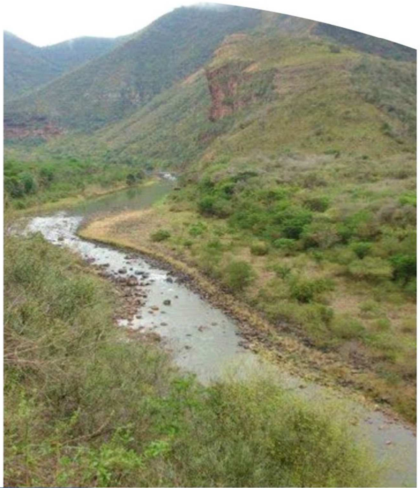
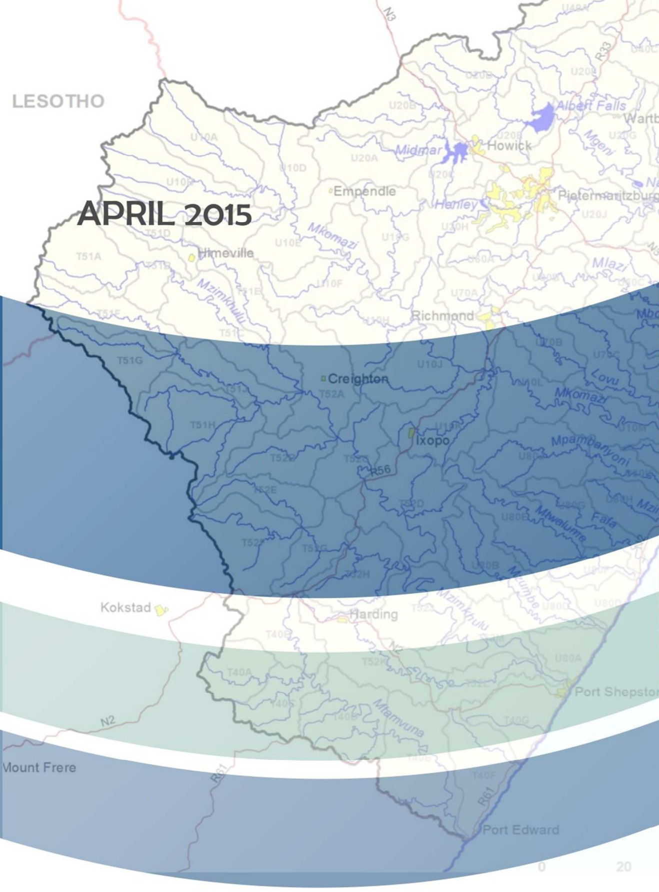
REPORT NO: RDM/WMA11/00/CON/CLA/0315

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

PROJECT NUMBER: WP 10679



VOLUME 1:
RIVER RESOURCE QUALITY OBJECTIVES



APRIL 2015

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

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CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

VOLUME 1: RIVER RESOURCE QUALITY OBJECTIVES

Report Number: RDM/WMA11/00/CON/CLA/0315

APRIL 2015

REFERENCE
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DOCUMENT INDEX

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2	Report Number: RDM/WMA11/00/CON/CLA/0113	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Status Quo assessment, IUA delineation and Biophysical Node identification**
3	Report Number: RDM/WMA11/00/CON/CLA/0213	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **River Resource Units and EWR sites**
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6	Report Number: RDM/WMA11/00/CON/CLA/0212	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **BHNR**
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8.3	Report Number: RDM/WMA11/00/CON/CLA/0714	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3 Supporting Information on the Determination of Water Resource Classes – Estuary specialist appendices (electronic information only)**
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Index Number	DWS Report Number	Report Title
9.2	Report Number: RDM/WMA11/00/CON/CLA/0415	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 2: Wetland RQOs**
9.3	Report Number: RDM/WMA11/00/CON/CLA/0515	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3: Groundwater RQOs**
9.4	Report Number: RDM/WMA11/00/CON/CLA/0615	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 4: Estuary RQOs**
10	Report Number: RDM/WMA11/00/CON/CLA/0715	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Implementation Report**
11	Report Number: RDM/WMA11/00/CON/CLA/0815	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Main Report**
12	Report Number: RDM/WMA11/00/CON/CLA/0116	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Closing Report**

DEPARTMENT OF WATER AND SANITATION
CHIEF DIRECTORATE: WATER ECOSYSTEMS

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

VOLUME 1: RIVER RESOURCE QUALITY OBJECTIVES

Approved for RFA by:

…………………………………….	…………………………………….
Delana Louw Project Manager	Date

DEPARTMENT OF WATER AND SANITATION (DWS)
Approved for DWS by:

…………………………………….	…………………………………….
Chief Director: Water Ecosystems	Date

AUTHORS

The information in this report was authored by the multi-disciplinary group of specialists involved. Contributions were provided as follows:

- Delana Louw: EWR coordinator, EcoClassification and EWR scenario process, application of the Index of Habitat Integrity
- Dr Andrew Deacon: Macro-invertebrates
- Shael Koekemoer: Diatoms
- Dr Pieter Kotze: Fish
- James Mackenzie: Riparian vegetation
- Dr Patsy Scherman: Water quality

Report Editor: Shael Koekemoer

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REPORT SCHEDULE

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First draft	April 2015
Final	June 2015

EXECUTIVE SUMMARY

BACKGROUND

The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area. The Mvoti to Umzimkulu WMA encompasses a total catchment area of approximately 27,000 km^2 and occurs largely within Kwazulu-Natal.

This task forms ***part*** of Step 6, i.e. the development of RQOs and provision of numerical limits. This step is closely linked to the next step where the class configuration and RQOs are gazetted and implemented. The results of Step 6 are documented in this report.

RESOURCE QUALITY OBJECTIVES

RQOs are numerical and/or descriptive statements about the biological, chemical and physical attributes that characterise a resource for the level of protection defined by its Class. The *National Water Resource Strategy* (NWRS) therefore stipulates that "Resource Quality Objectives might describe, among other things, the quantity, pattern and timing of instream flow; water quality; the character and condition of riparian habitat, and the characteristics and condition of the aquatic biota".

Operational scenarios, Water Resource Classes and RQOs are inherently linked as operational scenarios (Sc) to inform the Water Resource Class and RQOs define and/or describe the Water Resource Class (Figure below).

Links between RQOs and the Water Resource Class and operational scenarios

RIVER RESOURCE UNITS

Resource units (RUs) are delineated as follows:

- Sub-quaternary (SQ) reaches have been identified (DWA, 2013[1]) for the study area. These are surrogates for RUs in areas where further detailed RU determination will not be undertaken. These RUs are represented by desktop biophysical nodes (DWA, 2013).
- For the purposes of RQOs, the SQs were combined to form RUs which represent a homogenous area of similar state and land use. This process was followed in tributaries and rivers with no EWR sites which are usually lower priority areas and therefore do not include hotspots.
- In key rivers which include hotspots (DWA, 2013), a detailed RU assessment was undertaken to determine Management Resource Units (MRU). These also consist of a range of SQs, but the process and criteria used are more detailed than for the lower priority rivers. These MRUs

[1]Department of Water Affairs (DWA). 2013. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Status quo assessment, IUA delineation and biophysical node identification. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. Report Number: RDM/WMA11/00/CON/CLA/0113.

were identified during Reserve studies. Most MRUs are represented by key biophysical nodes (EWR sites).

Resource Unit (RU) priority is based on the outcome of the hotspot assessment (Step 1 of the integrated steps for the NWRC and RQO determination) as well as available information and confidence in the information.

There are three main priority levels each with the broad type and detail of RQOs indicated:

RU priority level		**Associated RQO**
Low (1)	1a	Flow RQO. Habitat RQO in terms of Present Ecological State (PES) and Recommended Ecological Category (REC) (EcoStatus).
	1b	Habitat RQO in terms of PES and REC (EcoStatus) (total river length usually in declared conservation areas).
Moderate (2)	2	Flow RQO. Habitat and biota RQO (broad).
High (3)	3a	Forms part of RU represented by an Ecological Water Requirement (EWR) site.
	3b	EWR site. Flow RQO related to Target EC. Detailed habitat and biota RQO (EcoSpecs).
	3WQ	User water quality RQOs included.. Water quality RQOs required as water quality is the driver at these sites. Habitat and biota RQO will be at a Priority level 2.

HYDROLOGY RQOs AT HIGH PRIORITY RIVER RUS (EWR SITES)

Table 1 provides an indication of the hydrological RQOs in terms of flow at biophysical nodes and Ecological Water Requirement (EWR) sites for the rivers in the study area. These summarised statistics are representative of the required flow regime in the river where the variability is dependent on the seasonal and temporal pattern of natural flow conditions. The mean monthly flows represent low flow requirements of a representative wet (February) and dry (September) month. Percentage points on the monthly low flow frequency distribution continuum at the nodes are defined 90% (representative of drought conditions) and 60%.

Table 1: RIVERS: Summary of key hydrological RQOs

RU	Biophysical node and EWR site	River	Target EC	nMAR (MCM)	Low flows (%nMAR)	Total flows (%nMAR)	Sep (m^2/s)		Feb (m^2/s)	
							90%	60%	90%	60%
MTAMVUNA (T4): IUA T4-1										
MRU MT B	T40E-05601 Mt_R_EWR1	Mtamvuna	**C**	79.22	19.1	32.1	0.332	0.525	1.157	1.606
uMKHOMAZI (U1): IUA U1-2										
MRU uMKHOMAZI B.3	U10E-04380 Mk_I_EWR1	uMkhomazi	**C**	683.17	18.1	27.2	0.890	1.458	4.130	5.542
uMKHOMAZI (U1): IUA U1-3										
MRU uMKHOMAZI C	U10J-04679 Mk_I_EWR2	uMkhomazi	**B**	890.91	14.2	35.8	1.551	2.869	5.991	10.488
uMKHOMAZI (U1): IUA U1-4										
MRU uMKHOMAZI D	U10M-04746 Mk_I_EWR3	uMkhomazi	**C**	1068.6	21.2	31.1	1.532	2.203	5.589	7.668
uMNGENI (U2): IUA U2-1										
MRU uMnA	U20A-04253 Mg_R_EWR1	uMngeni	**C/D**	79.22	10.1	21.7	0.016	0.098	0.179	0.327
uMNGENI (U2): IUA U2-2										
M KAR C	U20E-04170 Mg_R_EWR3	uMngeni	**B**	70.11	27.3	43.5	0.032	0.245	0.203	0.758
MRU uMnB	U20E-04243 Mg_I_EWR2	uMngeni	**C**	228.19	14.7	20	0.460	0.810	0.450	0.990
uMNGENI (U2): IUA U2-5										
MRU uMn D	U20L-04435 Mg_I_EWR5	uMngeni	**D**	583.66	21.2	24.3	0.856	2.017	1.655	2.477
MVOTI (U4): IUA U4-1 & U4-2										
MRU HEYNS A	U40B-03770 Mv_I_EWR1	Mvoti	**C**	17.36	18.2	27.9	0.030	0.037	0.067	0.093
MVOTI (U4): IUA U4-3										
MRU MVOTI C	U40H-04064 Mv_I_EWR2	Mvoti	**C**	273.96	14.4	21.2	0.174	0.402	0.622	1.336
LOVU (U7): IUA U7-1										
MRU LOVU D	U40H-04064 Lo_R_EWR1	Lovu	**B/C**	87.76	22.8	37.9	0.142	0.189	0.359	0.533

HABITAT, BIOTA AND WATER QUALITY RQOs AT HIGH PRIORITY RIVER RUs (EWR SITES)

Information is presented for High Priority EWR sites as a summary table (Table 2).

Table 2 RIVERS: Summary of key habitat, biota and water quality RQOs

Component/ Indicator	Target EC	RQO
IUA T4-1: MTAMVUNA		
RU EWR MT_R-EWR1 (T40E-05601, T40C-05520, T40D-05537, 05584, 05707)		
Fish	**B/C**	Maintain EC. Fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this unit. These species provide valuable indicators that should be used to monitor potential change. Primary indicator fish species for this reach is the semi-rheophilic Natal Scaly (BNAT).
Invertebrates	**B**	Community should be representative of a medium foothill stream assemblage with perennial flows.
Riparian vegetation	**C/D**	Agricultural activities shall not encroach into the riparian zone or floodplain and perennial invasive alien species shall be kept in check.

Component/ Indicator	Target EC	RQO
Water quality	A/B	Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
IUA U1-2: MIDDLE uMKHOMAZI		
RU MK_I_ EWR 1 DS (U10F-04528 DS)		
Fish	B	Four indigenous species. Primary indicator fish species is the semi-rheophilic Natal mountain catfish (ANAT). FROC of ANAT and BNAT will decrease and result in the drop of a B/C for Sc 21.
Invertebrates	B/C	Community should be representative of a medium-sized mountain stream assemblage with perennial flows. Maintain SIC (SIC) with moderate marginal vegetation habitat, deep water with slow flows and rocky bottoms.
Riparian vegetation	C	Perennial invasive alien species must be kept in check (especially wattle) to maintain the C EC. No increase of agricultural activities such as overgrazing and trampling
Water quality	A/B	Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
IUA 1-3: uMKHOMAZI GORGE		
RU MK_I_ EWR 2 (U10J-04679, U10JH-04638, 04675)		
Fish	B	Seven indigenous species. Primary indicator fish species is the semi-rheophilic ANAT. The abundance and FROC of most species, especially ANAT and BNAT will decrease and result in the drop to a C for Sc 21.
Invertebrates	B	Community should be representative of a lowland river assemblage with perennial flows. Maintain stones-incurrent with scanty marginal vegetation. Sediment scouring may impact on bottom dwelling taxa resulting in drop of category.
Riparian vegetation	B	Perennial invasive alien species must be kept in check to maintain the category. Agricultural activities must not encroach into the riparian zone or floodplain.
Water quality	A/B	Ensure that nutrient levels (phosphate) are within Acceptable limits: 50^{th} percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
		Ensure that electrical conductivity (salt) levels are within Ideal limits: 95^{th} percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
IUA U1-4: LOWER uMKHOMAZI		
RU MK_I_ EWR 3 (U10M-04746, U10J-04807, 04799, 04833, U10K-04838)		
Fish	B	23 indigenous species. Primary indicator fish species is the semi-rheophilic BNAT. The abundance and FROC of especially BNAT will decrease and result in the drop to a B/C for Sc 21.
Invertebrates	B	Community should be representative of a large lowland river assemblage with perennial flows. Maintain dominant alluvial run habitats with good SIC controls. The marginal vegetation habitat may become reduced during Sc 21, therefore the drop to a B/C.
Riparian vegetation	D	Perennial invasive alien species must be kept in check to maintain the D.
Water quality	A/B	Ensure that nutrient levels (phosphate) are within Acceptable limits: 50^{th} percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
		Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95^{th} percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).
IUA 2-1: uMNGENI UPSTREAM MIDMAR DAM		
RU Mg_R_ EWR 1 (U20A-04253, U20C-04275)		
Fish	D (C)	Alien fish major issue at site. Primary indicator species are ANAT and BNAT.
Invertebrates	C	Community should be representative of a small foothill stream assemblage with perennial flows. Good SIC with scanty marginal vegetation. Deeper pools also important.
Riparian vegetation	C/D	Perennial invasive alien species must be kept in check to maintain the C/D. Maintain the composition and diversity of the woody and non-woody species.
Water quality	B	Ensure that nutrient levels (phosphate) are within Acceptable limits: 50^{th} percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
		Meet faecal coliform and *E. coli* targets for full and partial contact.

