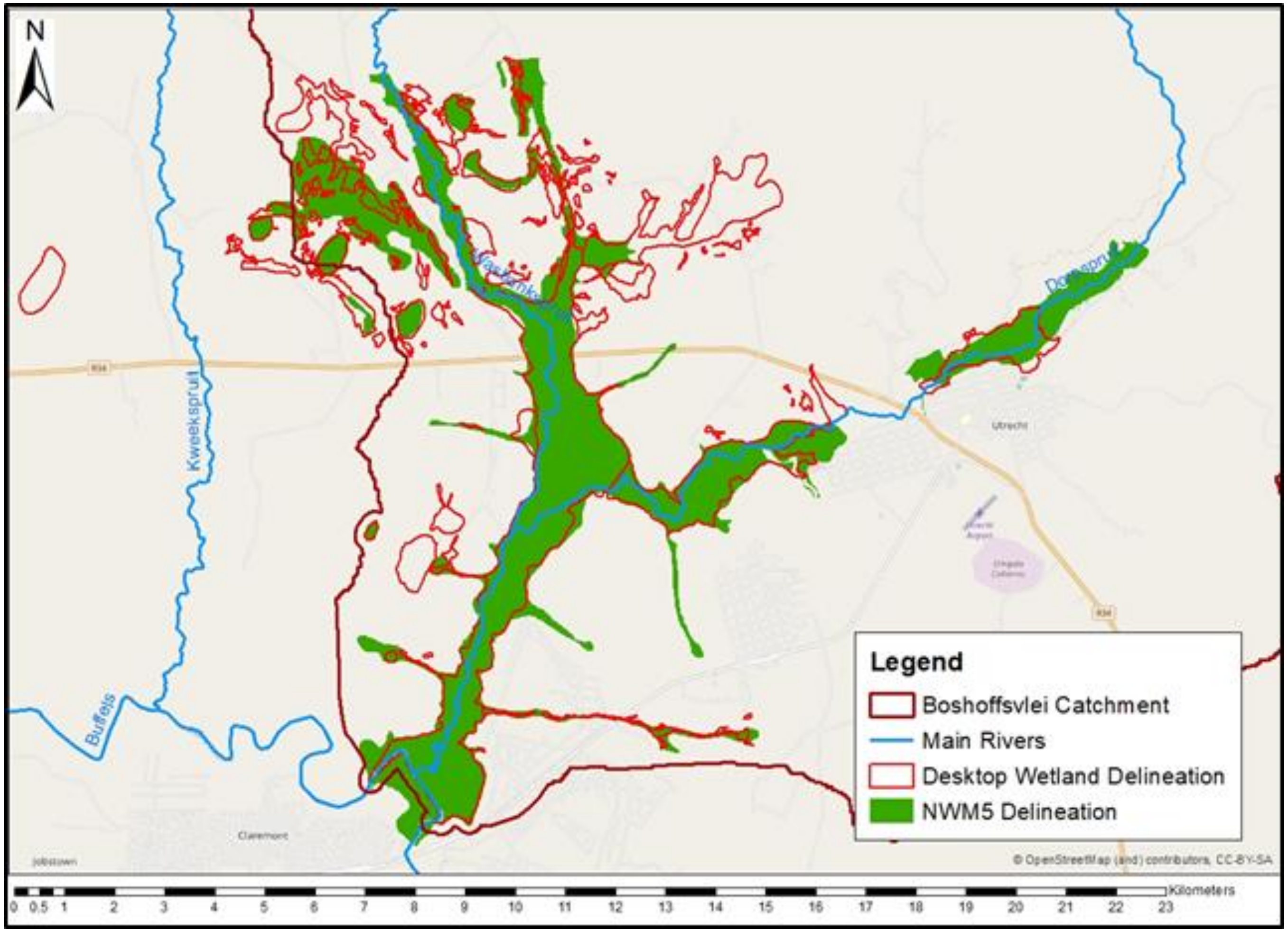
# Wetlands

# Wetland Data

| Wetland data availability | Confidence in the data | Approach used during this study to improve the confidence |
|---|---|---|
| **Wetlands in the Catchment**<br>National Wetland Map 5 (Van Deventer *et al*., 2018) - (GIS layer)<br>NFEPA wetland layer (Nel *et al*., 2011) - (GIS layer) | Low to medium confidence | Used available imagery of the Thukela catchment to identify gaps in the databases and/or verify the existing data where appropriate |
| **Identification of Priority Wetlands**<br>Used mainly old hard copy maps and report from Begg (1989). | High confidence | - |
| **Wetland Delineation** | Low confidence as all desktop mapping | Undertook more detailed (higher confidence) desktop mapping of each of the Priority Wetlands |
| **Wetland Typing** | Low confidence | Focused predominantly on the main system in each case rather than tributaries |
| **Wetland Categorisation**<br>PES or similar surrogate data only available for some systems - desktop level. No IS data available. | Low confidence | **PES** – Used a desktop assessment with 2018 National Landcover data for input.<br>**IS** – Used surrogate databases together with information from site visits |

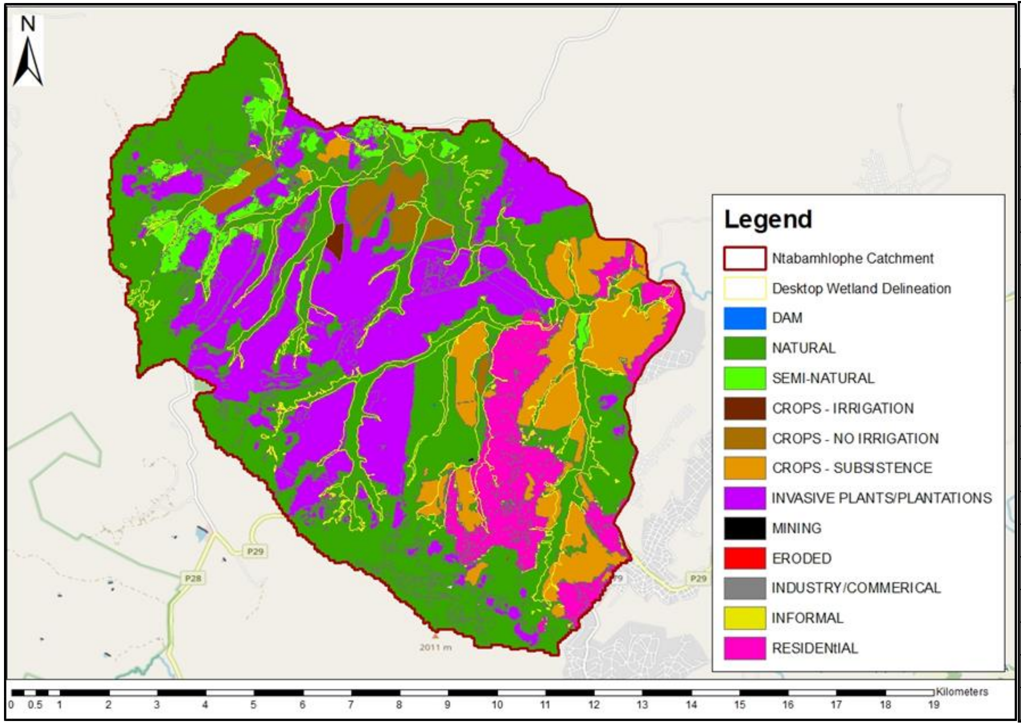
# Updated Mapping - Approach

- Desktop mapping using ArcGIS and multiple date/year aerial imagery; and
- Typing was done at a coarse level focusing on the main systems.



# Categorisation - Approach

- PES - Wet-Health Level 1a (MacFarlane *et al*., May 2020) desktop assessment;
- 2018 National Landcover data as the basis;
- 1990 National Landcover data used as a comparison to determine the trajectory of change; and
- IS – Desktop assessment using the method described in Rountree *et al*. (2013).




| | Hydrology | Geomorphology | | Water Quality | Vegetation |
|---|---|---|---|---|---|
| | Wet_Hydro | Wet_Geo_Pr | Wet_Geo_St | Wet_WQ | Wet_Veg |
| WATER_NAT | 0 | 0 | 0 | 0 | 0 |
| DAM | 7 | 4 | 4 | 0 | 10 |
| NATURAL | 0 | 0 | 0 | 0.4 | 1 |
| SEMI_NAT | 4 | 2 | 1 | 0.8 | 6 |
| ORCH_VINE | 7 | 5 | 2 | 6.1 | 10 |
| SUGARCANE | 8 | 6 | 2 | 6.4 | 10 |
| CROP_IRRIG | 7.5 | 6 | 2 | 6.9 | 10 |
| CROP_NOIRR | 7 | 6 | 2 | 6.5 | 10 |
| CROP_SUBS | 7 | 4 | 2 | 3.6 | 10 |
| PLANT_INV | 7 | 1 | 1 | 1.2 | 10 |
| MINING_L | 9 | 9 | 10 | 2.1 | 9 |
| MINING_M | 10 | 10 | 10 | 8.4 | 10 |
| MINING_H | 10 | 10 | 10 | 10 | 10 |
| ERODED | 7 | 7 | 8 | 2.2 | 9 |
| INDUS_COMM | 10 | 10 | 10 | 8.2 | 10 |
| INFORMAL | 7 | 4 | 8 | 7.6 | 9 |
| RESIDENT_H | 10 | 8 | 8 | 5 | 10 |
| RESIDENT_L | 6 | 6 | 5 | 4 | 6 |
| OPENSPACE | 3 | 4 | 1 | 4.2 | 9 |