Component/ Indicator	Target EC	RQO
IUA 2-2: uMNGENI, MIDMAR TO ALBERT FALLS		
RU Mg_I_ EWR 2 (U20E-04243, U20E-04221)		
Fish	**D**	PES in E. Must be improved to D – potential water quality issues. Alien fish major issue at site. Primary indicator species are ANAT and BNAT.
Invertebrates	**C**	Community should be representative of a foothill slope river assemblage with perennial flows. Good SIC with moderate marginal vegetation. Deeper pools also important.
Riparian vegetation	**C**	Perennial invasive alien species must be kept in check to maintain the C. Maintain the composition and diversity of the woody and non-woody species.
Water quality	**C/D**	Ensure that nutrient levels (phosphate) are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).
		Ensure that nutrient levels (TIN) are within Acceptable limits: 50th percentile of the data must be less than 0.85 mg/L TIN-N (Aquatic ecosystems: driver).
		Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
		Meet faecal coliform and *E. coli* targets for full and partial contact.
		Ensure that toxics (ammonia, aluminium, lead) are within Tolerable categories: 95th percentile of the data must be within the D category according to DWAF (2008b). Ensure that other toxics monitored are within Ideal limits or A categories (DWAF, 2008b) or the TWQR for toxics in DWAF (1996c).
RU Mg_R_ EWR 3 (U20E-04170)		
Fish	**B/C**	Maintain EC and 11 indigenous species. Primary indicator species is small ANAT and large BNAT.
Invertebrates	**B**	Community should be representative of a medium-sized foothill stream assemblage with perennial flows. Good SIC with good marginal vegetation. Deeper pools also important.
Riparian vegetation	**B**	Perennial invasive alien species must be kept in check to maintain the B Category. Maintain the composition and diversity of the woody and non-woody species.
Water quality	**B**	Ensure that nutrient levels (phosphate) are within Acceptable limit: 50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
IUA 2-4: uMNSUNDUZE		
RU Mg_R_ EWR 4 (U20J-03464, U20E-04401)		
Fish	**E**	The primary indicator fish species for this reach (especially in terms of flow-modification) is the large semi-rheophilic BNAT. This fish category needs to be improved to at least a D EC.
Invertebrates	**E**	The macro-invertebrate community should be representative of a medium-sized foot-hill stream assemblage with perennial flow, and should be improved to at least a D Category.
Riparian vegetation	**D/E**	The target EC for the site is to improve the EC to a Category D. Perennial invasive alien species must be removed and kept in check. Species composition within the riparian zone must reflect the target EC and maintain current levels of endemism.
Water quality	**E/F**	Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver): 50th percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).
		Ensure that periphyton chl-a levels are within Tolerable limits: 50th percentile of the data must be less than 52.5 mg/m^2 periphyton chl-a (Aquatic ecosystems: driver).
		Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
		Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with increased turbidity levels expected (Aquatic ecosystems: driver).
		Meet faecal coliform and *E. coli* targets for full and partial contact.
		Ensure that toxics are within prescribed limits to maintain or improve present state: Numerical limits (95th percentiles) can be found in DWAF (1996c) and DWAF (2008b).
		Ensure that dissolved oxygen levels are within Tolerable limits: 5th percentile of the data must be more than 5 mg/L dissolved oxygen (Aquatic ecosystems: driver).
IUA 2-5: uMNGENI DS uMNSUNDUZE CONFLUENCE TO INANDA DAM		
RU Mg_I_ EWR 5 (U20L-04435, U20M-04396)		

Component/ Indicator	Target EC	RQO
Fish	D	Maintain EC and 15 indigenous species. Primary indicator species is large BNAT.
Invertebrates	C/D	Community should be representative of a large lowland river assemblage with perennial flows. Good SIC with adequate marginal vegetion. Deeper pools also important.
Riparian vegetation	D	Perennial invasive alien species must be kept in check to maintain the very low D. Maintain the composition and diversity of the woody and non-woody species. No further removal of vegetation or bank disturbance should take place.
Water quality	C/D	Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). 50th percentile of the data must be less than 4.0 mg/L TIN-N (Aquatic ecosystems: driver).
		Ensure that periphyton chl-a levels are within Tolerable limits: 50th percentile of the data must be less than 21 mg/m^2 periphyton chl-a (Aquatic ecosystems: driver).
		Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).
		Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
		Meet faecal coliform and *E. coli* targets for full and partial contact.
IUA 4-1 AND 4-2: MVOTI		
RU MV_I_ EWR 1 (U40B-03770, HEINESSPRUIT)		
Fish	C	Maintain EC. Six indigenous species. Primary indicator species is BNAT.
Invertebrates	C	Community should be representative of a small mountain stream assemblage with perennial flows. Good SIC with moderate marginal vegetation.
Riparian vegetation	B/C	Perennial invasive alien species must be kept in check to maintain B/C. Maintain the composition and diversity of the woody and non-woody species.
Water quality	C	Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L PO_4-P (Aquatic ecosystems: driver). 50th percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).
		Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
		Meet faecal coliform and *E. coli* targets for full and partial contact.
		Ensure that toxics are within prescribed limits to maintain or improve present state: Numerical limits (95th percentiles) can be found in DWAF (1996c) and DWAF (2008b).
IUA 4-3: LOWER MVOTI		
RU MV_I_ EWR 2 (U40H-04064)		
Fish	B/C	Maintain EC and 16 indigenous species. Primary indicator species is large BNAT. Change in FROC will result in degradation to a C EC.
Invertebrates	B/C	Community should be representative of a large lowland river assemblage with perennial flows. Good SIC with adequate marginal vegetation and clean substrate in runs.
Riparian vegetation	C/D	Perennial invasive alien species must be kept in check to maintain a C/D. Maintain the composition and diversity of the woody and non-woody species.
Water quality	C	Ensure that nutrient levels (phosphate) are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L PO_4-P (Aquatic ecosystems: driver).
		Ensure that turbidity or clarity levels stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads (Aquatic ecosystems: driver
IUA 7-1: LOVU		
RU LO_R_ EWR 1 (U70C-04859)		
Fish	B/C	Twelve indigenous fish species. Fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this RU. These species provide valuable indicators that should be used to monitor potential change. Primary indicator fish species for this reach is the semi-rheophilic BNAT.
Invertebrates	B/C	Community should be representative of a medium foothill stream assemblage with perennial flows. Maintain SIC with marginal vegetation habitat.

Component/ Indicator	Target EC	RQO
Riparian vegetation	**B/C**	Perennial invasive alien species must be kept in check to maintain the B/C. Integrity of seep wetlands associated with the riparian zone must also be maintained.
Water quality	**B/C**	Ensure that turbidity or clarity levels stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads (Aquatic ecosystems: driver).

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ACRONYMS AND ABBREVIATIONS

ASPT	Average Score Per Taxon
AIP	Alien Invasive Plants
CD: WE	Chief Directorate: Water Ecosystems
CEV	Chronic Effects Value
DD	Data Deficient
DRM	Desktop Reserve Model
DSS	Decision Support System
DUCT	Duzi uMngeni Conservation Trust
DWA	Department of Water Affairs (Name change applicable after 2008)
DWAF	Department of Water Affairs and Forestry (Name change applicable after April 2009)
DWS	Department of Water Affairs and Sanitation (Name change apllicablehange after May 2014)
EC	Ecological Category
EcoSpecs	Ecological Specifications
EI	Environmental Importance
ES	Ecological Sensitivity
EWR	Ecological Water Requirement
FRAI	Fish Response Assessment Index
FROC	Frequency of Occurrence
GE	Google Earth
IBT	Inter-Basin Transfers
ind/min	Individuals per minute
IUA	Integrated Unit of Analysis
IAP	Invasie Alien Plants
IUCN	International Union for Conservation of Nature
LC	Least Concern
MAR	Mean Annual Runoff
MCM	Million Cubic Metres
MIRAI	Macro Invertebrate Response Assessment index
MMTS2	Mooi-uMngeni Transfer Scheme Phase 2
MRU	Management Resource Unit
nMAR	Natural Mean Annual Runoff
NMMP	National Microbial Monitoring Programme
NWRC	National Water Resource Classification
NWRS	National Water Resource Strategy
PAI	Physico-chemical Driver Assessment Index
PES	Present Ecological State
PESEIS	Present Ecological State and Ecological Importance - Ecological Sensitivity
pMAR	Present Day Mean Annual Runoff
PR	Priority Rating
PSP	Professional Service Provider
Quat	Quaternary catchment
RDRM	Revised Desktop Reserve Model
REC	Recommended Ecological Category
RHAM	Rapid Habitat Assessment Method
RQO	Resource Quality Objective
RU	Resource Unit
SASS 5	South African Scoring System version 5

Sc	Scenario
SIC	Stones in Current
SQ	Sub Quaternary
TEACHA	Tool for Ecological Aquatic Chemical Habitat Assessment
TEC	Target EC
TIN	Total Inorganic Nitrogen
TPCs	Thresholds of Potential Concern
TWG	Technical Working Group
TWQR	Target Water Quality Range
UW	Umgeni Water
VEGRAI	Riparian Vegetation Response Assessment Index
VIP	Ventilated Improved Pit sanitation system
WMA	Water Management Area
WMS	Water Management System
WRYM	Water Resource Yield Model
WWTW	Waste Water Treatment Works
Fish species name abbreviations	
AAEN	*Awaous aeneofuscus*
ABER	*Acanthopagrus berda*
ABIC	*Anguilla bicolor bicolor*
ALAB	*Anguilla bengalensis labiata*
AMAR	*Anguilla marmorata*
AMOS	*Anguilla mossambica*
BANO	*Barbus anoplus*
BGUR	*Barbus gurneyi*
BNAT	*Labeobarbus natalensis*
BPAL	*Barbus pallidus*
BPAU	*Barbus paludinosus*
BVIV	*Barbus viviparus*
CGAR	*Clarias gariepinus*
GAES	*Gilchristella aestuaria*
GCAL	*Glossogobius callidus*
GGIU	*Glossogobius giuris*
LMCR	*Liza macrolepis*
LRIC	*Liza richardsonii*
MBRA	*Microphis brachyurus*
MCAP	*Myxus capensis*
MCEP	*Mugil cephalus*
MCYP	*Megalops cyprinoides*
MFAL	*Monodactylus falciformis*
MFLU	*Microphis fluviatilis*
OMOS	*Oreochromis mossambicus*
OMYK	*Oncorhynchus mykiss*
PPHI	*Pseudocrenilabrus philander*
RDEW	*Redigobius dewaali*
TREN	*Tilapia rendalli*
TSPA	*Tilapia sparrmanii*
Fish and Macro-invertebrate Habitats	
FD	Fast Deep
FFCS	Fast flow over coarse sediment
FS	Fast Shallow
SD	Slow Deep

SIC	Stones in Current
SS	Slow Shallow
VFCS	Very fast flow over coarse sediment

1 INTRODUCTION

1.1 BACKGROUND

There is an urgency to ensure that water resources in the Mvoti to Umzimkulu Water Management Area (WMA) are able to sustain their level of uses and be maintained at their desired states. The determination of the Water Resource Classes of the significant water resources in Mvoti to Umzimkulu WMA will ensure that the desired condition of the water resources, and conversely, the degree to which they can be utilised is maintained and adequately managed within the economic, social and ecological goals of the water users (DWA, 2011a). The Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu WMA.

1.2 STUDY AREA OVERVIEW

The Mvoti to Umzimkulu WMA encompasses a total catchment area of approximately 27,000 km^2 and occurs largely within Kwazulu-Natal. A small portion of the Mtamvuna River and the upper and lower segments of the Umzimkulu River straddle the Eastern Cape, close to the Mzimvubu and Keiskamma WMA in the south (DWA, 2011b).

The WMA extends from the town of Zinkwazi, in the north to Port Edward and on the south along the KwaZulu-Natal coastline and envelopes the inland towns of Underberg and Greytown up until the Drakensberg escarpment. The WMA spans across the primary catchment “U” and incorporates the secondary drainage areas of T40 (Mtamvuna River in Port Shepstone) and T52 (Umzimkulu River). Ninety quaternary catchments constitute the water management area and the major rivers draining this WMA include the Mvoti, uMngeni, uMkhomazi, Umzimkulu and Mtamvuna (DWA, 2011b).

Two large river systems, the Umzimkulu and uMkhomazi rise in the Drakensberg. Two medium-sized river systems the uMngeni and Mvoti rise in the Natal Midlands and have been largely modified by human activities, mainly intensive agriculture, forestry and urban settlements. Several smaller river systems (e.g. Mzumbe, uMdloti, Tongaat, Fafa, and Lovu Rivers) also exist within the WMA (DWAF, 2004). Several parallel rivers arise in the escarpment and discharges into the Indian Ocean and the water courses in the study area display a prominent southeasterly flow direction (DWA, 2011b).

The WMA is very rugged and very steep slopes characterise the river valleys in the inland areas for all rivers and moderate slopes are found but comprise only 3% of the area of the WMA (DWAF, 2004).

1.3 INTEGRATED STEPS APPLIED IN THIS STUDY

The integrated steps for the National Water Classification System, the Reserve and RQOs (DWA, 2012a) are supplied in Table 1.1.

Table 1.1 Integrated study steps

Step	Description
1	Delineate the units of analysis and Resource Units, and describe the status quo of the water resource(s) (completed).
2	Initiation of stakeholder process and catchment visioning (on-going).
3	Quantify the Ecological Water Requirements and changes in non-water quality ecosystem.
4	Identification and evaluate scenarios within the Integrated Water Resource Management process.
5	Evaluate the scenarios with stakeholders and determine Water Resource Classes.
6	**Develop draft RQOs and numerical limits.**
7	Gazette and implement the class configuration and RQOs.

This task forms ***part*** of Step 6, i.e. the development of RQOs and provision of numerical limits. This step is closely linked to the next step where the class configuration and RQOs are gazetted and implemented. The results of Step 6 are documented in this report. The information generated during Step 1, 3, 4 and 5 forms the basis of the RQOs.

1.4 INTRODUCTION TO RQOs

RQOs are numerical and/or descriptive statements about the biological, chemical and physical attributes that characterise a resource for the level of protection defined by its Class. The *National Water Resource Strategy* (NWRS) therefore stipulates that “Resource Quality Objectives might describe, among other things, the quantity, pattern and timing of instream flow; water quality; the character and condition of riparian habitat, and the characteristics and condition of the aquatic biota”.

The 7 steps to be applied during the determination of RQOs and guidelines to determine RQOs are provided in DWA (2011a). Habitat and Biota RQOs (referred to as Ecological Specifications (EcoSpecs) and Thresholds of Potential Concern (TPC)) are according to DWA (2010).

1.5 TASK D6: RQO STEPS AND INTEGRATION

As there are significant overlap in the RQO steps with the Classification and Reserve steps, integrated steps have been designed which incorporates the RQO steps in an iterative manner and used during this study. The 7 steps are incorporated in the integrated steps (Table 1.1) and this integration is illustrated in Table 1.2.

Table 1.2 RQO steps as integrated in the Integrated Classification Steps

Integrated steps		RQO steps	Comment
1	Delineate the units of analysis and Resource Units (RUs), and describe the status quo of the water resource(s) (completed).	1. Delineate Integrated Units of Analysis (IUAs) and define RUs.	RUs are defined at a broad level on a sub-quaternary (SQ) basis.
		3. Prioritise and select RUs for RQO determination.	Process to determine priority areas called hotspots defines the priority levels for RQO determination.
2	Initiation of stakeholder process and catchment visioning (on-going).	2. Establish a vision for the catchment and key elements for the IUAs.	Undertaken during Step 1 above.
3	Quantify the Ecological Water Requirements (EWRs) and changes in non-water quality ecosystem.	3. Prioritise and select RUs for RQO determination.	More detailed RUs defined for high priority rivers.
		4 Prioritise sub-components for	Undertaken during Step 1 and 3 as

Integrated steps		RQO steps	Comment
		RQO determination, select indicators for monitoring and propose direction of change.	part of the EcoClassification process.
4	Identification and evaluation of scenarios within the Integrated Water Resource Management process.		
5	Evaluate the scenarios with stakeholders and determine Water Resource Classes.	6. Agree on RUs, RQOs and numerical limits with stakeholders.	Is undertaken during all preceding stakeholder meetings. RQOs (hydrological) are agreed on during the Water Resource Class decision making as the hydrological RQOs are the flows associated with the Water Resource Class.
6	**Develop draft RQOs and numerical limits.**	5. Develop draft RQOs and numerical limits.	The focus in this step is on finalising the habitat, biota and water quality RQOs.
7	Gazette and implement the class configuration and RQOs.	7. Finalise and gazette RQOs	

1.6 OPERATIONAL SCENARIOS, WATER RESOURCE CLASS AND RQOs

Operational scenarios, Water Resource Classes and RQOs are inherently linked as operational scenarios (Sc) to inform the Water Resource Class and RQOs define and/or describe the Water Resource Class (Figure 1.2).

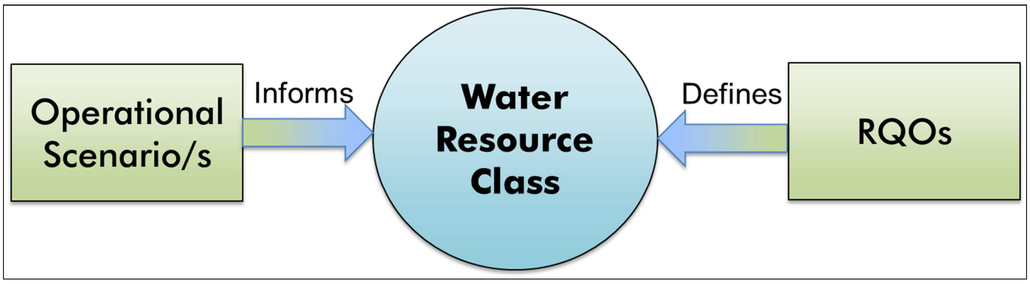


Figure 1.1 Links between RQOs and the Water Resource Class and operational scenarios

Various scenarios were tested and the selected Water Resource Class indicated for each scenario (DWS, 2014a). The recommended scenario (DWS, 2014a) for each river system consisted of the following:

1.6.1 uMkhomazi System

In the short term, the Water Resource Class associated with the status quo will be maintained. In the medium to long term, Sc MK21 is recommended and consists of the following:

- Updated water demands.
- Ultimate development demands and return flows (2040).
- uMkhomazi Water Project (Smith field Dam).
- EWR: Recommended Ecological Category (REC) total EWR flows released for EWR 2.
- Ngwadini Off channel Dam with support from Smithfield Dam and no support from Ngwadini.

The selection of either scenario for the purpose of classification would result in the same Water Resource Class.

RQOs are therefore determined for the hydrology and water quality and Ecological Categories (ECs) associated with the Water Resource Class for the present conditions. Where the catchment configuration differs for Sc MK21, a broad description of the predicted conditions is provided.

Table 1.3 TECs and Water Resource Classes for the uMkhomazi River System

IUA	Water Resource Class	Nodes	River	Length (Km)	TEC[1] for:	
					Short term	Sc MK21
U1-1	I	U10A-04115	Lotheni	27.0	A/B	A/B
		U10A-04202	Nhlathimbe	25.7	B	B
		U10A-04301	Lotheni	18.9	B	B
		U10B-04239	uMkhomazi	18.3	B	B
		U10B-04251	uMkhomazi	8.3	A	A
		U10B-04274	Nhlangeni	9.7	A	A
		U10B-04337	uMkhomazi	28.1	B	B
		U10B-04343	Mqatsheni	25.1	B	B
		U10C-04347	Mkhomazana	68.4	B	B
		U10D-04199	Nzinga	19.3	A	A
		U10D-04222	Rooidraai	13.0	B	B
		U10D-04298	Nzinga	27.1	B	B
		U10D-04349	uMkhomazi	17.2	B	B
		U10D-04434	uMkhomazi	1.4	B	B
U1-2	II	U10E-04380	uMkhomazi	39.5	C	C
		U10F-04528	uMkhomazi	7.0	C	C
		Mk_I_EWR1	uMkhomazi	14.0	C	C
		U10G-04388	Elands	26.5	B	B
		U10G-04405		12.2	C	C
		U10G-04473	Elands	44.5	B	B
U1-3	I	U10H-04576	Tholeni	15.8	B	B
		U10H-04666	Ngudwini	36.1	B/C	B
		U10H-04708	Ngudwini	7.5	B	B
		U10H-04729	Mzalanyoni	24.4	C	C
		Mk_I_EWR2	uMkhomazi	49.0	B	B
		U10J-04721	Pateni	13.8	B	B
U1-4	II	U10J-04713	Mkobeni	24.2	B	B
		U10J-04820	Lufafa	43.2	B	B
		U10J-04837		4.0	A/B	A/B
		U10K-04842	Nhlavini	26.2	B	B
		U10K-04899	Xobho	44.3	C/D	C/D
		U10K-04946	Nhlavini	21.8	B/C	B/C
		Mk_I_EWR3	uMkhomazi	113.0	C	C
U1-5	II	MK_Est	Estuary	-	B/C	B/C

1 Target Ecological Category.

1.6.2 Lovu River System

None of the scenarios impact on the REC of the Lovu River. The scenarios consist of the following:

- Updated Water demands.
- Ultimate development demands and return flows (2040).
- Reduced abstraction and afforested areas.

- EWR requirements.

The Water Resource Class is therefore set to maintain the status quo and REC in some areas by addressing some non-flow related issues.

1.6.3 uMngeni River System

None of the scenarios impact on the REC of the uMngeni River. The scenarios consist of the following:

- Updated Water demands.
- Demands and return flows (2023).
- Ultimate development demands and return flows (2040).
- EWR requirements.
- Mooi-uMngeni Transfer Scheme Phase 2 (MMTS2).
- Smithfield Dam.
- Darvill Re-use.
- Ethekwini Re-use (not applicable for rivers).

The Water Resource Class is therefore set to maintain the status quo and REC in some areas by addressing some non-flow related issues.

1.6.4 Mvoti River System

In the short term, the Water Resource Class associated with the status quo will be maintained. In the long term, Sc MV42 is recommended and consists of the following:

- Updated Water demands.
- Ultimate development demands and return flows (2040).
- EWR low flow requirements only for the REC.
- Mvoti River Development Project (Isithundo Dam)
- Imvutshane Dam.

The selection of either scenario for the purpose of classification would result in the same Water Resource Class.

Table 1.4 TECs and Water Resource Classes in the Mvoti River System

IUA	Water Resource Class	Nodes	River	Length (Km)	TEC for:	
					Short term	Sc MV42
U4-1	II	U40A-03869	Mvoti	54.5	B	B
		U40B-03708	Intinda	18.7	C	C
		U40B-03740	Mvozana	11.0	C	C
		Mv_I_EWR_1	Heinespruit	27.8	C	C
		U40B-03832	Mvozana	16.7	C/D	C/D
		U40B-03896	Mvoti	9.7	C	C
		U40C-03982	Khamanzi	40.2	B	B
		U40D-03867	Mvoti	18.6	B	B
U4-2	I	U40D-03908	Mtize	18.9	B	B
		U40D-03957	Mvoti	27.7	B	B
		U40E-03967	Mvoti	8.4	B/C	B/C

IUA	Water Resource Class	Nodes	River	Length (Km)	TEC for:	
					Short term	Sc MV42
		U40E-03985	Mvoti	27.7	B	B
		U40E-04079	Faye	21.2	B	B
		U40E-04082	Sikoto	8.0	B	B
		U40E-04137	Sikoto	23.1	B	B
		U40F-03690	Potspruit	17.3	C	C
		U40F-03694	Hlimbitwa	11.0	C	C
		U40F-03730	Cubhu	24.3	C	C
		U40F-03769	Hlimbitwa	13.3	C	C
		U40F-03790	Nseleni	5.9	B/C	B/C
		U40F-03806	Hlimbitwa	6.1	B	B
		U40G-03843	Hlimbitwa	42.5	B	B
U4-3	II	Mv_I_EWR_2	Mvoti	62.9	C	C
		U40H-04091	Pambela	17.5	B	B
		U40H-04117	Nsuze	2.7	B	B
		U40H-04133	Nsuze	27.9	B	B
U4-4	II	Mv_Est	Mv_Est	-	C	C

1.7 PURPOSE AND OUTLINE OF THIS REPORT

The purpose of this document is to provide a summary of the narrative and numerical RQOs for rivers of the Mvoti to Umzimkulu WMA.

The report outline is as follows:

Chapter 1: Introduction
This Chapter provides general background to the project Task.

Chapter 2: Prioritising RUs and Indicator Components
This Chapter provides an overview of the important Resource Units in the study area, the approach and format of selected RQO components.

Chapter 3: Approach
Outlines the various multi-disciplinary methodologies adopted during this task.

Chapter 4 – 26: Resource Quality Objectives
These chapters outline the RQOs of the various components per IUA.

Chapter 27: References

Chapter 28: Appendix A: Report Comments

2 PRIORITISING RUs AND INDICATOR COMPONENTS

As part of the Classification process, once the IUAs have been defined, RUs and biophysical nodes must be identified for different levels of EWR assessment and the setting of RQOs. RUs are sections of a river that frequently have different natural flow patterns, react differently to stress according to their sensitivity, and therefore require individual specifications of the Reserve appropriate for that reach. The guiding principle is that if the hydrology, geomorphic characteristics (i.e. geomorphic zone), physico-chemical attributes and river size remains relatively similar, a RU can be demarcated (DWAF, 2008a).

Management requirements (DWAF, 1999a, volume 3) also play a role in the delineation. An example could be where large dams and/or transfer schemes occur. Furthermore, the type of disturbance/impact on the river plays a role to select homogenous river reaches from a biophysical basis under present circumstances. These are called Management Resource Units (MRUs) and the purpose of distinguishing MRUs is to identify a management unit within which the EWR can be implemented and managed based on one set of identified flow requirements. MRUs are homogenous units which are sufficiently different from adjacent areas to warrant a separate EWR assessment being undertaken (Louw and Hughes, 2002). This means that an EWR site in the MRU, according to the EWR site selection criteria in context of the MRU, will provide for the whole MRU. Hydrological changes due to incremental runoff must obviously be taken into account (DWAF, 2008a).

Therefore an IUA can consist of RUs, MRUs or both.

Resource Units are delineated as follows:

- SQ reaches have been identified (DWA, 2013a) for the study area. These are surrogate for RUs in areas where further detailed RU determination will not be undertaken. These RUs are represented by desktop biophysical nodes (DWA, 2013a).
- For the purposes of RQOs, the SQs were combined to form RUs which represent a homogenous area of similar state and landuse. This process is followed in tributaries and rivers with no EWR sites which are usually lower priority areas and therefore do not include hotpots (DWA, 2013a)
- In key rivers which include hotspots (DWA, 2013a), a detailed RU assessment was undertaken to determine MRUs (DWA, 2013b). These also consist of a range of SQs, but the process and criteria used are more detailed than for the lower priority rivers.

RU priority is based on the outcome of the hotspot assessment (DWA, 2013a) (Step 1 of the integrated steps for the National Water Resource Classification (NWRC) and RQO determination; DWA (2007)) as well as available information and confidence in the information.

There are three main priority levels (Table 2.1) each with the detail of RQOs indicated.