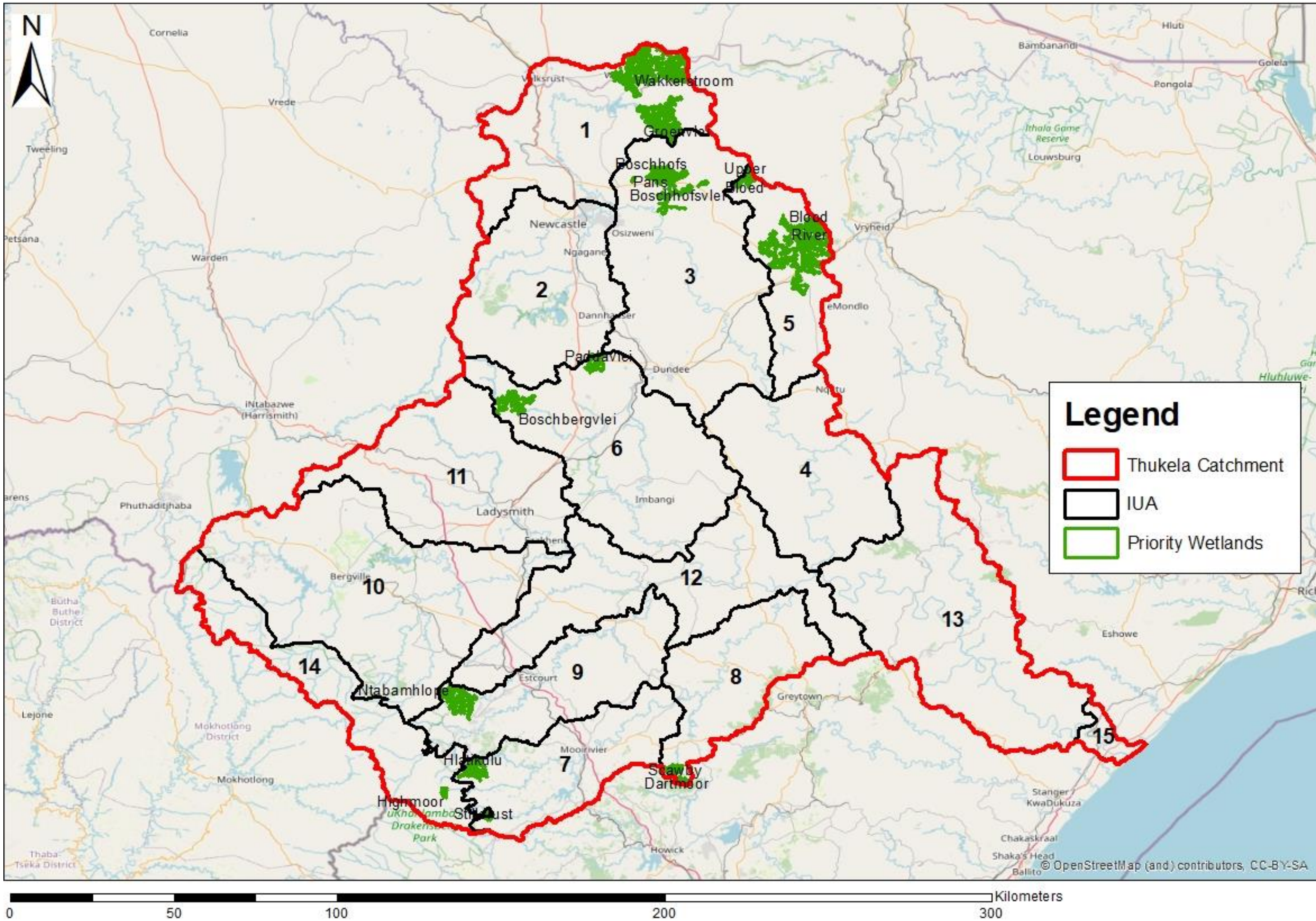
# Categorisation - Approach

| | Open Water – Natural | Open Water - Artificial | Natural / Minimally impacted | Semi-natural | Orchards and vineyards | Sugar cane | Commercial annual crops (irrigated) | Commercial annual crops (non-irrigated) | Subsistence crops | Plantations and dense alien vegetation | Mining - low risk | Mining - medium risk | Mining - high risk | Eroded areas (& heavily degraded land) | Urban Industrial/Commercial | Urban Informal | Urban Residential – high density | Urban Residential – low density | Urban Open Space | Total Area (ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wetland_ID | WATER_NAT | DAM | NATURAL | SEMI_NAT | ORCH_VINE | SUGARCANE | CROP_IRRIG | CROP_NOIRR | CROP_SUBS | PLANT_INV | MINING_L | MINING_M | MINING_H | ERODED | INDUS_COMM | INFORMAL | RESIDENT_H | RESIDENT_L | OPENSPACE | **AREA_TOT** |
| NH1 | | 0.2 | 10.4 | | | | | | | 1.1 | | | | | 0.1 | | | | | 11.8 |
| NH10 | | 0.0 | 78.5 | 0.8 | | | | | 6.6 | 0.7 | | | | | | 0.4 | 2.6 | | | 89.6 |
| NH11 | | | 96.0 | 14.1 | | | | | 27.2 | | | | | 0.0 | 0.0 | 0.3 | 1.6 | | | 139.3 |
| NH12 | | | 117.8 | 0.1 | | | | 0.3 | | 1.4 | | | | | 0.0 | | | | | 119.5 |
| NH13 | | | 31.9 | | | | | 11.8 | 0.9 | | | | | | | 0.5 | 22.3 | | | 67.4 |
| NH14 | | 0.2 | 123.3 | | | | | | 0.5 | 6.8 | | | | | | 0.1 | 2.6 | | | 133.5 |
| NH15 | | | 15.0 | | | | | | 0.8 | | | | | | | | | | | 15.8 |
| NH16 | | | 4.4 | | | | | | 4.2 | | | | | | | | | | | 8.6 |
| NH17 | | | 2.1 | | | | | | 0.3 | | | | | | | 0.3 | 1.2 | | | 3.9 |
| NH18 | | | 5.7 | | | | | | 6.3 | | | | | | | | | | | 12.0 |
| NH19 | | | 47.4 | | | | | 0.8 | | 1.5 | | | | | | | | | | 49.7 |
| NH2 | | | 16.3 | 13.6 | | | | 0.2 | | 0.0 | | | | | | | | | | 30.1 |
| NH20 | | | 13.9 | | | | | | | 0.9 | | | | | | | | | | 14.7 |
| NH21 | | 0.1 | 70.5 | 21.6 | | | | 0.0 | 0.4 | 0.9 | | | | | | | | | | 93.6 |
| NH3 | | 0.0 | 13.4 | 11.2 | | | | 0.0 | | 0.2 | | | | | | | | | | 24.8 |
| NH4 | | | 18.3 | | | | | | | 3.1 | | | | | | | | | | 21.4 |
| NH5 | | | 9.7 | | | | | | 18.6 | | | | | | | 0.4 | 2.0 | | | 30.7 |
| NH6 | | | 11.7 | 0.1 | | | | | | | | | | | | | | | | 11.9 |
| NH7 | | 0.2 | 0.9 | 0.1 | | | | | 0.2 | 0.8 | | | | | | | | | | 2.2 |
| NH8 | | | 69.8 | | | | 0.1 | | | 1.8 | | | | | | | | | | 71.6 |
| NH9 | | | 36.7 | 2.8 | | | 0.1 | | | 2.9 | | | | | | | | | | 42.5 |