Table 2.1 RU priority level and associated RQO description

RU priority level	RU priority level	Associated RQO
Low (1)	1a	Flow RQO. Habitat RQO in terms of Present Ecological State (PES) and Recommended Ecological Category (REC) (EcoStatus).
	1b	Habitat RQO in terms of PES and REC (EcoStatus) (total river length usually in declared conservation areas).
Moderate (2)	2	Flow RQO. Habitat and biota RQO (broad).
High (3)	3a	Forms part of RU represented by an EWR site.
	3b	EWR site. Flow RQO related to preferred scenario. Detailed habitat and biota RQO (EcoSpecs).
	3WQ	Water quality RQOs required as water quality is the driver at these sites. Usually high priority water quality problem areas. Habitat and biota RQO will be at a priority level 2.

2.1 PRIORITY OF RESOURCE UNITS

The allocated priority level of each RU consisting of SQ reaches, each represented by biophysical node is provided in Table 2.2 to 2.8 and Figure 2.1 to 2.5 according to secondary catchment.

Table 2.2 Mtamvuna (T4) River System: Priority level of RQO RUs

RU	SQ	River	RU Priority
IUA T4-1			
RU MT1	T40A-05450	Mafadobo	2
	T40A-05487	Goxe	
	T40C-05510	Mtamvuna	
RU MT2	T40C-05530	Mtamvuna	2
	T40C-05566	Ludeke	
	T40C-05589	KuNtlamvukazi	
	T40C-05600	Ludeke	
MRU MTB	T40C-05520	Mtamvuna	3a
	T40D-05537	Mtamvuna	
	T40D-05584	Mtamvuna	
	T40D-05707	Mtamvuna	
	T40E-05601 Mt_R_EWR1	Mtamvuna	
RU MT3	T40B-05337	Weza	2
	T40D-05615	Tungwana	
	T40D-05643	Gwala	
	T40D-05683	Ntelekweni	
	T40D-05719	Londobezi	
	T40E-05767	Hlolweni	
IUA SC			
RU SC1	T40F-05666	Mbizana	2
RU SC2	T40G-05616	Vungu	3WQ

Table 2.3 Umzimkulu (T5) River System: Priority level of RQO RUs

RU	SQ	River	RU Priority
IUA T5-1			
RU Mz1	MzRap1	Mzimkhulu	2
	T51B-04421	Mzimkhulu	
RU Mz2	T51A-04522	Mzimude	2
	T51A-04608		
	T51A-04551	Mzimude	
Ru Mz7	MzRap4	Ndawana	2
	T51G-04751		
RU Mz3	MzRap2	Pholela	2
RU Mz5	T51F-04566	Boesmans	1
	T51F-04611	Ngwangwane	
IUA T5-2			
MRU MzA	T51C-04606		1
	MzEWR2i	Mzimkhulu	3a
	T51C-04760	Mzimkhulu	
RU Mz4	T51D-04460	Pholelana	2
	T51E-04536		
	T51E-04478	Pholela	
	MzEWR9r	Pholela	
Ru Mz6	T51F-04674		2
	MzRap3	Ngwangwane	
	MzEWR8r	Ngwangwane	
	T51G-04722	Ndawana	
	T51J-04747	Ngwangwane	
	T51J-04844	Ngwangwane	
Ru Mz8	T51H-04828	Gungununu	2
	T51H-04846	Lubhukwini	
	MzRap5	Gungununu	
Ru Mz9	T51H-04913	Nonginqa	2
	T51H-04923	Malenge	
	T51H-04884	Gungununu	
	T51H-04908	Gungununu	
MRU MzB	MzEWR3i	Mzimkhulu	3a
	T52C-04960	Mzimkhulu	
	MzRap13	Mzimkhulu	
	T52D-05137	Mzimkhulu	
Ru Mz10	MzRap8	Cabane	2
Ru Mz11	T52C-04880		2
	T52D-05024	Ncalu	
	T52D-05061	Mgodi	
Ru Mz12	T52E-05053	Upper Bisi	2
	T52F-05104	Little Bisi	
	T52F-05190	Mbumba	
	T52F-05139	Little Bisi	
	T52G-05226	uMbumbane	
	T52G-05171	Bisi	

RU	SQ	River	RU Priority
	T52H-05244	Mahobe	
	MzEWR14r	Bisi	
MRU Mz D	T52K-05353	Mzimkhulwana	3a
	T52K-05475	Nkondwana	
	MzEWR17i	Mzimkhulwana	
IUA T5-3			
MRU MzC	MzEWR5i	Mzimkhulu	3a
	MzEWR6i	Mzimkhulu	
Ru Mz13	T52H-05295	Magogo	2
	T52H-05178	Bisi	
	T52H-05189	Bisi	

Table 2.4 uMkhomazi (U1) River System: Priority level of RQO RUs

RU	SQ	River	RU Priority
IUA U1-1			
RU Mk4	U10A-04115	Lotheni	2
	U10A-04202	Nhlathimbe	
	U10A-04301	Lotheni	
MRU uA	U10B-04239	uMkhomazi	2
	U10B-04337	uMkhomazi	
RU Mk1	U10B-04274	Nhlangeni	1
	U10B-04251	uMkhomazi	
RU Mk2	U10B-04343	Mqatsheni	2
RU Mk3	U10C-04347	Mkhomazana	2
RU Mk5	U10D-04199	Nzinga	2
	U10D-04222	Rooidraai	
	U10D-04298	Nzinga	
MRU uMkhomazi B.1	U10D-04349	uMkhomazi	3b
	U10D-04434	uMkhomazi	
IUA U1-2			
MRU uMkhomazi B.2	U10E-04380 Mk_I_EWR1US	uMkhomazi	3a
	U10F-04528US	uMkhomazi	
MRU uMkhomazi B.3	U10F-04528DS Mk_I_EWR1DS	uMkhomazi	3a
RU MK6	U10F-04560	Luhane	2
RU MK7	U10G-04388	Elands	2
	U10G-04405	Tributary of Elands	
	U10G-04473	Elands	
IUA U1-3			
RU MK8	U10H-04576	Tholeni	2
RU MK9	U10H-04666	Ngudwini	2
	U10H-04708	Ngudwini	
	U10H-04729	Mzalanyoni	
MRU uMkhomazi B.4	U10H-04638	uMkhomazi	3b
	U10H-04675	uMkhomazi	
MRU uMkhomazi C	U10J-04679 Mk_I_EWR2	uMkhomazi	3a

RU	SQ	River	RU Priority
RU MK10	U10J-04721	Pateni	2
IUA U1-4 (and small part of U1-3 for main uMkhomazi River)			
RU MK11	U10J-04820	Lufafa	2
MRU uMkhomazi D	U10J-04807	uMkhomazi	3a
	U10J-04799	uMkhomazi	
	U10J-04833	uMkhomazi	
	U10K-04838	uMkhomazi	
	U10M-04746 Mk_I_EWR3	uMkhomazi	
RU MK12	U10J-04713	Mkobeni	2
	U10K-04842	Nhlavini	2
	U10K-04899	Xobho	2
	U10K-04946	Nhlavini	2

Table 2.5 uMngeni (U2) River System: Priority level of RQO RUs

RU	SQ	IUA	River	RU Priority
IUA U2-1				
MRU uMnA	U20A-04253 Mg_R_EWR1	U2-1	uMngeni	3a
	U20C-04275	U2-1	uMngeni	
RU uMn1	U20B-04074	U2-1	Ndiza	2
	U20B-04144 us IBT[1]	U2-1	Mpofana	
	U20B-04173	U2-1	Lions	
RU uMn2	U20B-04144 ds IBT	U2-1	Mpofana	2
	U20B-04185	U2-1	Lions	
	U20C-04190	U2-1	Lions	
RU uMn3	U20C-04332	U2-1	Gqishi	3WQ
	U20C-04340	U2-1	Nguklu	
IUA U2-2				
RU uMn4	U20D-04029	U2-2	Yarrow	2
	U20D-04098	U2-2	Kusane	
MRU KarA	U20D-04032	U2-2	Karkloof	2
MRU KarB	U20D-04151	U2-2	Karkloof	2
MRU KarC	U20E-04170 Mg_R_EWR3	U2-2	Karkloof	3a
MRU uMnB	U20E-04221	U2-2	uMngeni	3a
	U20E-04243 Mg_I_EWR 2	U2-2	uMngeni	
RU uMn5	U20E-04136	U2-2	Nculwane	2
	U20E-04271	U2-2	Doring Spruit	
RU uMn6	U20F-04011	U2-2	Sterkspruit	2
	U20F-04095.	U2-3	Mpolweni	
IUA U2-3				
RU uMn7	U20F-04131	U2-3	Mhlalane	3WQ
	U20F-04204	U2-3	Sterkspruit	
	U20F-04224	U2-3	Mpolweni	
	U20G-04194	U2-3	Mkabela	
	U20G-04215	U2-3	Cramond Stream	

RU	SQ	IUA	River	RU Priority
MRU uMnC	U20G-04240	U2-3	uMngeni	3WQ
	U20G-04259	U2-3	uMngeni	
	U20G-04385	U2-3	uMngeni	
IUA U2-4				
RU uMn8	U20H-04410	U2-4	Nqabeni	2
	U20J-04452	U2-4	Mpushini	
	U20J-04461	U2-4	Slang Spruit	3WQ
	U20J-04488	U2-4	Mshwati	
MRU Duze A	U20H-04449	U2-4	uMnsunduze	2
MRU Duze B	U20J-04364 Mg_R_EWR4	U2-4	uMnsunduze	3
	U20J-04401	U2-4	uMnsunduze	
MRU Duze C	U20J-04391	U2-4	uMnsunduze	3WQ
MRU Duze D	U20J-04459	U2-4	uMnsunduze	3
IUA U2-5 AND PART OF IUA 2-6				
MRU uMn D	U20L-04435 Mg_I_EWR 5	U2-5	uMngeni	3
	U20M-04396	U2-6	uMngeni (upstream of Inanda dam)	
RU uMn9	U20K-04181	U2-5	Mqeku	2
	U20K-04296	U2-5	Tholeni	
	U20K-04411	U2-5	Mqeku	
IUA U2-6				
RU uMn10	U20M-04625	U2-6		**3WQ**
	U20M-04639	U2-6	Palmiet	
	U20M-04642	U2-6	Palmiet	
	U20M-04649	U2-6	Mbongokazi	
	U20M-04653	U2-6	Palmiet	
	U20M-04659	U2-6	Palmiet	
	U20M-04682	U2-6		

1 Inter-Basin Transfer.

Table 2.6 Mvoti (U4) River System: Priority level of RQO RUs

RU	SQ	IUA	River	RU Priority
IUA U4-1 AND U4-2				
MRU Heyns A	U40B-03770 Mv_I_EWR1	U4-1	Heinespruit	3a
MRU Mvoti A	U40A-03869	U4-1	Mvoti	2
RU Mv1	U40B-03708		Intinda	2, 3WQ
	U40B-03740		Mvozana	
	U40B-03832		Mvozana	
RU MV2	U40C-03982		Khamanzi	2
MRU Mvoti B	U40B-03896	U4-1	Mvoti	3
	U40D-03867	U4-1	Mvoti	
	U40D-03957	U4-2	Mvoti	
	U40E-03967		Mvoti	
	U40E-03985		Mvoti	
IUA U4-2				
RU MV3	U40D-03908	U4-2	Mtize	2

RU	SQ	IUA	River	RU Priority
RU MV 4	U40E-04079	U4-2	Faye	2
	U40E-04082		Sikoto	
	U40E-04137		Sikoto	
RU Mv 5	U40F-03690	U4-2	Potspruit	2
	U40F-03694		Hlimbitwa	
	U40F-03730		Cubhu	
	U40F-03769		Hlimbitwa	
	U40F-03790		Nseleni	
	U40F-03806		Hlimbitwa	
RU Mv 6	U40G-03843	U4-2	Hlimbitwa	2
IUA U4-3				
MRU Mvoti C	U40H-04064 Mv_I_EWR2	U4-3	Mvoti	3a
MRU Mvoti C MRU Mvoti D	U40J-03998	U4-3	Mvoti	3WQ
RU MV 7	U40H-04091	U4-3	Pambela	2
	U40H-04117		Nsuze	
	U40H-04133		Nsuze	

Table 2.7 Lovu (U7) River System: Priority level of RQO RUs

RU	SQ	River	RU Priority
IUA U7-1			
MRU Lovu A	U70A-04609	Lovu	2
	U70A-04685	Lovu	
RU L1	U70A-04599	Serpentine	2
	U70A-04618		
MRU Lovu B	U70B-04655	Lovu	3WQ
RU L2	U70C-04710	Mgwahumbe	2
	U70C-04724		
	U70C-04732		
MRU Lovu D	U70C-04859 Lo_R_EWR1	Lovu	3
RU L3	U70D-04800	Nungwane	**2**
IUA 7 CC			
RU CC1	U70E-04942	Umsimbazi	**2**
	U70E-04974	uMgababa	
RU CC2	U70F-04845	aManzimtoti	**3WQ**
	U70F-04893	Little aManzimtoti River	

Table 2.8 U3, 5, 6, and 8 River Systems: Priority level of RQO RUs

RU	SQ	River	RU Priority
IUA U3-1			
RU U3.1	U30A-04228	uMdloti	**3WQ**
	U30A-04363	Mwangala	
	U30A-04360	uMdloti	
IUA U3-2			
RU U3.2	U30B-04465	Black Mhlashini	**3WQ**

RU	SQ	River	RU Priority
IUA U3-3			
RU U3.3	U30C-04227	uThongathi	**2**
	U30C-04272	Mona	
IUA 3 NC			
RU NC.1	U30E-04207	Mhlali	**3WQ**
U5			
RU NC.2	U50A-04018	Zinkwazi	**2**
	U50A-04021	Nonoti	
	U50A-04141	Mdlotane	
IUA U6-1			
RU U6.1	U60A-04533	uMlazi	**3WQ**
	U60B-04614	Mkuzane	
	U60C-04555	uMlazi	
RU U6.2	U60C-04556	Sterkspruit	**3WQ**
RU U6.3	U60C-04613	Wekeweke	**3WQ**
IUA U6-2			
RU U6.4	U60D-04661	uMlazi	**3WQ**
IUA U6-3			
RU U6.5	U60E-04714	Mbokodweni	**2**
	U60E-04795	Bivane	
RU U6.6	U60E-04792	Mbokodweni	**3WQ**
IUA 6 CC			
RU U6CC	U60F-04597	Mhlatuzana	**3WQ**
	U60F-04632	Umbilo	
	U70F-04893	Little aManzimtoti River	
IUA 8 SC			
RU SC 3	U80G-05097	Fafa	**2**
RU SC4	U80H-05109	Mzinto	**2**
RU SC5	U80J-04979	Mpambanyoni	**2**
	U80J-05043	Ndonyane	
RU SC6	U80K-04952	Mpambanyoni	**2**
RU SC7	U80L-05020	aMahlongwa	**2**
IUA U8-1			
RU U8 1	U80B-05145	Mzumbe	**2**
	U80B-05161	Mhlabatshane	
	U80C-05231	Mzumbe	
	U80C-05329	Kwa-Malukaka	
IUA U8-2			
RU U8 2	U80E-05028	Mtwalume	**2**
RU U8 3	U80E-05212	Quha	**2**
	U80F-05258	Mtwalume	
	U80F-05301	uMngeni	

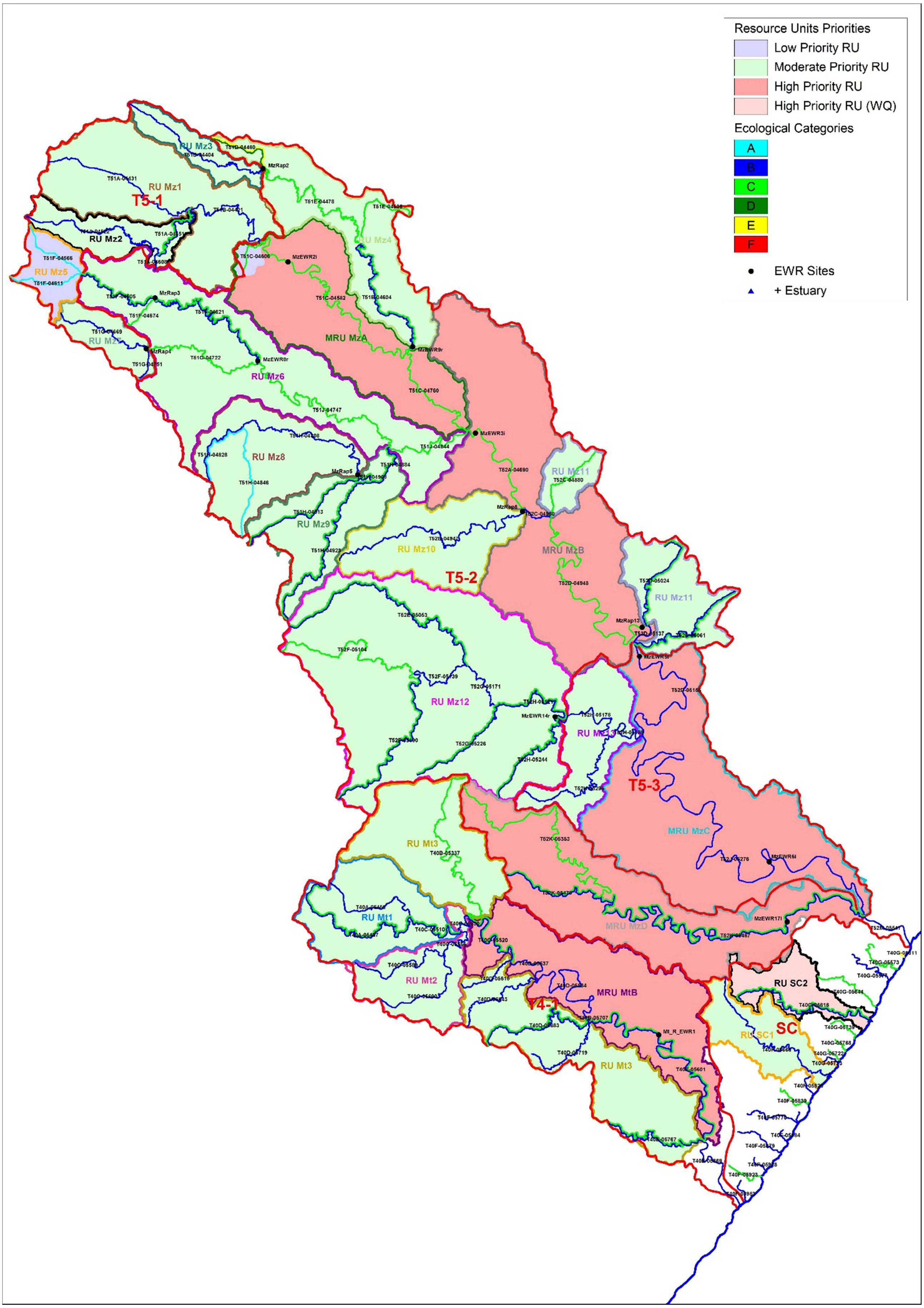


Figure 2.1 **T4 (Mtamvuna) and T5 (Umzimkulu): Low, Moderate and High RUs for RQO determination**