| | Open Water – Natural | Open Water - Artificial | Natural / Minimally impacted | Semi-natural | Orchards and vineyards | Sugar cane | Commercial annual crops (irrigated) | Commercial annual crops (non-irrigated) | Subsistence crops | Plantations and dense alien vegetation | Mining - low risk | Mining - medium risk | Mining - high risk | Eroded areas (& heavily degraded land) | Urban Industrial/Commercial | Urban Informal | Urban Residential – high density | Urban Residential – low density | Urban Open Space | Total Area (ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wetland_ID | WATER_NAT | DAM | NATURAL | SEMI_NAT | ORCH_VINE | SUGARCANE | CROP_IRRIG | CROP_NOIRR | CROP_SUBS | PLANT_INV | MINING_L | MINING_M | MINING_H | ERODED | INDUS_COMM | INFORMAL | RESIDENT_H | RESIDENT_L | OPENSPACE | **AREA_TOT** |
| NH1 | | | 11.84732074 | | | | | | | 37.53702354 | | | | 0.131662467 | 0.216130598 | | | | | 49.73213734 |
| NH10 | | 0.019423845 | 91.91906388 | 3.396841397 | | | | | 80.92505182 | 63.75532037 | | | | 0.430546233 | 0.186643885 | 4.32043897 | 50.11504928 | | | 295.0683797 |
| NH11 | | | 196.8337045 | 0.829220376 | | | | | 185.5473705 | 1.931806709 | | | | 0.122161091 | 0.069844936 | 8.889844009 | 67.54728154 | | | 461.7712337 |
| NH12 | | | 135.3818817 | 22.4677429 | | | | 22.17025682 | | 35.71333972 | | | | 0.773744507 | 0.625232643 | | | | | 217.1321983 |
| NH13 | | | 37.87289293 | | | | | 0.005112291 | 70.69726187 | | 0.689844161 | | | | | 2.492475691 | 126.9794266 | | | 238.7370136 |
| NH14 | | 0.0243889 | 181.4039205 | | | | | | 16.44922933 | 212.1262254 | | | | | | 4.83328857 | 32.54659896 | | | 447.3836517 |
| NH15 | | 0.053994153 | 126.817892 | | | | | | 18.88864556 | 10.89270603 | | | | | 0.020673443 | | | | | 156.6739112 |
| NH16 | | | 24.45098264 | | | | | | 46.40119971 | | | | | | | | | | | 70.85218234 |
| NH17 | | | 4.372580417 | | | | | | 19.18325112 | | | | | | | 2.773243276 | 23.85479248 | | | 50.1838673 |
| NH18 | | | 11.24170565 | | | | | | 66.75471821 | | | | | 0.025615234 | | 1.453513825 | 1.448351438 | | | 80.92390436 |
| NH19 | | | 35.213772 | | | | | 40.04637567 | | 126.9373727 | | | | | 0.330140778 | | | | | 202.5276612 |
| NH2 | | | 68.33499918 | 73.38398341 | | | | 29.05864631 | | 19.69008779 | | | | | | | | | | 190.4677167 |
| NH20 | | | 28.26933747 | 1.318413618 | | | | | | 68.50086681 | | | | | 0.521768925 | | | | | 98.61038682 |
| NH21 | | 0.003839017 | 126.252213 | 65.68576166 | | | | 12.00941885 | 6.932993408 | 87.45666605 | | | | | 0.116170357 | 0.08 | 1.002925068 | | | 299.5399874 |
| NH3 | | | 61.44873423 | 23.56527894 | | | | 7.226749872 | | 17.4351986 | | | | | | 2.977229586 | | | | 112.6531912 |
| NH4 | | | 111.6442554 | | | | | | | 58.83847154 | | | | | | | | | | 170.4827269 |
| NH5 | | | 54.99391405 | | | | | | 18.07535111 | 0.940609398 | 0.768769684 | | | | 0.060988198 | 1.743688596 | 27.13450436 | | | 103.7178254 |
| NH6 | | | 113.5157123 | 13.08529939 | | | | | | 1.598360292 | | | | | | | | | | 128.199372 |
| NH7 | | 0.057146891 | 5.757722052 | 10.6861023 | | | | | 6.886424167 | 17.32450854 | | | | | | | | | | 40.71190395 |
| NH8 | | | 62.80408758 | 1.091893415 | | | 9.989730327 | | 0.000573505 | 129.3400089 | | | | | | 0.35084052 | 2.426750925 | | | 206.0038852 |
| NH9 | | | 53.21978546 | 2.606796274 | | | 6.909560384 | | | 115.7737369 | | | | | | | | | | 178.509879 |

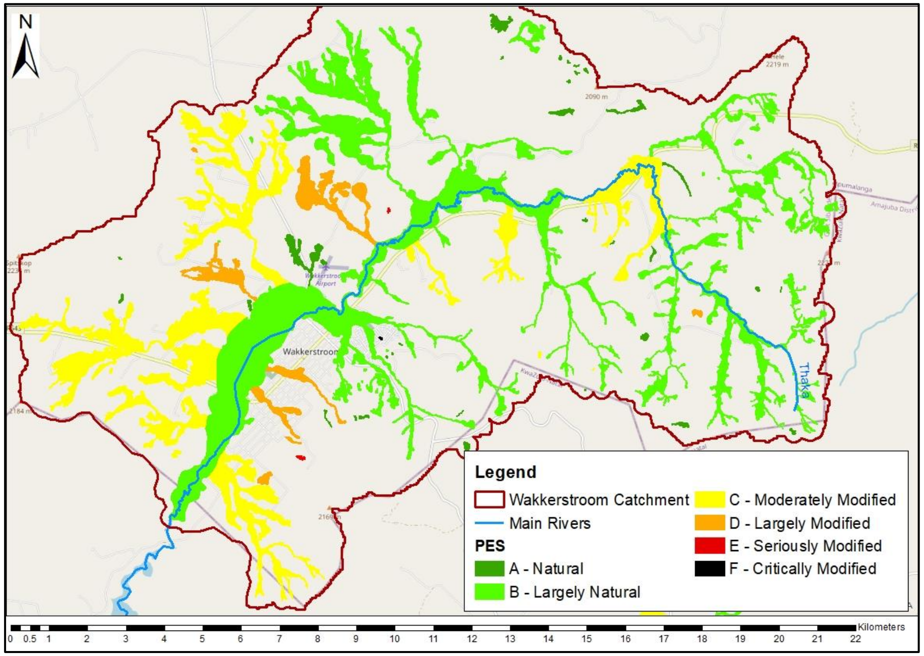
| | | HYDROLOGY | | | GEOMORPHOLOGY | | | WATER QUALITY | | | VEGETATION | | | OVERALL CONDITION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Wetland_ID** | **Wetland area (Ha)** | Impact Score | PES Score (%) | Ecological Category | Impact Score | PES Score (%) | Ecological Category | Impact Score | PES Score (%) | Ecological Category | Impact Score | PES Score (%) | Ecological Category | Combined Impact Score | Overall PES Score (%) | Combined Ecological Category | **HECTARE EQUIVALENTS (based on Overall PES)** |
| Wetland_ID | WET_AREA | IMPACT_HYD | PES_HYDRO | EC_HYDRO | IMPACT_GEO | PES_GEO | EC_GEO | IMPACT_WQ | PES_WQ | EC_WQ | IMPACT_VEG | PES_VEG | EC_VEG | IMPACT_ALL | PES_ALL | EC_ALL | HA_EQUIV |
| NH1 | 11.8 | 5.6 | 44.4 | D | 1.9 | 81.5 | B | 1.8 | 82.2 | B | 2.0 | 79.7 | C | 3.1 | 68.9 | C | 8.1 |
| NH10 | 89.6 | 4.5 | 55.2 | D | 2.0 | 80.3 | B | 2.6 | 73.8 | C | 2.1 | 79.2 | C | 3.0 | 70.3 | C | 63.0 |
| NH11 | 139.3 | 4.7 | 52.5 | D | 2.2 | 78.4 | C | 2.9 | 70.6 | C | 3.4 | 66.1 | C | 3.5 | 65.3 | C | 91.0 |
| NH12 | 119.5 | 3.2 | 68.0 | C | 1.2 | 87.6 | B | 1.8 | 82.1 | B | 1.1 | 88.7 | B | 2.0 | 80.1 | B | 95.7 |
| NH13 | 67.4 | 6.8 | 32.5 | E | 4.4 | 55.9 | D | 5.0 | 50.5 | D | 5.7 | 42.6 | D | 5.9 | 41.1 | D | 27.7 |
| NH14 | 133.5 | 4.6 | 53.7 | D | 1.7 | 83.5 | B | 1.9 | 80.6 | B | 1.7 | 83.1 | B | 2.7 | 72.8 | C | 97.2 |
| NH15 | 15.8 | 2.9 | 71.0 | C | 1.2 | 88.1 | B | 1.7 | 82.7 | B | 1.5 | 85.3 | B | 1.9 | 80.6 | B | 12.7 |
| NH16 | 8.6 | 6.0 | 40.5 | D | 2.8 | 71.6 | C | 3.6 | 63.9 | C | 5.4 | 45.9 | D | 4.6 | 53.8 | D | 4.6 |
| NH17 | 3.9 | 6.4 | 36.0 | E | 4.3 | 56.7 | D | 4.7 | 52.7 | D | 5.1 | 49.4 | D | 5.6 | 44.5 | D | 1.7 |
| NH18 | 12.0 | 6.4 | 35.8 | E | 3.1 | 68.6 | C | 4.0 | 60.0 | D | 5.7 | 42.5 | D | 5.4 | 46.4 | D | 5.6 |
| NH19 | 49.7 | 5.2 | 47.8 | D | 1.9 | 81.0 | B | 2.3 | 77.1 | C | 1.4 | 85.8 | B | 3.0 | 70.1 | C | 34.8 |
| NH2 | 30.1 | 4.3 | 56.6 | D | 1.9 | 80.9 | B | 2.1 | 78.8 | C | 3.3 | 66.6 | C | 3.1 | 69.2 | C | 20.8 |
| NH20 | 14.7 | 5.2 | 48.4 | D | 1.7 | 83.5 | B | 1.7 | 83.0 | B | 1.5 | 84.6 | B | 2.8 | 71.9 | C | 10.6 |
| NH21 | 93.6 | 4.3 | 56.9 | D | 1.6 | 83.6 | B | 1.8 | 82.0 | B | 2.3 | 77.0 | C | 2.7 | 72.9 | C | 68.3 |
| NH3 | 24.8 | 4.3 | 57.1 | D | 1.8 | 82.2 | B | 1.9 | 80.9 | B | 3.3 | 66.6 | C | 3.0 | 70.1 | C | 17.4 |
| NH4 | 21.4 | 4.2 | 57.9 | D | 1.3 | 86.7 | B | 1.6 | 83.9 | B | 2.3 | 77.0 | C | 2.6 | 74.3 | C | 15.9 |
| NH5 | 30.7 | 6.5 | 34.6 | E | 3.3 | 67.1 | C | 4.1 | 58.5 | D | 7.1 | 28.7 | E | 5.7 | 43.0 | D | 13.2 |
| NH6 | 11.9 | 1.2 | 87.9 | B | 0.6 | 94.2 | A | 1.1 | 89.4 | B | 1.1 | 89.5 | B | 1.0 | 90.0 | B | 10.7 |
| NH7 | 2.2 | 7.0 | 29.7 | E | 2.6 | 74.0 | C | 2.3 | 77.4 | C | 6.1 | 39.5 | E | 5.3 | 46.6 | D | 1.0 |
| NH8 | 71.6 | 5.0 | 50.2 | D | 1.6 | 83.6 | B | 1.8 | 81.8 | B | 1.2 | 87.7 | B | 2.7 | 73.0 | C | 52.3 |
| NH9 | 42.5 | 5.3 | 47.1 | D | 1.8 | 82.4 | B | 1.8 | 81.7 | B | 2.0 | 80.4 | B | 3.0 | 70.0 | C | 29.8 |