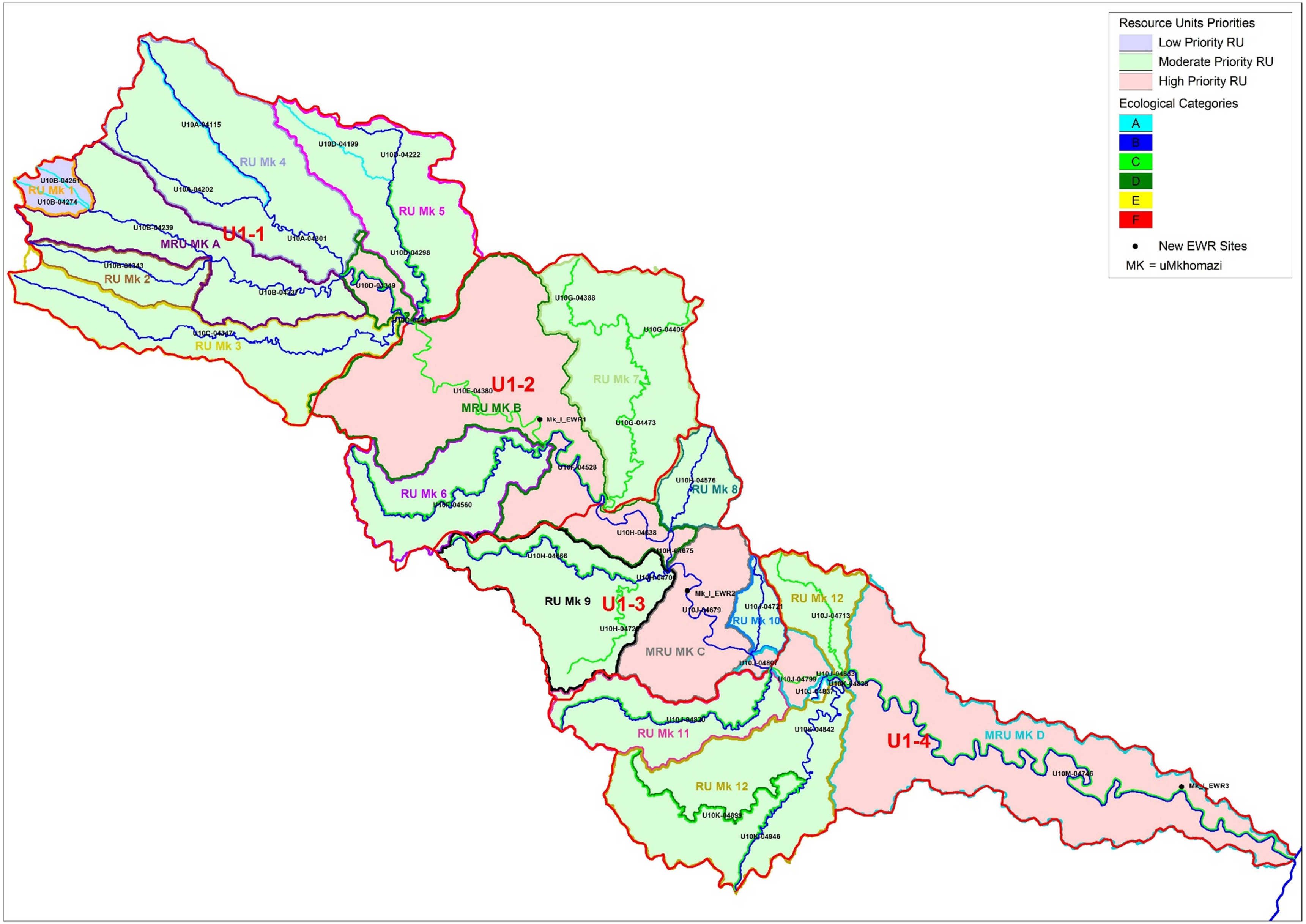


Figure 2.2 U1 (uMkhomazi): Low, Moderate and High RUs for RQO determination

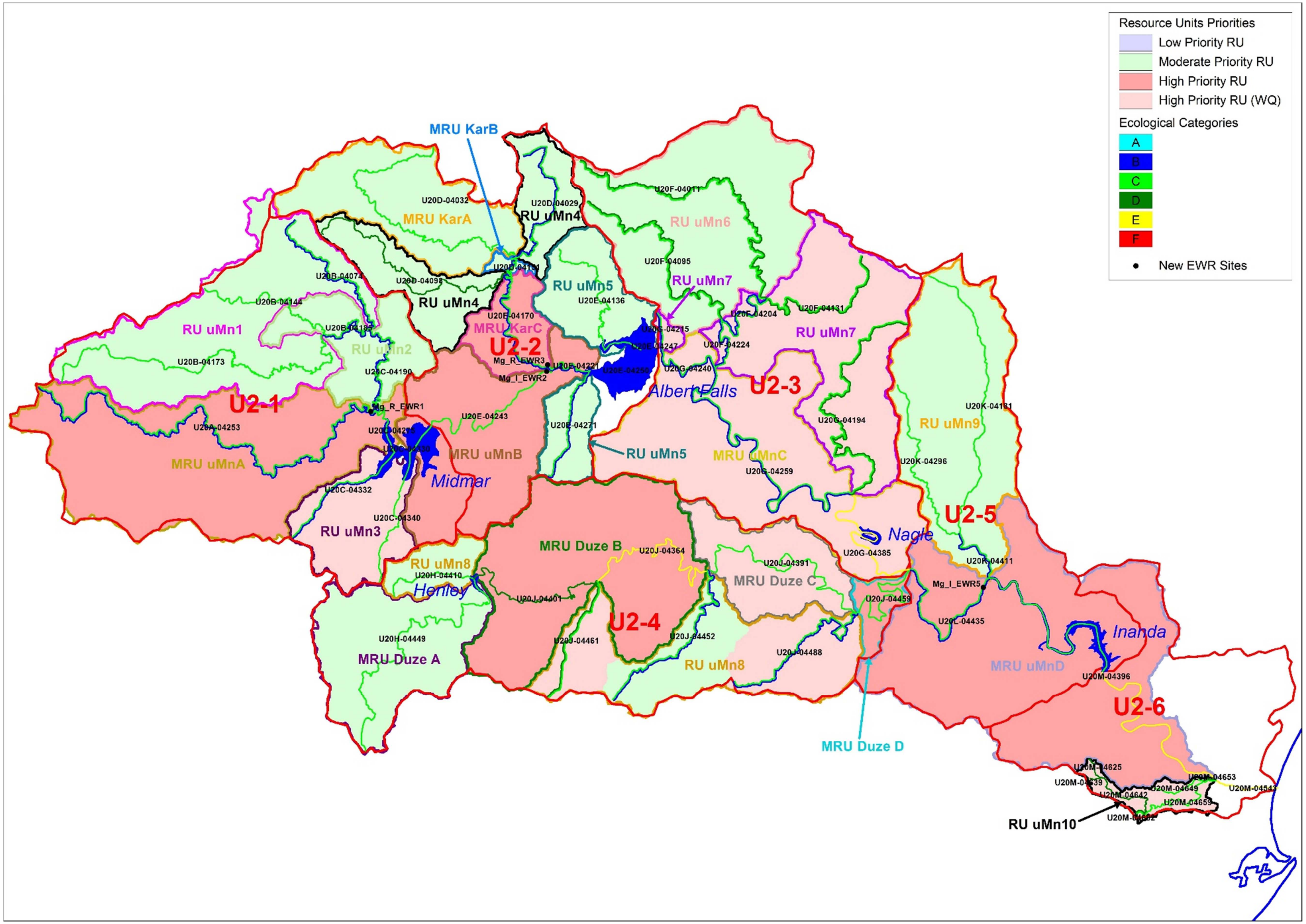


Figure 2.3 U2 (uMngeni): Low, Moderate and High RUs for RQO determination

Figure 2.4 U4 (Mvoti): Low, Moderate and High RUs for RQO determination

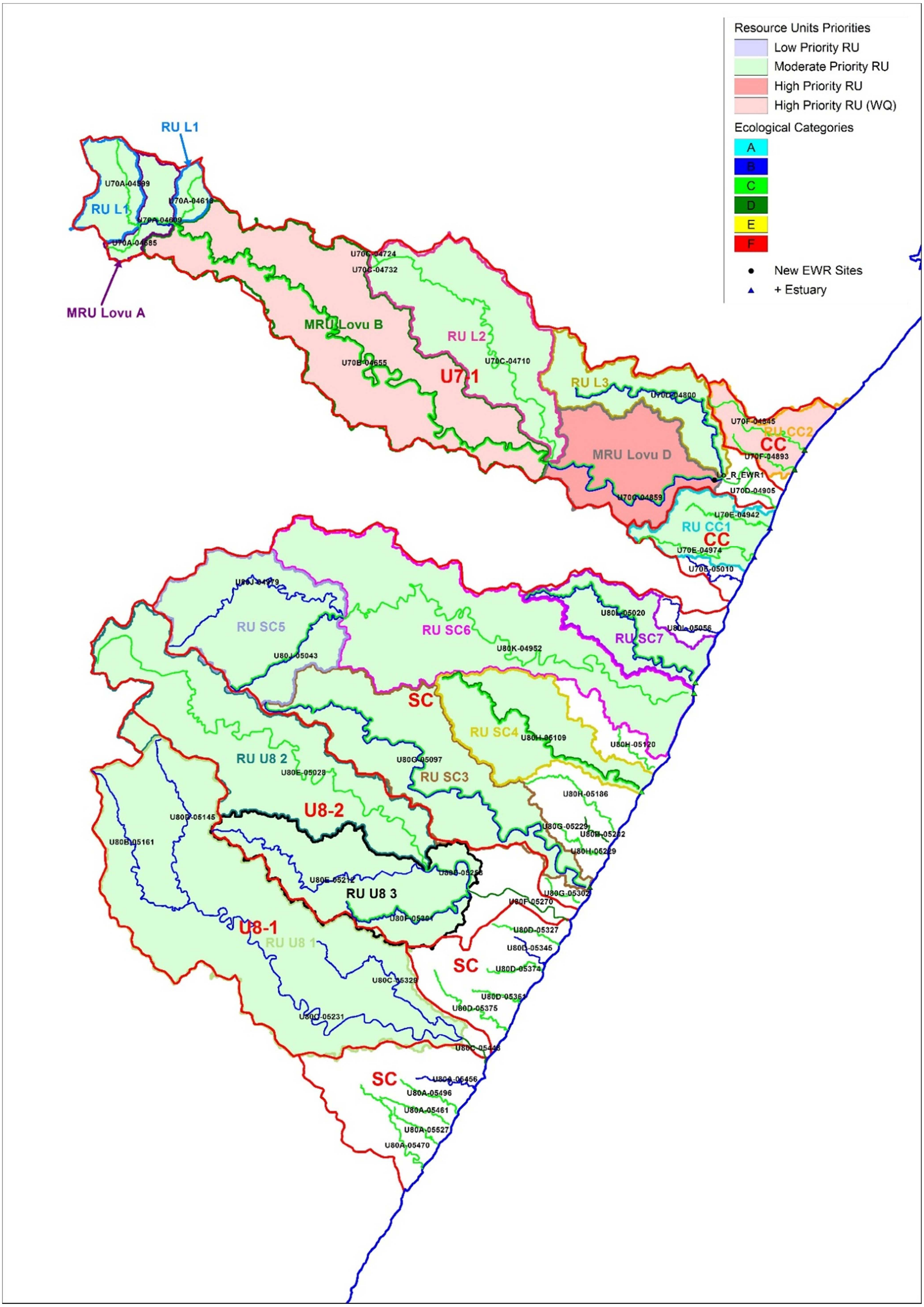


Figure 2.5 U7 (Lovu) and U8: Low, Moderate and High RUs for RQO determination

2.2 FORMAT OF RQO COMPONENTS

RQOs are set for the following components:

- Quantity, pattern and timing of instream flow (hydrology).
- Water quality.
- Characteristics and condition of riparian habitat and biota.
- Characteristics and condition of instream habitat and biota.

Hydrological RQOs are provided as a flow regime (described by means of a time series) associated with the Water Resource Classes (i.e. relating to a recommended scenario) or the flows required for the REC. The output is for;

- Flow duration table based on a hydrological time series. The full EWR rule is available electronically.
- Summary using various statistics.
- Defined quantity and frequency.

Water quality RQOs were set for Moderate (Level 2) priority RUs where identified as an indicator, and all High (Level 3) Priority RUs. Note that Level 3 WQ RUs were also identified and are areas where water quality only is considered a high priority. The water quality component of developing Level 2 and 3 RQOs is discussed in Section 3.1.2.

Habitat and biota is described as the habitat and biota associated with an EC. The EC can be the target resulting from the Water Resource Class that will be implemented or the REC. The format of the RQOs depends on the priority level of the RU and the indicator selected. The format can range as follows:

- Overall TEC – usually the REC.
- EC for each component.
- EcoSpecs (Ecological specifications) for components.
- Ecological objectives for components.

2.3 RIVERS: SELECTION OF RQO COMPONENTS AND INDICATORS

RQO components and RQO indicators are selected for RQO determination. Only relevant indicators (or high priority ones) are selected and the range selected links directly to the priority level of the RU. The indicators can be for different components, subcomponents and specific species or taxa.

High Priority RUs (3a or 3b): These require RQOs to be provided in as much detail as available information allows for all components. As such, no selection of RQO component indicators are required as EcoSpecs are provided for all relevant components which are:

- Hydrology.
- Physico-chemical variables (water quality).
- Geomorphology.
- Riparian vegetation.
- Fish.
- Macro-invertebrates.

To provide this level of detail, the RU should include an EWR site as the most detailed level of investigations are undertaken at these sites in terms of EWR assessment. This is why the hotspot selection is undertaken during the beginning of the study as the key rivers (i.e. high priority RUs) in which EWR sites should be selected must be identified up front.

If there are water quality issues (3WQ), then user water quality specifications will also be supplied for selected variables and specific users. Note that these will be different from the water quality EcoSpecs although these can inform the user water quality RQOs. Note that even though the water quality RQOs may be at a high level, the biota and habitat RQOs is likely to be at level 2.

Moderate Priority RUs (2): RQOs will not be identified for all components as done for High Priority RUs. A process of prioritisation for the components to be addressed is followed. Hydrology RQOs are provided as a standard for each SQ as for the High Priority RQOs. The component prioritisation process is therefore relevant for instream and riparian habitat and biota as well as water quality. As a first filter, the specific sources and causes that have caused changes in the state of the ecosystem are used to guide the selection of relevant components. The following guidelines are used to aid the identification of component indicators for which RQOs must be provided for each moderate priority RU:

- If the causes and sources are non-flow related, then riparian vegetation is likely to be the key indicator component.
- If the system is seasonal, then riparian vegetation is likely to be the key indicator component.
- If causes and sources are flow related, then instream biota and habitat are likely to be the key indicator components.
- If water quality causes and sources are identified as an issue, broad EcoSpecs and/or user water quality RQOs are provided. Note that these are linked to driving variables and if a monitoring database is not yet available, RQOs presented are only predicted values. These RQOs are not immediately applicable, and only become applicable once monitoring has been conducted and provisional RQOs can be verified.

Tables 2.9 to 2.15 provide the key causes and sources in Column e per River System. This column provides the most significant causes and sources, i.e. the highest two ratings (None, Small, Moderate, Large, Serious, Critical). I.e., if all impacts have been rated and the evaluation provided are for Small, Moderate and Large, then the descriptions associated with the Moderate and Large ratings will be provided.

Column f provides the derived indicator components for which RQOs will be determined.

Column g identifies the water quality role players (or users), while Column h lists the primary water quality variables for which water quality RQOs (immediately applicable or provisional) are provided.

Low Priority RUs (1a and 1b): For level 1a hydrology RQOs will be provided and a habitat and biota EcoSpec in terms of the EcoStatus Ecological Category for the REC. For level 1b, hydrology RQOs will not be provided. These usually represent rivers which are protected for the total length of river, and as there is no threat of development, and therefore a flow RQO is unnecessary.

Table 2.9 Mtamvuna (T4) River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
RU	**SQ**	**River**	**RU priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
IUA T4-1							
RU MT1	T40A-05450	Mafadobo	2	Small plantations.	1. Riparian vegetation 2. Instream biota 3. Water quality	Settlements	Turbidity
	T40A-05487	Goxe		Sml plantations, cleared areas (old fields), low density rural settlements, subsistence farming, roads, Alien Invasive Plants (AIP) in riparian zone.			
	T40C-05510	Mtamvuna		AIP in riparian zone, road crossing, cleared areas (old fields), subsistence farming.			
RU MT2	T40C-05530	Mtamvuna	2	AIP in riparian zone and floodplain areas, erosion, subsistence farming, old fields	1. Riparian vegetation 2. Instream biota 3. Water quality	Settlements (VIP sanitation); grazing (erosion)	Turbidity
	T40C-05566	Ludeke		Cleared areas (old fields), grazing, low density rural settlements, and crossings.			
	T40C-05589	KuNtlamvukazi		Scattered plantations, cleared areas (old fields), low density rural settlements, road crossings.			
	T40C-05600	Ludeke		Cleared areas (old fields), low density rural settlements.			
MRU MT B	T40C-05520	Mtamvuna	3	Scattered AIP, cleared areas (old fields), low density rural settlements, grazing, road crossing.	All	Settlements; dryland cultivation; erosion	Turbidity
	T40D-05537	Mtamvuna		Subsistence farming.			
	T40D-05584	Mtamvuna		Rural, small scale subsistence farming.			
	T40D-05707	Mtamvuna		Abandoned lands.			
	T40E-05601 Mt_R_EWR1	Mtamvuna		Rural, low density rural settlements in middle reaches, small area cultivation in lower reaches, roads, forms border of Mtamvuna Nature Reserve in lower reach.			
RU MT3	T40B-05337	Weza	2	Ext forestry in upper parts, numerous roads, timber mill, settlements in lower reaches, regional water abstraction. Amamzamnyama and other large tributary not digitised.	1. Riparian vegetation 2. Instream biota 3. Water quality	Settlements (rural and urban (Bizana; WWTW)); grazing	Turbidity, nutrients, faecal coliforms
	T40D-05615	Tungwana		Cleared areas (old fields), subsistence farming, grazing.			
	T40D-05643	Gwala		Rural settlement in upper reaches, subsistence farming, grazing, road crossings.			
	T40D-05683	Ntelekweni		Forestry in upper parts, numerous roads, instream dam, urban (Bizana), maturation pond, informal settlements, low density rural, subsistence farming.			
	T40D-05719	Londobezi		Rural settlement at top, subsistence farming, grazing, road			

a	b	c	d	e	f	g	h
RU	SQ	River	RU priority	Comments	Biota, habitat and WQ component indicators	WQ users	WQ variables
				crossings.			
	T40E-05767	Hlolweni		Rural settlements, subsistence farming, old fields, sand mining, roads. Large tributary (possibly mainstem) not digitised.			
IUA 4 SC							
RU SC1	T40F-05666	Mbizana	2	Low density rural settlements in upper reaches, old fields, roads, sand mining, small area orchards in lower reaches, lower reach estuarine.	1. Riparian vegetation 2. Instream biota 3. Water quality	Settlements; sand-mining	Turbidity
RU SC2	T40G-05616	Vungu	3WQ	Sugarcane, roads, instream dam in upper reaches, high density settlement - WWTW, quarry on both sides of the river in lower reaches - impact on estuary, urban (Uvongo), middle reaches in Mbumbazi Nature Reserve, lower reach estuarine.	1. Water quality 2. Riparian vegetation (Level 2) 2. Instream biota (Level 2)	High density settlements; urban impacts (Uvongo); WWTW (Uvongo and Gamalakhe); sand-mining (quarry)	Turbidity, nutrients, salts, faecal coliforms

Table 2.10 Umzimkulu (T5) River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RU	SQ	River	RU Priority	Comments	Biota, habitat and WQ component indicators	WQ users	WQ variables
IUA T5-1							
RU Mz1	MzRap1	Mzimkhulu	2	AIP, hotel upstream, part of World Heritage Site. Rapid.	1. Instream biota 2. Riparian veg		
	T51B-04421	Mzimkhulu		Extensive irrigation, dams in tributaries, dammed wetlands, AIP, Underberg.			
RU Mz2	T51A-04522	Mzimude	2	Irrigation, some on drained wetlands, forestry, AIP. Numerous wetlands (floodplain, valley bottom, ox-bows).	1. Water quality 1. Instream biota 1. Riparian veg	Some irrigation; trout hatchery; cattle	Nutrients, turbidity
	T51A-04608			Small dam in upper reaches, cattle.			
	T51A-04551	Mzimude		Forestry, AIP (brambles), dams in tributaries, wetlands/dammed, irrigation, agricultural lands, trout hatchery.			
Ru Mz7	MzRap4	Ndawana	2	Small areas of AIP (wattle), forestry. Abandoned lands. Cattle grazing, some bank erosion. Irrigation in lower reaches. Rapid.	1. Instream biota 2. Riparian	Some irrigation; erosion	Nutrients, turbidity

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
	T51G-04751			Some grazing, erosion. Abandoned lands. Small irrigation, agricultural lands.	vegetation 3. Water quality		
RU Mz3	MzRap2	Pholela	2	Cobam Nature Reserve (upper reaches of sub-quat). Forestry, extensive irrigation, AIP, dams in tributaries.Nutrients. Wetlands in lower reaches of sub-quat.	1. Riparian vegetation 1. Instream biota 2. Water quality	Irrigation, recreation	Nutrients, salts
RU Mz5	T51F-04566	Boesmans	1	In National Park. AIP (small).	Habitat		
	T51F-04611	Ngwangwane		In National Park. AIP (small).			
IUA T5-2							
MRU MzA	T51C-04606		1	Irrigation, instream dams, nutrients.	1. Habitat 2. Water quality	Irrigation	Nutrients, salts
	MzEWR2i	Mzimkhulu	3	Return flows from Underberg. Irrigation in upper reaches. Dams in tributaries. Small areas of forestry. Community water use, subsistence farming, erosion. Intermediate.	All	Irrigation; erosion	Nutrients, salts, turbidity
	T51C-04760	Mzimkhulu		Extensive erosion, enhanced by over grazing. Sediments. Forestry. Irrigation in lower reaches.			
RU Mz4	T51D-04460	Pholelana	2	Large instream dams (damming of wetlands), irrigation. Dairy and sheep farming. Nutrients.	1. Riparian vegetation 2. Instream biota 3. Water quality	Irrigation; dairy and sheep farming; small WWTW at Pholela hospital	Nutrients, salts, toxics, faecal coliforms
	T51E-04536			Irrigation, dairy 2 dams instream. Lower dam was a wetland. Road crossings, some AIP (wattle).			
	T51E-04478	Pholela		Extensive irrigation, AIP (salix), new large instream dam just below outlet of T51D. Swamps.			
	MzEWR9r	Pholela		Extensive forestry, AIP (willow, wattle). Irrigation. Subsistence farming in lower reaches. Rapid.			
Ru Mz6	T51F-04674		2	Irrigation, road crossings. Small dam in upper reaches. Nutrients.	1. Instream biota 2. Riparian vegetation 3. Water quality	Irrigation; settlements and grazing (erosion), recreation	Nutrients, turbidity, salts, toxics
	MzRap3	Ngwangwane		Irrigation, forestry and AIP wattle). Dams in tributaries. Erosion, nutrients. Rapid.			
	MzEWR8r	Ngwangwane		Extensive irrigation. AIP. Dams in tributaries. Lower reaches in Coleford Nature Reserve. Degraded wetlands (floodplain). Rapid.			
	T51G-04722	Ndawana		Irrigation, large instream dam in upper reaches. Wetland systems (ox-bows). Rural settlements, forestry, abandoned lands in lower reaches. Erosion.			
	T51J-04747	Ngwangwane		AIP, some plantations. Abandoned lands. Subsistence farming, cattle grazing.			
	T51J-04844	Ngwangwane		AIP, community water use, subsistence farming. Cattle			

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
				grazing, erosion.			
Ru Mz8	T51H-04828	Gungununu	2	Few impacts. Small AIP. Cattle grazing from communities.	1. Instream biota 2. Riparian vegetation		
	T51H-04846	Lubhukwini		Drains Ntsikeni wetland. Mostly in National Park. AIP. Community use in lower reaches outside Park.			
	MzRap5	Gungununu		Forestry, AIP in riparian zones. Community water use, cattle grazing. Subsistence farming. Temporay wood piles. Erosion. Rapid.			
Ru Mz9	T51H-04913	Nonginqa	2	Extensive forestry (Tuduma State Forest), rural in lower reaches. Abandoned lands, subsistence farming. Cattle grazing, some erosion.	1. Instream biota 2. Riparian vegetation 3. Water quality	Settlements (pit latrines); erosion	Nutrients, turbidity
	T51H-04923	Malenge		Dam in upper reaches. Some forestry. Extensive community settlements. Cattle grazing, erosion from degraded catchment. AIP in riparian zone. Large areas of subsistence farming. Frequent burning.			
	T51H-04884	Gungununu		Subsistence farming, cattle grazing. Erosion, AIP in riparian zoone.			
	T51H-04908	Gungununu		Subsistence farming, cattle grazing. Erosion, AIP in riparian zoone.			
MRU MzB	MzEWR3i	Mzimkhulu	3	Irrigation, AIP. Abandoned lands. Community water use. Cattle grazing, subsistence farming. Forestry in lower reaches. Intermediate.	All	Irrigation; grazing, erosion	Nutrients, salts, turbidity
	T52C-04960	Mzimkhulu		Extensive farming in upper and middle reaches. Community water use, subsistence farming. Abandoned lands, erosion. AIP.			
	MzRap13	Mzimkhulu		Community water use.			
	T52D-05137	Mzimkhulu		Community water use, subsistence farming. Intermediate.			
Ru Mz10	MzRap8	Cabane	3	Extensive forestry. Road crossings. Dam within forestry area. Irrigation in upper reaches.	1. Riparian vegetation 2. Instream biota		
Ru Mz11	T52C-04880		3	Extensive forestry. Some irrigation, subsistence farming. Road along river.	1. Riparian vegetation 2. Instream biota 3. Water quality	Irrigation; urban (T52D-05061; Umzimkhulu)	Nutrients, salts, faecal coliforms, toxics
	T52D-05024	Ncalu		Forestry in upper reaches. Community water use, subsistence farming in middle reaches. Small AIP.			
	T52D-05061	Mgodi		Irrigation, subsistence farming, cattle grazing. Town of Umzimkhulu. Abandoned lands. Rapid.			
Ru Mz12	T52E-05053	Upper Bisi	2	Exstensive forestry in upper reaches. Extensive communities, cattle grazing. Sedimentation. Numerous roads.	1. Riparian vegetation	Extensvie settlements in	Nutrients, turbidity, faecal coliforms

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
	T52F-05104	Little Bisi		Extensive forestry, numerous roads. Community water use, subsistence farming. Erosion.	2. Instream biota 3. Water quality	area; erosion	
	T52F-05190	Mbumba		Community water use, subsistence farming. Erosion.			
	T52F-05139	Little Bisi		Subsistence farming, cattle grazing. Sediments AIP.			
	T52G-05226	uMbumbane		Community water use, subsistence farming. Some wetlands. Limited erosion. Frequent burning. Few AIP. Fairly natural.			
	T52G-05171	Bisi		Few AIP (sesbania). Algal growth. Road building. Community water use. Over grazing, sediments. Rapid.			
	T52H-05244	Mahobe		Community water use. Subsistence farming, cattle grazing. Erosion.			
	MzEWR14r	Bisi		Rural. Few communities, subsistence farming.			
MRU Mz D	T52K-05353	Mzimkhulwana	3	Forestry and sugarcane, large dam in upper reaches.	All	Irrigation, Hikers, climbers	Nutrients, salts
	T52K-05475	Nkondwana		Agricultural lands and irrigation (sugar cane). Communities, subsistence farming, AIP. Dam in small tributary (Lake Eland) before nature reserve. Oribi Gorge Nature Reserve. Limestone mining in lower reach before confluence with Mzimkhulu. Rapid, intermediate.			
	MzEWR17i	Mzimkhulwana		Abstraction of water from St Helen's Rock for regional water supply.			
IUA T5-3							
MRU MzC	MzEWR5i	Mzimkhulu	3	Exstensive forestry in upper 50% of reach. Small dams in forestry dams. Community water use, cattle grazing. Sedimentation. Numerous roads.	All as availabile from report	Erosion; urban impacts (Harding) incl WWTW discharging into the Mzimkhulwana	Nutrients, salts, toxics, turbidity, coliform
	MzEWR6i	Mzimkhulu		Extensive forestry and sugarcane. AIP. Town of Harding. Abstraction from run-of-river - use of sand bags to dam river.			
Ru Mz13	T52H-05295	Magogo	2	Upper part fairly natural. Dense settlements in lower reaches. Subsistence farming, cattle grazing. Localised sand mining, bank instability, sediments. Intermediate.	1. Riparian vegetation 2. Instream biota 3. Water quality	Settlements in area; erosion (grazing, sand-mining); localized irrigation	Nutrients, turbidity
	T52H-05178	Bisi		Rural. Few communities, subsistence farming. Gorge area.			
	T52H-05189	Bisi		Largely natural. Scattered communities. Abandoned lands, subsistence farming, cattle grazing. Localised sand mining. AIP. Irrigation in horse shoe area. Cwabeni off-channel dam with abstraction from new weir on Mzimkhulu for regional water supply. Rapid, intermediate.			

Table 2.11 uMkhomazi (U1) River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota and habitat component indicators**	**WQ users**	**WQ Variables**
IUA U1-1							
RU4	U10A-04115 U10A-04202 U10A-04301	Lotheni Nhlathimbe Lotheni	2	AIP (brambles, wattles), small dams, Lotheni Nature Reserve, camp sites. Community water use, subsistance farming, AIP (wattles) in lower reaches outside the Nature Reserve.	1. Riparian veg 2. Instream biota 3. WQ	Giants Castle WWTW	Nutrients, feacal colifors
MRU uMkhomazi A	U10B-04239 U10B-04337	uMkhomazi uMkhomazi	2	Community water use, AIP (wattle) in catchment. Road adjacent to river, 1 crossing. Forestry, subsistence farming.		Settlements	Turbidity, nutrients, faecal coliforms
RU 1	U10B-04274 U10B-04251	Nhlangeni uMkhomazi	1	Few impacts, if any. Part of Vergelegen Nature Reserve.			
RU2	U10B-04343	Mqatsheni	2	Community water use, AIP (wattle), erosion outside Nature Reserve. Cattle trampling. Some abandoned lands. Diatoms.	1. Riparian veg 2. instream biota		
RU3	U10C-04347	Mkhomazana	2	SaniPass tourism, golf course, hotel with possible sewage. Small dams in tribs. Agricultural lands - irrigated, AIP, community water use/semi-residential area. Sedimentation from road. Fish, inverts, diatoms.	1. Riparian veg 2. Instream biota 3. WQ	Urban/tourism, agriculture	Turbidity, nutrients, E. coli, salts
RU 5	U10D-04199 U10D-04222 U10D-04298	Nzinga Rooidraai Nzinga	2	Mkhomazi National Park, waterfalls. Degraded grasslands, some wattle, bramble. Trout farm at bottom of Park. Dams, irrigation, AIP (wattle), forestry, dryland agriculture. Agricultural lands.	1. Riparian veg 2. Instream biota 3. WQ	Dryland agriculture (incl. Nzinga commercial community agriculture), Nzinga WWTW, trout-fishing	Turbidity, nutrients, faecal oliforms, salts
MRU uMkhomazi B.1	U10D-04349 U10D-04434	uMkhomazi uMkhomazi	**3b**		As for MRU uMkhomazi B.2		
IUA U1-2							
MRU uMkhomazi B.2	U10E-04380 Mk_I_EWR1US U10F-04528US	uMkhomazi uMkhomazi	**3a**	AIP, subsitence farming. Abandoned lands, some erosion - natural? Forestry, agricultural lands, community water use, grazing, Impendle Nature Reserve.	All (Scenarios do not impact on site)	Some agriculture, erosion	Turbidity
MRU uMkhomazi B.3	U10F-04528DS Mk_I_EWR1DS	uMkhomazi	**3a**		All (PES EcoSpecs as for Mk_I_EWR1US but scenarios impact of Smithfield Dam		

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota and habitat component indicators**	**WQ users**	**WQ Variables**
					shown here)		
RU6	U10F-04560	Luhane	**2**	Bulwer, irrigation, forestry, community water use. Subsistence farming. Dam construction, erosion, numerous roads adjacent to river, road crossings. Alien grass (gliceria maxima). Fish, inverts, diatoms.	1. Riparian veg 2. Instream biota 3. WQ	Urban incl WWTW, subsistance farming, erosion	Turbidity, nutrients, salts, faecal coliforms
RU7	U10G-04388	Elands	**2**	Small dams, irrigation, forestry, AIP, agricultural lands, nutrients. Diatoms, numerous roads, irrigation, Boston.	1. Riparian veg 2. Instream biota 3. WQ	Agriculture, dairy farming (waste ponds on tributary)	Nutrients, salts, faecal coliforms
	U10G-04405	Tributary of Elands					
	U10G-04473	Elands					
IUA U1-3							
RU8	U10H-04576	Tholeni	**2**	Extensive forestry, small dam. Eucalyptus extraction plant. Diatoms.	1. Riparian veg 2. instream biota		
RU9	U10H-04666	Ngudwini	**2**	Community water use in upper reaches, subsistence farming. Extensive forestry in middle and lower reaches. Irrigation, dams, cattle.	1. Riparian veg 2. Instream biota 3. WQ	Cattle (irrigated pasture), dariy waste ponds	Nutrients, turbidity, faecal coliforms
	U10H-04708	Ngudwini					
	U10H-04729	Mzalanyoni					
MRU uMkhomazi B.4	U10H-04638	uMkhomazi	**3b**		As for MRU uMkhomazi C		
	U10H-04675	uMkhomazi					
MRU uMkhomazi C	U10J-04679 Mk_I_EWR2	uMkhomazi	**3**	Agricultural lands, AIP (peanut butter bush). Fish, inverts, diatoms.	All	Agriculture	Nutrients, salts
RU10	U10J-04721	Pateni	**2**	Extensive forestry in upper and middle reaches, dryland agriculture.	1. Riparian veg 2. instream biota		
IUA U1-4 (and small part of U1-3 for main uMkhomazi River)							
RU11	U10J-04820	Lufafa	**2**	Forestry, irrigation, dams in upper 50% of catchment. Agricultural lands, subsistence farming. Community water use. Extensive algal growth. Fish, inverts, diatoms.	1. Riparian veg 2. Instream biota 3. WQ	Agriculture	Nutrients, salts
MRU uMkhomazi D	U10J-04807	uMkhomazi	**3**	Abandoned lands, agricultural lands, irrigation, community water use, roads, abstraction for Sappi Saiccor, weirs. Possible nutrients from Lufafa.	As for MRU uMkhomazi C	Intensive agriculture, poultry farming, some settlements	Nutrients, salts, faecal coliforms
	U10J-04799	uMkhomazi					
	U10J-04833	uMkhomazi					
	U10K-04838	uMkhomazi					
	U10M-04746 Mk_I_EWR3	uMkhomazi					
RU12	U10J-04713	Mkobeni	**2**	Forestry in upper and lower parts, subsistence farming, agricultural lands (sugar cane).	1. Riparian veg 2. instream biota		
	U10K-04842	Nhlavini	**2**	Small area of forestry, AIP, agricultural lands, irrigated (sugarcane). Small community ater use.	1. Riparian veg 2. Instream biota 3. WQ	Agriculture, settlements, urban impacts (Ixopo WWTW, Clover Dairy	Nutrients, salts, faecal coliforms, toxics
	U10K-04899	Xobho	**2**	Large dams Instream and off-channel), irrigation (sugarcane and other), forestry, Ixopo. Fish, inverts, diatoms.			