# Priority Wetlands



# Priority Wetland 1 – IUA 1

## Wakkerstroom Wetland


## Wakkerstroom Wetland

IUA 1

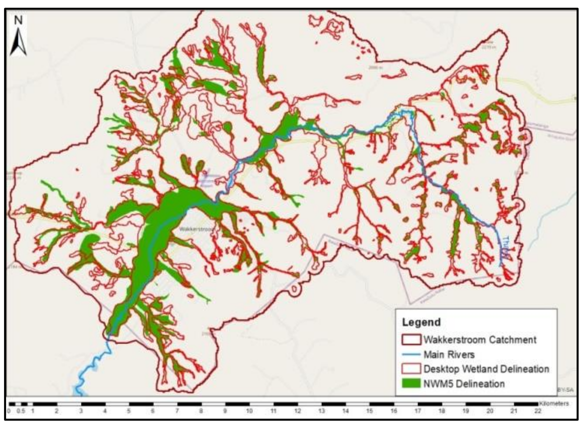
Quaternary Catchment – V31A

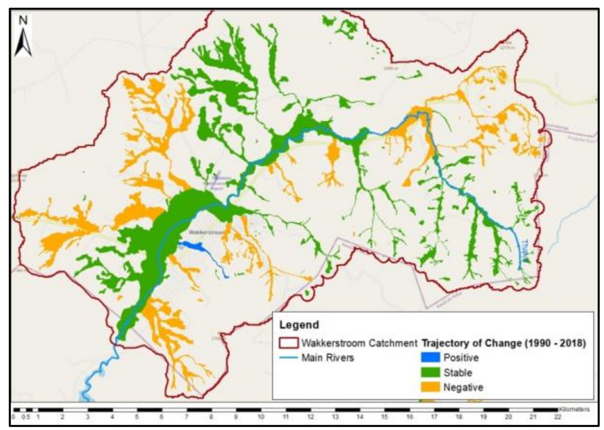
Total wetland area mapped – 4 101 hectares (main wetland ~ 715 ha)

Wetland sub-catchment – 20 973 hectares

HGM – Main wetland Unchannelled Valley Bottom (others include Floodplain, Valley Bottom, Seep, Depression)

- Flow reduction, WWTW inputs




| Wakkerstroom Catchment | |
|---|---|
| **Landcover Class** | **% cover** |
| Dams | 0.2% |
| Natural | 79.1% |
| Semi-Natural | 8.4% |
| Cultivation (irrigated) | 0.0% |
| **Cultivation (non-irrigated)** | **8.2%** |
| Cultivation (subsistence) | 0.2% |
| **Plantations & Aliens trees** | **1.5%** |
| Mining | 0.0% |
| Eroded areas | 0.1% |
| Industrial/Commercial/Roads | 0.1% |
| Informal Settlements | 0.2% |
| **Residential** | **2.0%** |
| **TOTAL** | **100%** |

# Priority Wetland 3 – IUA 3

## Boschoffsvlei Pans

## Boshoffsvlei Wetland and Pans

IUA 3

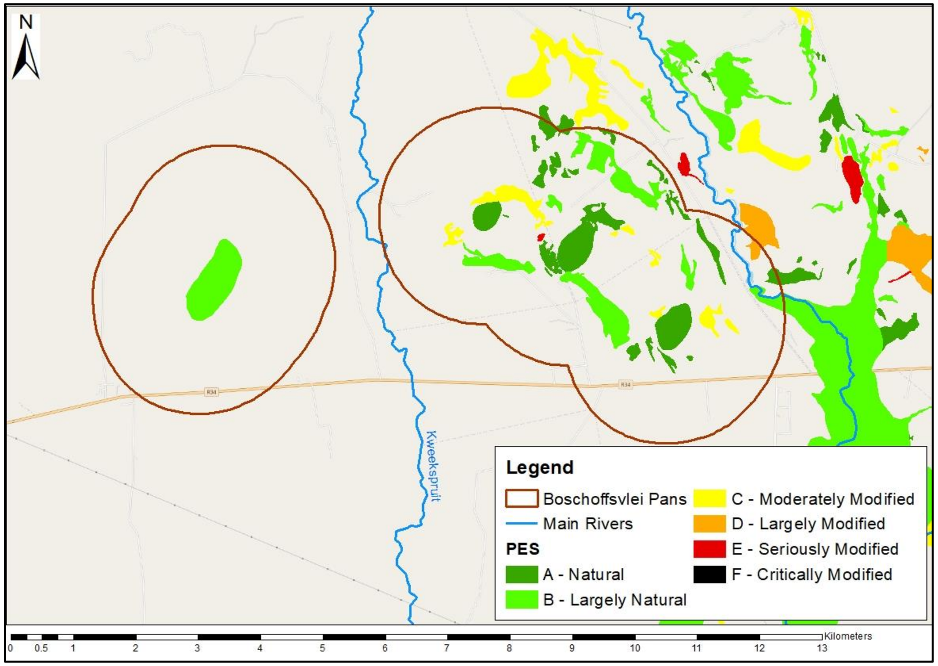
Quaternary Catchment – V32B

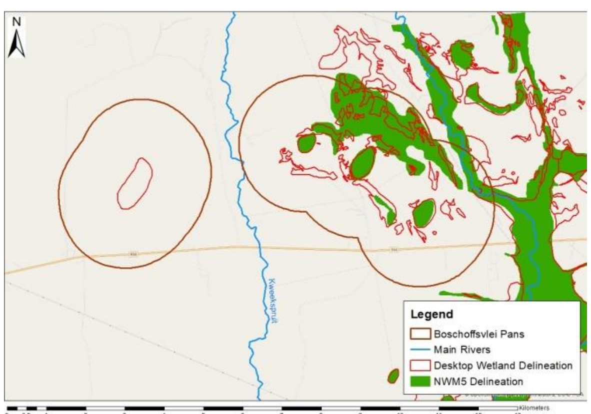
Total wetland area mapped – 2 836 hectares (main wetland ~ 1149 ha)

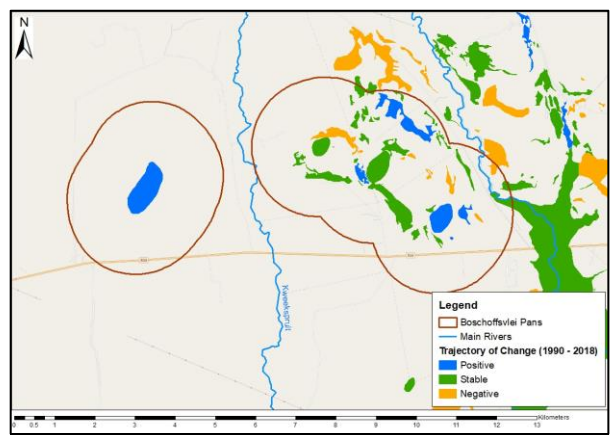
Wetland sub-catchment – 50 480 hectares

HGM – Main wetland Floodplain, Depressions and Seeps (others include Valley Bottom)

- Erosion
- Cultivation
- Overgrazing
- WWTW



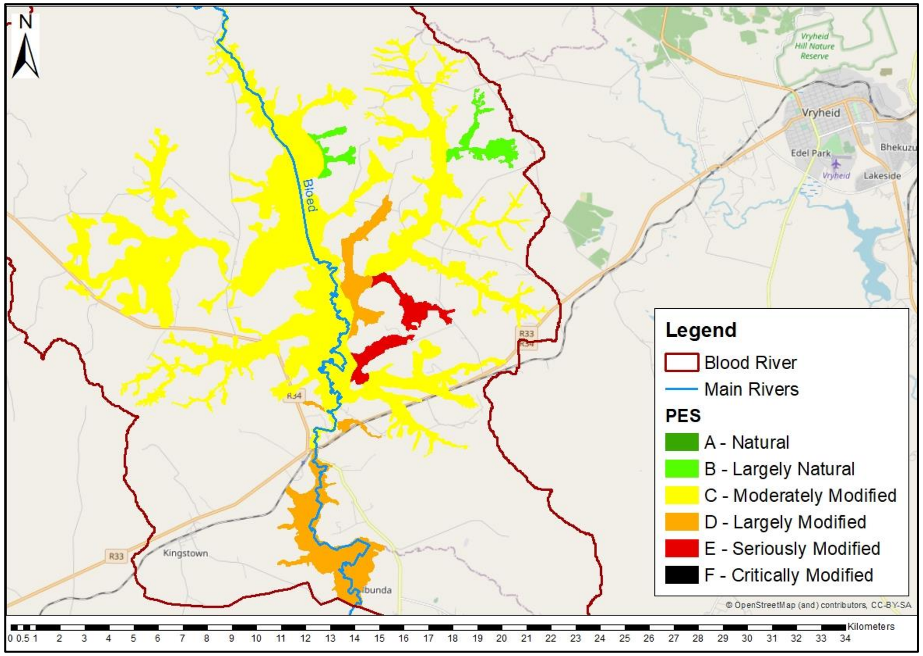




| Boschoffsvlei Catchment | |
|---|---|
| **Landcover Class** | **% cover** |
| Dams | 0.2% |
| Natural | 77.3% |
| Semi-Natural | 9.7% |
| Orchards | 0.0% |
| Cultivation (irrigated) | 0.6% |
| **Cultivation (non-irrigated)** | **4.7%** |
| Cultivation (subsistence) | 1.0% |
| **Plantations & Aliens trees** | **1.6%** |
| Mining | 0.4% |
| **Eroded areas** | **1.6%** |
| Industrial/Commercial/Roads | 0.1% |
| Informal Settlements | 0.4% |
| Residential (high density) | 1.5% |
| Residential (low density | 0.7% |
| Urban open space | 0.1% |
| **TOTAL** | **100%** |

# Priority Wetland 5 – IUA 5

## Blood River Vlei




## Blood River Vlei

IUA 5

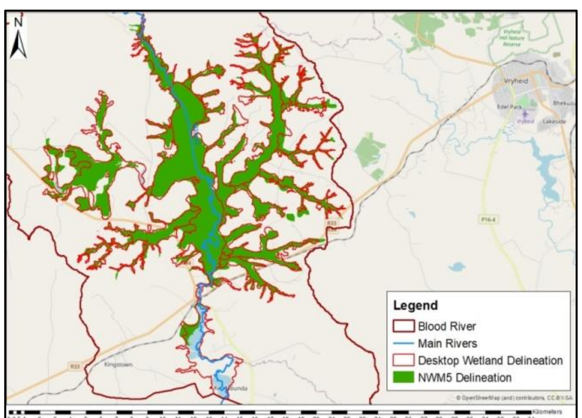
Quaternary Catchment – V32G & V32H

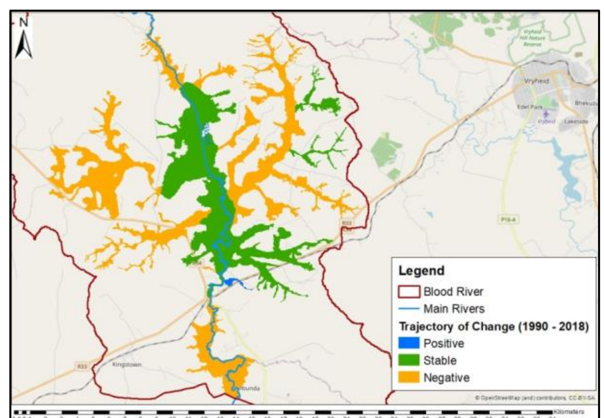
Total wetland area mapped – 8 899 hectares (main wetland ~ 2427 ha)

Wetland sub-catchment – 66 163 hectares

HGM – Main system Unchannelled Valley Bottom and Floodplain (others include Seep)

- Dams
- Cultivation

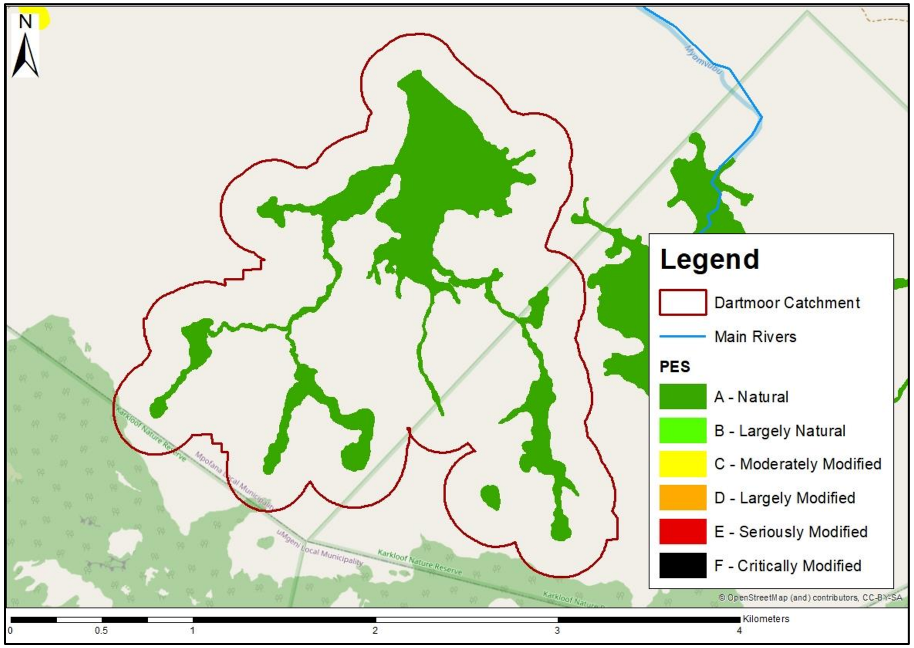



| Blood River Wetland Catchment | |
|---|---|
| **Landcover Class** | **% cover** |
| Dams | 1.1% |
| Natural | 65.8% |
| Semi-Natural | 10.5% |
| **Cultivation (irrigated)** | **3.2%** |
| **Cultivation (non-irrigated)** | **13.6%** |
| Cultivation (subsistence) | 1.5% |
| **Plantations & Aliens trees** | **2.6%** |
| Eroded areas | 0.3% |
| Industrial/Commercial/Roads | 0.1% |
| Informal Settlements | 0.4% |
| Residential (high density) | 0.9% |
| **TOTAL** | **100%** |

# Priority Wetland 10 – IUA 8

## Myamvubu Vlei Systems – Dartmoor Wetland




## Dartmoor Wetland

IUA 8

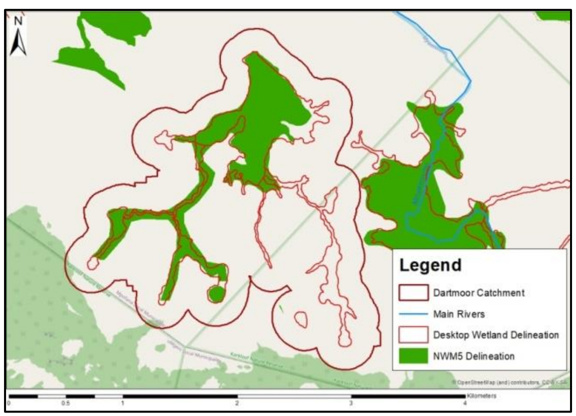
Quaternary Catchment – V20F

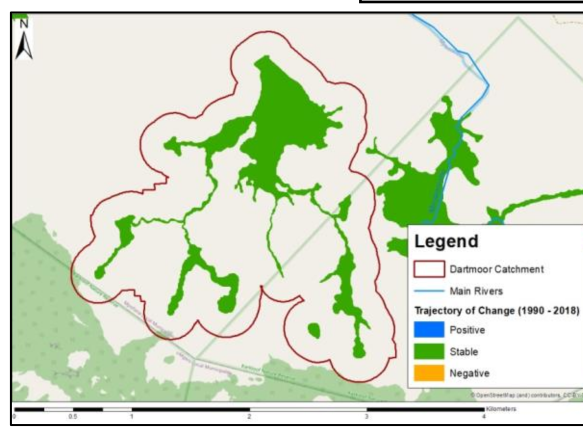
Total wetland area mapped – 92 hectares (main wetland ~ 53 ha)

Wetland sub-catchment – 479 hectares

HGM – Main system Channelled and Unchannelled Valley Bottom (others include Seep)

- Drains
- Wildlands Trust




| Dartmoor Catchment | |
|---|---|
| **Landcover Class** | **% cover** |
| Dams | 0.3% |
| Natural | 99.3% |
| Cultivation (non-irrigated) | 0.3% |
| Eroded areas | 0.0% |
| **TOTAL** | **100%** |

# Categorisation Summary

| No | IUA | Quaternary Catchment | Wetland Name | Wetland Type (main system) | PES | IS | REC | BAS | Conf. (0-5) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | V31A | Wakkerstroom | UVB | B | VH | A | B/C | 4 |
| 2 | 1 | V31A | Groenvlei | CVB and FP | C | H | B/C | C | 3 |
| 3 | 3 | V32B | Boschoffsvlei | FP | C* | H | B/C | C | 3 |
| 4 | 3 | V32B | Boschoffsvlei pan complex | P and S | A & B | VH | A | A/B | 4 |
| 5 | 5 | V32G | Upper Blood River | S and UVB | A & B | H | A/B | A/B | 4 |
| 6 | 5 | V32G | Blood River | UVB and FP | C | VH | B | C | 3 |
| 7 | 6 | V60D | Paddavlei | CVB and UVB | B | H | A/B | B | 3 |
| 8 | 6 | V60B | Boschberg | FP | B/C* | H | B | C | 3 |
| 9 | 7 | V20C | Hlatikulu | UVB and CVB | C | VH | B | C | 3 |
| 10 | 7 | V20A | Stillerust | CVB and FP | A | VH | A | A | 4 |
| 11 | 8 | V20F | Melmoth | UVB | A | VH | A | A | 4 |
| 12 | 8 | V20F | Dartmoor | UVB and CVB | A | VH | A | A | 4 |
| 13 | 8 | V20F | Scawby | UVB | C | VH | B | B/C | 3 |
| 14 | 9 | V70D | Ntabamhlope | FP and UVB | B | VH | A | C | 3 |
| 15 | 14 | V11B,G; V13A; V70A,B; V20A,B,C | Natal Drakensberg Park including the Highmoor wetlands | UVB, CVB and S | A & C | H | A/B | A/B | 4 |

* Modified PES based on expert opinion and site observations

# Wetland RQO's – Limitations

- Limited to no flow or water quality data (especially updated information) are available for the majority of the Priority Wetlands, with the Wakkerstroom Priority Wetland being the exception.

*RQO's for the wetlands are thus qualitative and confidence in the components is low for water quantity and quality where these are indicated and medium for Habitat and Biota, based on the limitations imposed by the existing information.*

# Wetland REC

- The PES and IS served as the starting point;
- Used a modification of the principles outlined in Rountree *et al*. 2013 to derive the REC; and
- Expert judgement and the trajectory of change over the past 28 years was used to derive a BAS (preliminary at this stage) for each priority wetland – whether the systems are likely to either stay the same or change depending on the pressures they previously experienced, and based on likely additional threats or pressures going forward.

# Wetland RQO's

## Setting Preliminary Wetland RQO's

- Generic and specific preliminary RQO's for each of the Priority Wetlands have been developed as applicable;
- These still need to be workshopped with the project team and amended as necessary;

*Outcome – Preliminary RQO's for the Priority Wetlands*

- Once amended, these will need to be presented for comments, review and inputs at the respective stakeholder meetings.

*Outcome – Final RQO's for the Priority Wetlands*

# Preliminary Wetland RQO's - Wakkerstroom

| Component prioritised | Indicator | RQO | Numerical Criteria |
|---|---|---|---|
| Quantity | River and groundwater indicators apply. | River objective to be added.<br><br>A constant baseflow must be maintained that ensures that the system remains perennial and the peatland is permanently saturated. | River and groundwater numerical limits must apply (see river and groundwater numerical limits). |
| | Others TBD with inputs from various stakeholders involved with the system. | | |
| Quality | River and groundwater indicators apply (see river and groundwater indicators). | River and groundwater RQO's apply (see river and groundwater indicators). | River and groundwater numerical limits apply (see river and groundwater numerical limits). |
| | Others TBD with inputs from various stakeholders involved with the system. | | |
| Habitat | 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 supplement through field verification where and if available) and used for the within-wetland land cover. 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. | Maintain desktop PES category of B (84.1 %) although the likely BAS Category is C (70 %) due to flow reduction as a result of climate change factors. | Less than 10% deterioration in PES score from the baseline of 84.1% . |
| | Peat depth and humification – determine using the von Post Humification Scale (after von Post, 1922; von Post and Granlund, 1926) at selected points in the wetland to determine depth and humification of the peat. Determine baseline and repeat every 5 years. | Peat depth and humification should be constant over time | Less than 10% deterioration in peat depth and humification over time. |
| Biota | Presence of Critically Endangered White-winged Flufftail | Maintain a population of White-winged Flufftail in the wetland. | Continued presence of White-winged Flufftail. |
| | SABAP 2 reporting rates for aquatic/wetland dependent Red Data bird species:<br>• 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<br><br>Verify from monitoring records and recorded sightings from available avifaunal reporting data.<br><br>Report on this every 3 to 5 years. | Overall diversity and populations of aquatic/wetland dependent bird species must be maintained. | TBD with inputs from various stakeholders involved with the system. |

# Preliminary Wetland RQO's – Boschoffsvlei Pans

| Component prioritised | Indicator | RQO | Numerical Criteria |
|---|---|---|---|
| Quantity | Pan wetted perimeter as measured from desktop mapping in relation to antecedent rainfall.<br><br>Compile an accurate desktop basemap for the pans prior to the start of monitoring using the most recent available remote imagery and determine the wetted perimeter in relation to antecedent rainfall for the pans.<br><br>Repeat the above every 3 to 5 years and assess and report on this with a view to assess if there have been any measurable changes in the relationship between wetted perimeter and antecedent rainfall in the pan. | 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. | TBD |
| Quality | 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.<br><br>Sample every 3 to 5 years. | 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 this particular water chemistry pan type. | TBD |
| Habitat | 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 supplement through field verification where and if available) and used for the within-wetland land cover. 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. | Maintain desktop PES category of pans. | Less than 10% deterioration in PES score from the baseline. Baseline PES scores for pans from west to east:<br>• 90 %<br>• 92.8 %<br>• 92.2 %<br>• 90.7 % |
| Biota | Reporting rates for aquatic/wetland dependent Red Data bird species:<br>• Grey Crowned Crane<br>• African Marsh Harrier<br>• Blue Crane<br>• Greater Flamingo<br>• Lesser Flamingo<br><br>Verify from monitoring records and recorded sightings from available avifaunal reporting data.<br><br>Report on this every 3 to 5 years. | Overall diversity and populations of aquatic/wetland dependent bird species must be maintained. | Blue and Grey Crowned Crane aspects TBD/confirmed with input from the EWT.<br><br>Reporting rates for other aquatic/wetland dependent Red Data bird species TBD. |

# Preliminary Wetland RQO's – Blood River Vlei

| Component prioritised | Indicator | RQO | Numerical Criteria |
|---|---|---|---|
| Quantity | Extent and frequency of flooding in relation to rainfall in the catchment.<br><br>Using available suitable remote imagery, estimate the extent and frequency of inundation/flooding in relation to rainfall for the wetland.<br><br>Repeat the above every 5 years and assess and report on this with a view to assess if there are any measurable changes in the relationship between flooding extent and rainfall events. | Floods are necessary to inundate the floodplain thereby providing the wetting regime required for supporting the floodplain vegetation, particularly the facultative hydrophytic grasses, sedges and forbs that are dependent on flooding for their life cycles. | TBD |
| | Extent of dams and Surface Flow Reduction (SFR) activities (e.g. irrigated cultivation, plantations, etc.) | Existing water inputs to the wetland from its' catchment must be maintained, with no increase in direct abstraction from the wetland. | Current extent of dams and SFR activities within the catchment. To be determined. |
| | River indicators apply for baseflow (see river indicators). | River RQO's apply (see river RQO's). | River numerical limits apply (see river numerical limits). |
| Quality | River indicators apply (see river indicators). | River RQO's apply (see river RQO's). | River numerical limits apply (see river numerical limits). |
| Habitat | 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 supplement through field verification where and if available) and used for the within-wetland land cover. 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. | Maintain desktop PES category of wetland. | Less than 10% deterioration in PES score from the baseline:<br>North of R34 crossing – 75 %<br>South of R34 crossing – 55.7 % |
| Biota | Reporting rates for aquatic/wetland dependent Red Data bird species:<br>• Grey Crowned Crane<br>• African Marsh Harrier<br>• Blue Crane<br><br>Verify from monitoring records and recorded sightings from available avifaunal reporting data.<br><br>Report on this every 3 to 5 years. | Overall diversity and populations of aquatic/wetland dependent bird species must be maintained. | Grey Crowned Crane aspects TBD/confirmed with input from the EWT.<br><br>Reporting rates for the African Marsh Harrier TBD. |

# Preliminary Wetland RQO's - Dartmoor

| Component prioritised | Indicator | RQO | Numerical Criteria |
|---|---|---|---|
| Habitat | 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 supplement through field verification where and if available) and used for the within-wetland land cover. 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. | Maintain desktop PES category of wetland. | Less than 10% deterioration in PES score from the baseline – 95 % |
| Biota | Reporting rates for aquatic/wetland dependent Red Data bird species:<br>• Wattled Crane<br>• Grey Crowned Crane<br>• African Marsh Harrier<br>• Blue Crane<br><br>Verify from monitoring records and recorded sightings from available avifaunal reporting data.<br><br>Report on this every 3 to 5 years. | Overall diversity and populations of aquatic/wetland dependent bird species must be maintained. Species specific TBD with input from Willdlands Trust, Ezemvelo KZN Wildlife and the EWT. | TBD with input from Willdlands Trust, Ezemvelo KZN Wildlife and the EWT.<br><br>Reporting rates for the African Marsh Harrier TBD. |

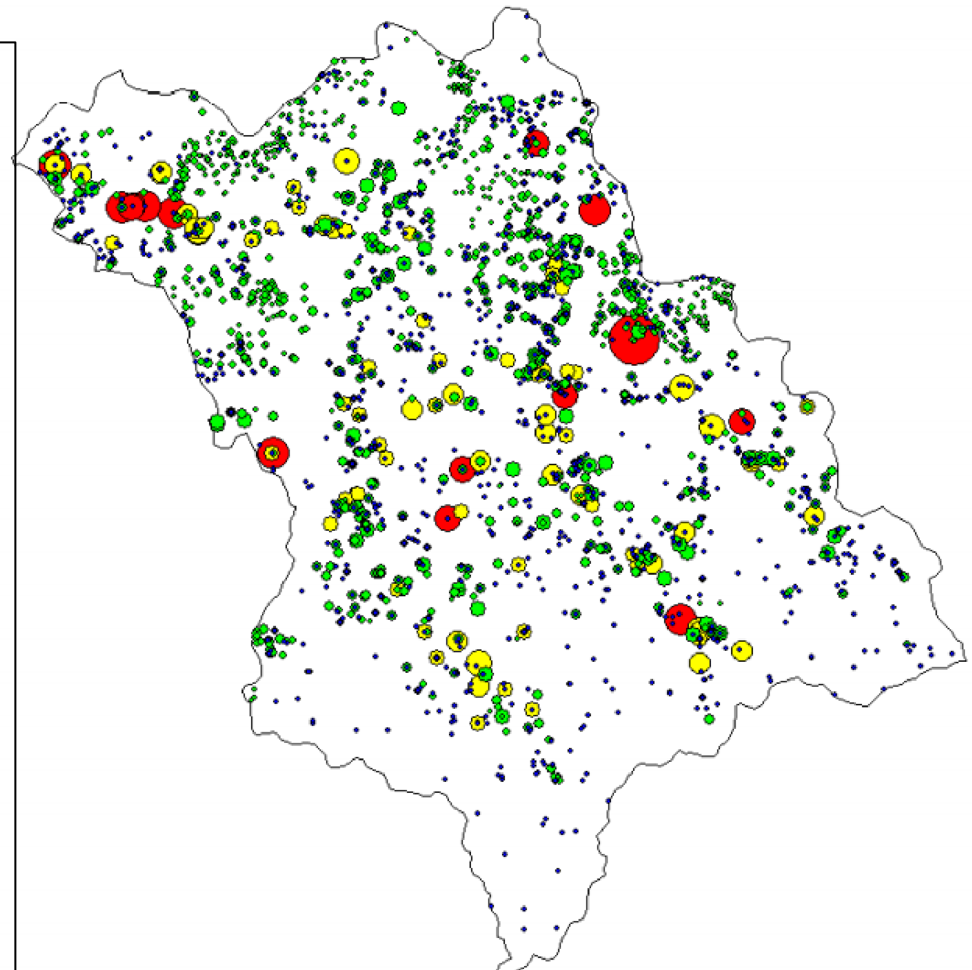
RESOURCE QUALITY OBJECTIVES

# Groundwater (Example)

# Example of groundwater quality status

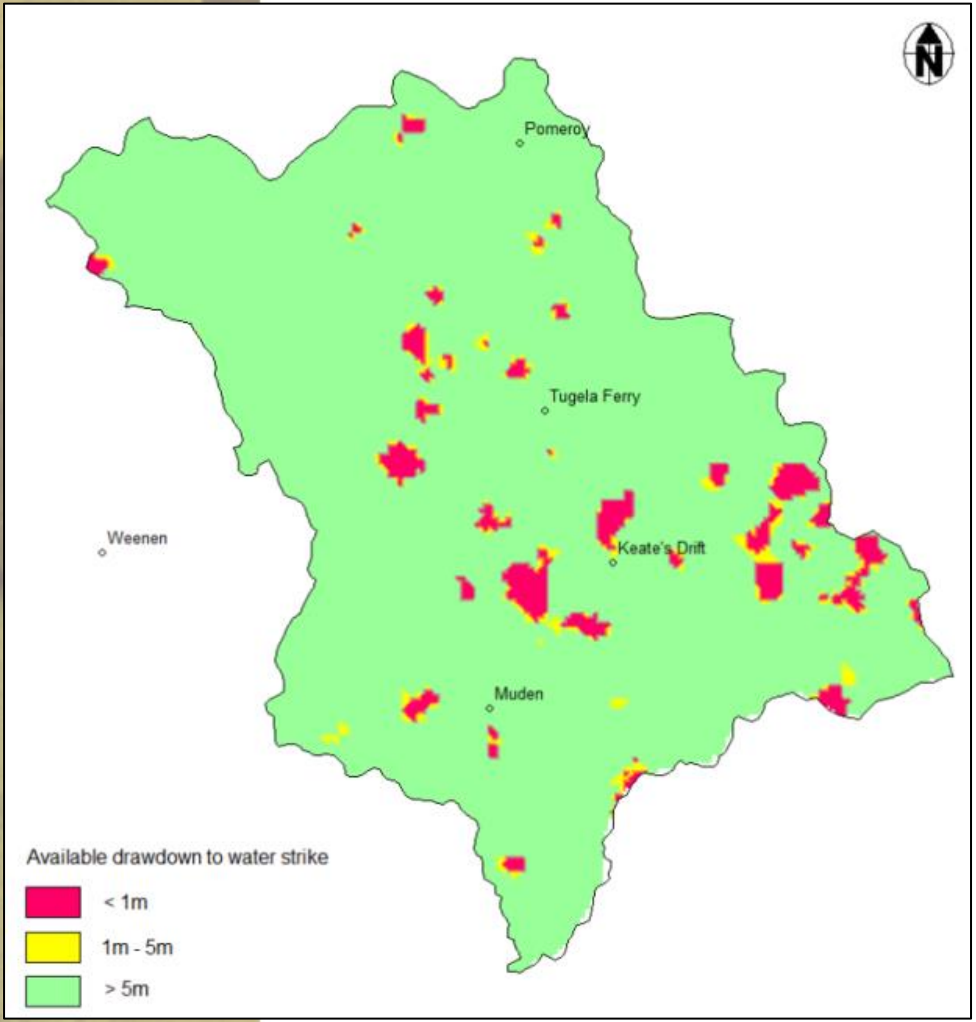
Example of occurrences of groundwater quality "Hotspots" in GRUs 8 and 12 (from the 2009 Reserve Study Dataset)

- This is the "worst case" of groundwater quality status in the Thukela Catchment and is point source pollution in boreholes;
- Background groundwater quality is in most cases an "Ideal" or "Good" water quality (<150mgTDS/L.
- Constituents of Concern (CoCs) are mainly Na (sodium), Cl (chloride) and $SO_4$ (sulphate). TAL is high (~300 to 400 mg$CaCO_3$/L; high Total Hardness).



Surface Water  Ground Water  No Value  value < 1000.00  value < 2400.00  value > 2400.00
Total dissolved solids [mg/l] (Last value measured) - SANS 241:2005

# Example of occurrences groundwater quantity status



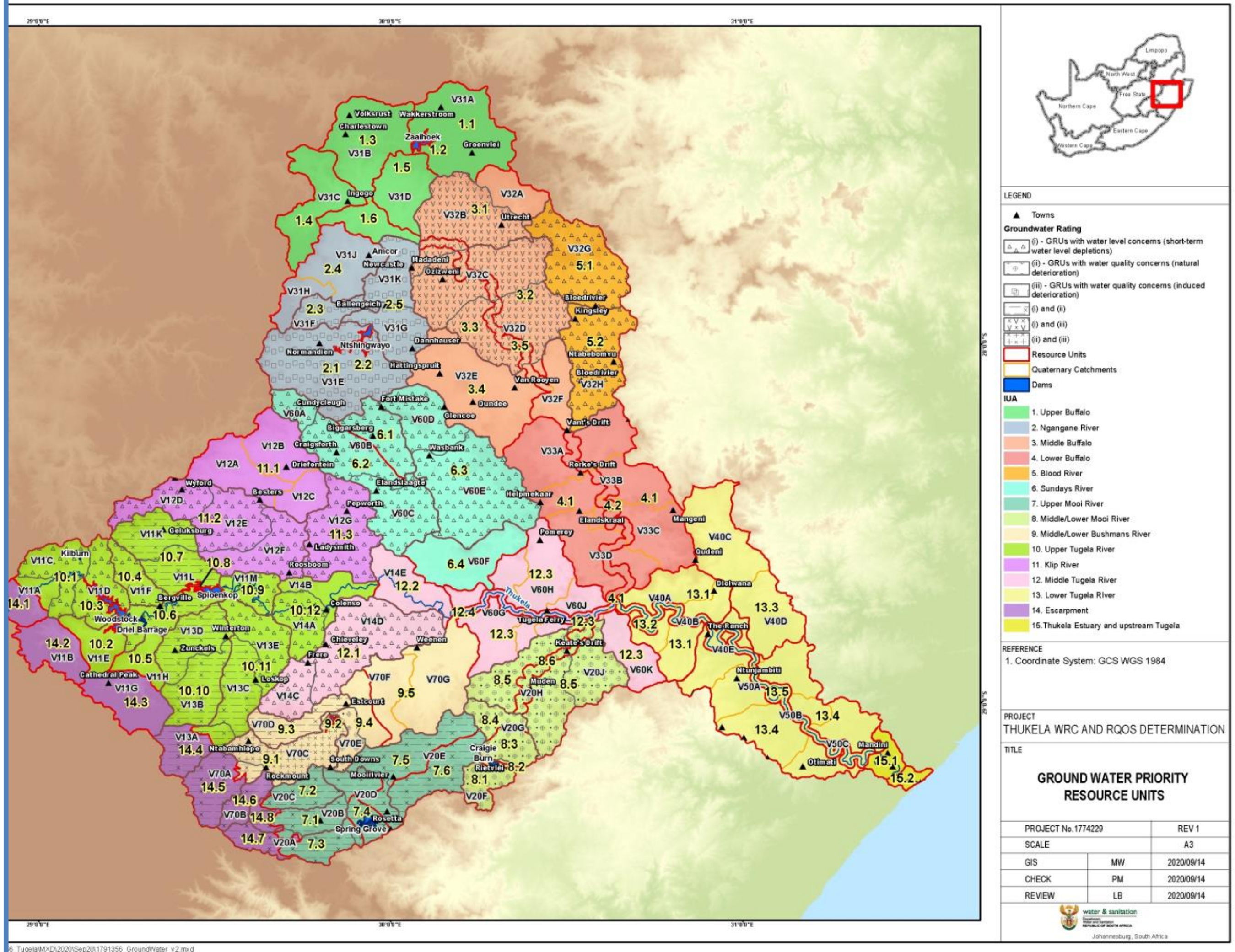

Example of occurrences groundwater quantity (i.e., aquifer saturation water level) “Hotspots” in GRUs 8 and 12 (from the 2009 Reserve Study Dataset)

- An illustration of locations where the groundwater level is impacted by abstraction form the aquifer system which results in a local dewatering zone of X m over time;
- If not replenished annually, these spots will spread up to a point [in time] where the borehole(s) can’t function economically.
- The RQOs should address this deterioration by means if limits in the individual water level drawdown value per borehole/wellfield; and
- Supported by a monitoring program where long-term time-series datasets will be able to manage abstraction figures.

# Study Overview: Groundwater

Groundwater RU prioritisation was based on the following criteria:

- RUs where aquifer sustainability due to recharge and saturation levels are a concern due to over abstraction and/or insignificant replenishment may occur,
- RUs where groundwater quality is a concern, and
- RUs where groundwater quality is a concern due to induced deterioration as the result of production/storage of concentrated waste material



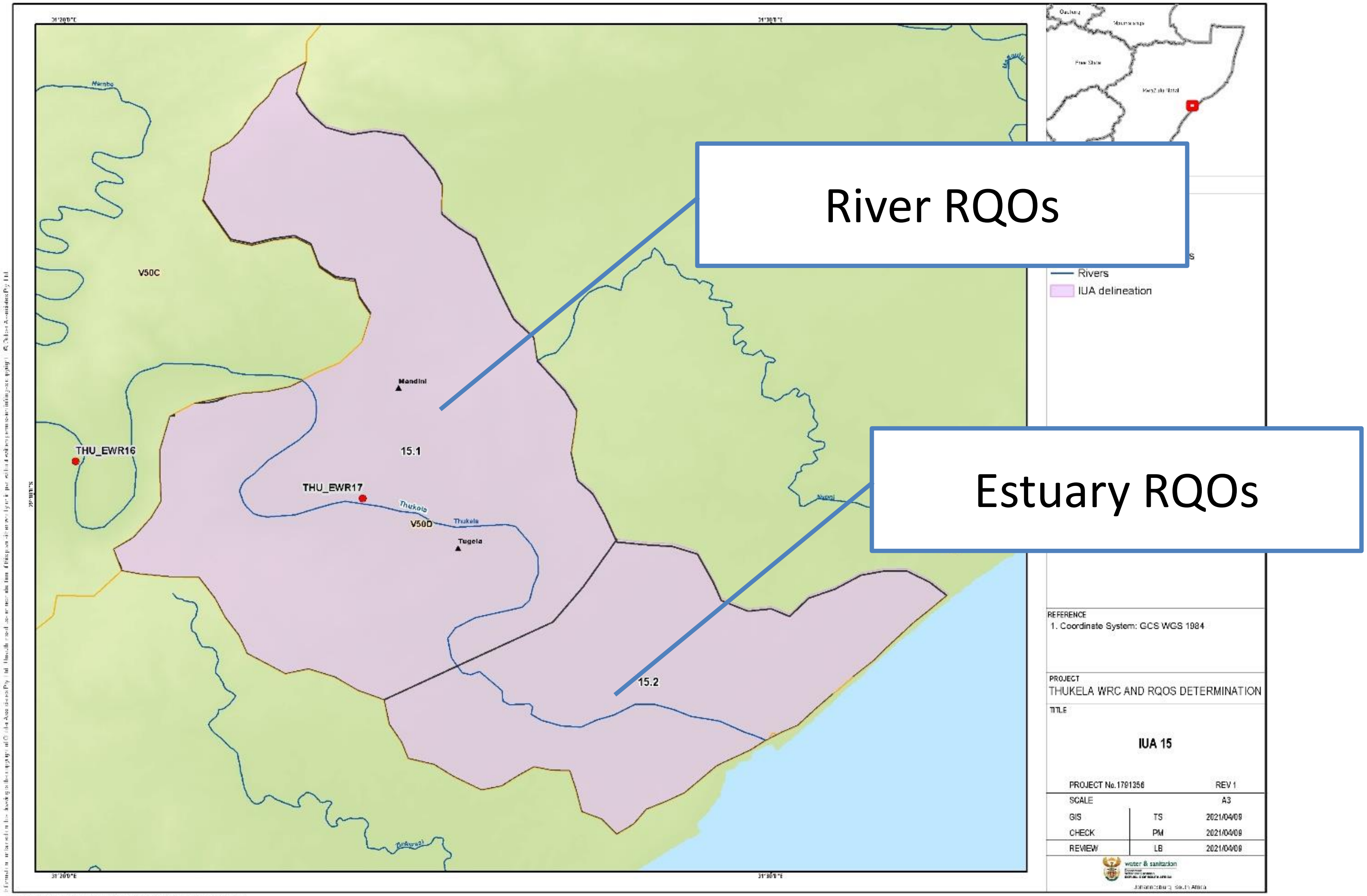
# Groundwater RQOs

| IUA/ GRU$_{(2020)}$ | Quantity (Qn) -Narrative | Quality (Ql) Narrative | Protection Criteria/Numerical Limits |
|---|---|---|---|
| **IUA 1: Upper Buffalo River (GRU-1)** | Gwater Balance: Groundwater yield balance (aquifer abstraction/recharge=S.I.) needs to be assessed for wet and dry cycles (to secure groundwater yields during dry periods). | Salinity: Concentrations should not increase.<br>Concentrations must be maintained at levels to secure an Ideal-Good water quality status.<br>Note: Natural water quality signature: Ca/Mg/**Na-HCO$_3$** | Qn: Stress Index should remain ≤0.65 (≤65% of annual recharge).<br>Note: SI is ~31%.<br>Ql: TDS – <450mg/L. Long-term trend should not approach +10% (∴~500 mg/L). |
| | Water table depths: Regular water level monitorin at wellfield(s) and background (viz. recharge) areas; | Macro-element constituents of concern (CoC): Chlorite and sulphate<br>Note: TAL is dominant anion hydrochemistry constituent – should remain <300 mgHCO$_3$/L. | Qn: Water level in wellfield area(s) should remain +5 above the main water strike (MWS).<br>Note: Scattered areas where water level is <1 m above MWS in QC V31B and should be regarded as a "Hotspot" area.<br>Ql: Chloride: <90 mgCl/L. Long-term trend should not approach+10% (∴100 mg/l).<br>Ql: Sulphate: <180 mgSO$_4$/L. Long-term trend should not approach+10% (∴200mg/l). |
| | Piezometric trends (time series): Long-term water level time series assessment should confirm annual rise, stable or falling (recession) status. | Toxicity: Nitrate, fluoride concentrations must be maintained to support domestic water user criteria (upper limit of Good WQC (water quality class). | Qn: Water level recession rate must be less than 0.5 m/a.<br>Ql: Nitrate: Less than 3.0 mg/l. Long-term trend should not approach +10% (~3.3 mg/l).<br>Fluoride: Less than 1.0 mg/L. Long-term trend should not approach +10% (∴~1.1 mg/l). |

RESOURCE QUALITY OBJECTIVES

# Estuary

# Estuary RQOs



# Resource Quality Objectives (RQO)

- 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 for the estuary.

# Estuary RQOs

- The character and function of estuaries tends to differ substantially from the receiving rivers so are managed as individual Resource Units (RUs).

- 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.

# Estuary RQOs (cont.)

- 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 C.
- In terms of RQOs for recreational use, the targets proposed are 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.

# Estuary RQOs (cont.)

- 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.

# Estuary RQOs (cont.)

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

| 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) |

# Estuary RQOs (RU 15.2)

| Component | Sub-component | RQO | Indicator | Numerical Limit/ measure | Context of the RQO and/ or Numerical limit |
|---|---|---|---|---|---|
| Quantity | Low Flows | Flows must be met to maintain the open mouth of the estuary. | Base flows | Must exceed 5$m^3$/s + LTBWSS abstraction (0.64 $m^3$/s during Phase 1 and 1.27 $m^3$/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.<br>[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 linefish 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<br>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 protect the aquatic ecosystem health and ensure the prescribed ecological category is met. | Salinity | Saline water within TEC may penetrate up to 6 km from the mouth at river flows close to 5 $m^3$/s | The vertical and longitudinal salinity gradients provide a 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.<br>$NH_4^+$ < 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.<br>$NH_4^+$ < 0.05 mg-N/L throughout.<br>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 | Water clarity to be maintained as specified to support the estuarine ecosystem. | Total Suspended Solids (TSS), Secchi depth, and/ or Turbidimeter | Turbidity should be < 20 mg/L (or < 20 NTU) at low river flows, close to 5 $m^3$/s, and near the mouth in saline waters.<br>Turbidity should increase above 20 mg/L (or > 20 NTU) as river flow increases and in the fresher upstream areas. | 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 of debris occurs during turbulent conditions, usually caused by strong wind, wave action and strong river flow.<br>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. |
| | 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.<br>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 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.<br>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.<br>Organic: Organotins, total petroleum hydrocarbons, algal toxins, tainting substances, polycyclic aromatics, halogenated aliphatics and ethers, monocyclic aromatics, nitrosamines, biocides, resin acids, and surfactants.<br>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 %ile)<br>*Escherichia coli* < 500 counts per 100 ml (90 %ile).) | For recreational use in estuaries (based on DEA, 2012).<br>Faecal *Streptococcus* can provide a more direct measure of human-sourced wastewater effluent. |

| Component | Sub-component | RQO | Indicator | Numerical Limit/ measure | Context of the RQO and/ or Numerical limit |
|---|---|---|---|---|---|
| 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. |
| | 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<br>Ash-free dry weight<br>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.<br>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.<br>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.<br>Maintain median subtidal and intertidal benthic chl-a < 42 mg/m$^2$. | 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.<br>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.<br>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.<br>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.<br>Macrobenthos: Eckman sediment grab sampling and sieving.<br>Zooplankton: Night collection using Bongo nets.<br>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.<br>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.<br>During low flows, open mouth, fauna typically dominated by estuarine and marine spp.; polychaetes, amphipods, isopods, Tanaidacea, gastropods and bivalves.<br>Zooplankton (estuarine): High diversity, low abundance during State 3 will switch to low diversity, high abundance during State 2.<br>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. | 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.<br>Estuaries support a variety of marine, estuarine and freshwater holo- and meroplanktonic zooplankton, dominance of which depends on estuarine characteristics (including abiotic states).<br>Macrocrustacea use estuaries for shelter and 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)<br>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. |
| | 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.<br>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. |

# 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.

# Discussion