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota and habitat component indicators**	**WQ users**	**WQ Variables**
	U10K-04946	Nhlavini	**2**	Forestry, dryland agriculture, irrigation, AIP. Small dams. Diatoms.		depot, hopsital)	

Table 2.12 uMngeni (U2) River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
IUA U2-1							
MRU uMnA	U20A-04253 Mg_R_EWR1	uMngeni	3	uMngeni Vlei in upper reaches, Lake Lindhurst - trout, bass fishing, instr dam, chicken houses, irrigation in lower reaches, AIP (brambles), off-channel dam for irrigation in U20B.	All	Agriculture; chicken farms; dairy and piggeries; hiking, camping, climbing and fishing in upper reaches	Nutrients, faecal coliforms
	U20C-04275	uMngeni		Small mouth bass, otters, cultivation, AIP in riparian zone, cattle grazing, bottom 2/3 in Midmar Dam.			
RU uMn1	U20B-04074	Ndiza	2	Dams in tribs (trout, bass), forestry, good grassland and natural forest, instr dam, chicken farms, irrigation in lower reaches, Boschhoek golf estate.	1. Instream biota 2. Riparian veg 3. Water quality	Agriculture; dairy and chicken farms; WWTW and ponding system; textile industry; brewery; hiking and fishing in upper reaches	Nutrients, salts, faecal coliforms
	U20B-04144 us IBT	Mpofana		Dams in tribs, irrigation, instr dams, chicken farms, interbasin transfer in middle reaches, AIP (wattle), small mouth bass in lower reaches, dairy farming, scouring from IBT (~8 MCM). Flow mod = 4 for lower reaches due to IBT. Continuous flow suiting small mouth bass, yellow fish to be impacted in long term.			
	U20B-04173	Lions		Instr dams, dams in tribs, irrigation, Lidgeton, diary farming, forestry in middle to lower reaches, meanders and waterfalls in lower reaches.			
RU uMn2	U20B-04144 ds IBT	Mpofana	2	Dams in tribs, irrigation, instr dams, chicken farms, interbasin transfer in middle reaches, AIP (wattle), small mouth bass in lower reaches, dairy farming, scouring from IBT (~8mcm). Flow mod = 4 for lower reaches due to IBT. Continuous flow suiting small mouth bass, yellow fish to be impacted in long term	1. Instream biota 2. Riparian veg 3. Water quality	Chicken farms; dairies; commercial agriculture; fishing and hiking in upper reaches	Nutrients, faecal coliforms
	U20B-04185	Lions		Extensive forestry, ox bows, IBT from Mooi (increased flows) - posibble sediment from upstream scouring			

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
	U20C-04190	Lions		Large wetland area, forestry, dams in tribs, AIP, cultivation, IBT from Mooi River.			
RU uMn3	U20C-04332	Gqishi	3WQ	Road crossings, irrigation, ext forestry in upper reaches, instr dams, lower 1/3 in Midmar Dam.	1. Water quality 2. Instream biota (level 2) 2. Riparian veg (level 2)	Irrigation; quarry; landfill (solid wastes), dysfunctional sewers	Nutrients, turbidity, toxics, faecal coliforms
	U20C-04340	Nguklu		Mtinzima Stream not digitised. Forestry, Mpophomeni (semi-urban), quarry, solid waste dumping, AIP, lower 1/3 in Midmar Dam.			
IUA U2-2							
RU uMn4	U20D-04029	Yarrow	2	Dryland agric, ext forestry, forestry roads, wetlands.	1. Instream biota 2. Riparian veg		
	U20D-04098	Kusane		Instr dams, forestry, dams in tribs, road crossings, irrigation.			
MRU KarA	U20D-04032	Karkloof	2	Wetland at top, grassland, forestry in middle reaches, AIP (wattle), cultivation, catchment erosion, abandoned lands, forest roads, flood plain in lower reaches (wattled crane area), chicken farm, drainage of wetlands for agriculture.	1. Instream biota 2. Riparian veg		
MRU KarB	U20D-04151	Karkloof	3	Wetlands, sml area irrigation, dryland agric, wetlands - flood plain, ox bows.	1. Instream biota 2. Riparian veg		
MRU KarC	U20E-04170 Mg_R_EWR3	Karkloof	3	Wetlands (ox bows), irrigation, forestry, Karkloof falls, AIP in riparian zone, abandoned lands.	All		
MRU uMnB	U20E-04221	uMngeni	3	Morton's Drift, cultivation, mostly sugarcane, lower 5% in Albert Falls Dam.	All	Irrigation; urban (Howick, incl WWTW; U20E-04243))	Nutrients, toxics + faecal coliforms (U20E-04243)
	U20E-04243 Mg_I_EWR 2	uMngeni		Upper part in Midmar Dam, Howick, industrial, Howick falls, Howick WWTW, AIP in riparian zone, informal areas, dryland agric. Sakabula Stream and Riet not digitised.			
RU uMn5	U20E-04136	Nculwane	2	Ext forestry, roads, cultivation, lower 20% in Albert Falls Dam.	1. Riparian veg 2. Instream biota		
	U20E-04271	Doring Spruit		Forestry, small instr dams in upper reach, irrigation (sugarcane), off channels dams, lower 10% in Albert Falls Dam.			
RU uMn6	U20F-04011	Sterkspruit	2	Forestry, large dams in trib, instr dam, AIP, cultivation (sugarcane), New Hanover.	1. Water quality 1. Riparian veg 2. Instream biota	Poultry farming; agricutlture; Eskom Training Centre WWTW	Nutrients, faecal coliforms
	U20F-04095 in IUA U2-3	Mpolweni		Ext forestry, instr dams, cultivation (sugar cane).			
IUA U2-3							
RU uMn7	U20F-04131	Mhlalane	3WQ	Cultivation (sugarcane), urban (Coolair??), instr dams, settlement.	1. Instream biota 2. Riparian veg	Settlements; irrigation;	Nutrients, turbidity, faecal coliforms

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
	U20F-04204	Sterkspruit		Cultivation (sugarcane).	3. Water quality	sawmill and timber processing; AF North and Coolair WWTW[1]; some sand-mining	
	U20F-04224	Mpolweni		Low density settlement, AIP in riparian zone.			
	U20G-04194	Mkabela		Instr dams, forestry, cultivation (sugarcane), dams in tribs, sawmill, scattered settlements (communal land).			
	U20G-04215	Cramond Stream		Forestry, bark chips processing plants, Cramond, informal settlement, cultivation (sugarcane).			
MRU uMnC	U20G-04240	uMngeni	3WQ	Flow hydrograph reversed, feedlot, crocodile farm, chicken farms, cultivation, high nutrients, dams in tribs.	1. Water quality 2. Instream biota (level 2) 2. Riparian veg (level 2)	Feedlots; sand-mining; AF South WWTW; timber processing; extensive poultry farming and Argyle Chickens Abattoir; veg production and nurseries; crocodile farms.	Nutrients, turbidity, faecal coliforms, toxics
	U20G-04259	uMngeni		Cultivation, feedlot, AIP in rip zone (mulberry, privet, gums), sand mining, reverse confidence.			
	U20G-04385	uMngeni		Diversion weir just uptream Nagle Dam, abstraction from and below dam for Durban, almost no flow below dam to confluence with Msunduze. Not assessed due to operating rule for almost no flow up to Msunduze confluence.			
IUA U2-4							
RU uMn8	U20H-04410	Nqabeni	2	Henley Dam, subsistence farming, rural settlements, stormwater, overgrazing.	1. Instream biota 2. Riparian veg		
	U20J-04452	Mpushini		Dams in tribs, instream dams, abandoned lands, semi-urban, WWTW, quarries in lower reaches.			
	U20J-04461	Slang Spruit	3WQ	Forestry in upper reaches, abandoned lands, semi-urban - not serviced, roads, urban, industrial in lower reaches.	Water quality	Urban (industrial, Lynnfield Park and Camperdown WWTW) impacts; settlements; quarries; poultry farming (Rainbow Chickens); Ashburton Horse Training Centre sewage ponds	Nutrients, salts, toxics, turbidity, faecal coliforms
	U20J-04488	Mshwati		Chicken farm at the top, woodland, sml dam possibly oxidation pond??, Urban (Camperdown), rural settlement – sediments.			

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
MRU Duze A	U20H-04449	uMnsunduze	2	Edendale Valley, low density settlements, subsistence farming, instr dams, chicken farms, overgrazing, abandoned land highly eroded, old forestry areas, AIP (wattle).	1. Instream biota 2. Riparian veg		
MRU Duze B	U20J-04364 Mg_R_EWR4	uMnsunduze	3	Campsdrift, weir without fish ladder, industries, stormwater runoff, urban, road crossings, Dorpspruit, settlements, WWTW (Darvill) return flows, Bainspruit (pollution), oil industry, chicken farms.	All (not hydro)	Pietermaritzburg urban and industrial impacts (incl. Davill WWTW); settlements; chicken farms; solid waste; recreation (e.g. canoeing)	Nutrients, salts, toxics, turbidity, dissolved oxygen, faecal coliforms
	U20J-04401	uMnsunduze		Waterfall, some AIP in riparian zone, settlements/semi-urban, subsistence farming on floodplain, small tributaries carrying solid waste, settling ponds, tanneries, end of reach in Campsdrift.			
MRU Duze C	U20J-04391	uMnsunduze	3WQ	Alien aquatic weeds (hyacinth, water lettuce), cultivation - run-of-river, return flows from WWTW (Darvill), road crossing, communal lands.	Water quality	Upstream wq impacts, sand-mining, poultry farming	Turbidity, nutrients, faecal coliforms
MRU Duze D	U20J-04459	uMnsunduze	3	Rural - communal lands, erosion, return flows of Darvill WWTW.	1. Water quality 2. Instream biota (Level 2) 2. Riparian veg (Level 2)	Upstream wq impacts, sand-mining	Turbidity, faecal coliforms
IUA U2-5 AND PART OF IUA 2-6							
MRU uMn D	U20L-04435 Mg_I_EWR 5	uMngeni	3	Mainly flows from Duzi due to operation of Nagle Dam. Rural settlements - local impacts on riparian zone, AIP, gauging weir.	All	Settlements and associated sewage systems; sand-mining; quarries; Maphephetwa and Northern WWTW; urban	Nutrients, faecal coliforms, turbidity, toxics
	U20M-04396	uMngeni (upstream of Inanda dam)		Road crossings, road along river, ext hyasinth, sand mining. Inanda Dam in middle reach, small release. Return flows from WWTW into lower part of this reach. Lower part of reach urban then into estuary. Umzinyathi, Piesang, Umhlangane rivers not digitised.			
RU uMn9	U20K-04181	Mqeku	2	Ext cultivation (sugarcane), forestry, instr dams, dams in tribs in upper reaches, Valley of a 1000 Hills, sediments.	1. Instream biota 2. Riparian veg		
	U20K-04296	Tholeni		Ext cultivation in upper reaches, rural settlements - subsistence farming.			
	U20K-04411	Mqeku		Rural area - subsistence farming, sml isolated sand mining in lower reach.			
IUA U2-6							

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
RU uMn10	U20M-04625		3WQ	Semi-urban (Kloof), AIP in riparian zone, road crossings.	1. Water quality 2. Riparian veg (level 2)	Urban (residential and limited industrial) impacts; septic tanks and unsewered areas; hiking (Palmiet); New Germany WWTW (Palmiet).	Nutrients, toxics, salts, faecal coliforms
	U20M-04639	Palmiet		Residential area, road crossings.			
	U20M-04642	Palmiet		Residential area, road crossings, indistrial area in middle reach, numerous road crossings, stormwater.			
	U20M-04649	Mbongokazi		Residential area, road crossings.			
	U20M-04653	Palmiet		Highway crossing, golf course, AIP in riparian zone.			
	U20M-04659	Palmiet		Residential, Palmiet Nature Reserve, abandoned quarry, road crossings.			
	U20M-04682			Residential area, road crossings.			

1 Waste Water Treatment Works

Table 2.13 Mvoti (U4) River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comment**	**Biota and habitat component indicators**	**WQ users**	**WQ variables**
IUA U4-1 AND U4-2							
MRU Heyns A	U40B-03770 Mv_I_EWR1	Heinespruit	3	Non-flow: Forestry, Agriculture (veg removal), barrier.		Agriculture, urban (incl. Greytown WWTW)	Nutrients, salts, toxics, faecal coliforms
MRU Mvoti A	U40A-03869	Mvoti	2	Non-flow: Forestry, Agriculture (veg removal). Flow: Centre pivot, dams in tribs	1. Riparian veg 2. Instream biota 3. Water quality	Agriculture	Nutrients, salts
RU Mv 1	U40B-03708	Intinda	2, 3WQ	Non-flow: Forestry, Agriculture (veg removal). Barriers.	1. Riparian veg 2. Instream biota 3. Water quality	Agriculture	Nutrients, salts
	U40B-03740	Mvozana		Non-flow: Forestry, Agriculture (veg removal). Barrier. Inundation.			
	U40B-03832	Mvozana		Non flow: Agriculture (veg removal). Barriers, veg removal, water quality. Flow: Abstraction for irrigation.			
RU MV 2	U40C-03982	Khamanzi	2	Non-flow: Forestry, agriculture, and overgrazing.	1. Riparian veg 2. Instream biota		

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comment**	**Biota and habitat component indicators**	**WQ users**	**WQ variables**
MRU Mvoti B	U40B-03896	Mvoti	3b	Non flow: Aquatic alien macrophytes. Agriculture (veg removal) encroachment.		Settlements and sedimentation	Turbidity, **faecal coliforms**
	U40D-03867	Mvoti		Non-flow: Overgrazing, erosion.			
	U40D-03957	Mvoti		Non-flow: Overgrazing.			
	U40E-03967	Mvoti		Non-flow: Overgrazing, informal agriculture.			
	U40E-03985	Mvoti		Non-flow: Overgrazing, sedimentation.			
IUA U4-2							
RU MV3	U40D-03908	Mtize	2	Low density settlements in upper reaches.	1. Riparian veg 2. Instream biota		
RU MV 4	U40E-04079	Faye	2	Sugarcane in upper reaches. Small instream dam.	1. Riparian veg 2. Instream biota		
	U40E-04082	Sikoto		Waterfalls in upper reaches, planned dam in bottom reach.			
	U40E-04137	Sikoto		Forestry, irrigation (sugarcane, small instream dams.			
RU Mv 5	U40F-03690	Potspruit	2	Non-FLow: Forestry, agriculture, inundation, Barrier.	1. Riparian veg 2. Instream biota		
	U40F-03694	Hlimbitwa		Non-Flow: Veg removal (Agriculture and forestry), Canalisation.			
	U40F-03730	Cubhu		Non-Flow: Forestry, agriculture, Overgrazing, barrier impacts.			
	U40F-03769	Hlimbitwa		Flow: Large dam in SQ and US. Non-flow: Forestry and Agric.			
	U40F-03790	Nseleni		Non-flow: Forestry and agriculture.			
	U40F-03806	Hlimbitwa		Forestry, AIP in riparian zone, erosion in lower reaches.			
RU Mv 6	U40G-03843	Hlimbitwa	2	Subsistence farming, AIP in riparian zone. Overgrazing erosion.	1. Riparian veg 2. Instream biota 3. Water quality	Dispersed settlements and edimentation	Turbidity
IUA U4-3							
MRU Mvoti C	U40H-04064 Mv_I_EWR2	Mvoti	3	Non-Flow: Sedimentation, overgrazing, trampling		Sedimentation	Turbidity
MRU Mvoti C MRU Mvoti D	U40J-03998	Mvoti	3WQ	Non-Flow: Sedimentation, overgrazing. Flow: cumulative dams in tribs, small abstractions.	Water quality	Urban/ industrial, Mvoti and Stanger WWTW. Dispersed settlements and sedimentation;	Nutrients, salts, toxics, faecal coliforms, turbidity

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comment**	**Biota and habitat component indicators**	**WQ users**	**WQ variables**
						extensive sand-mining; Ushukela sugar mill and Sappi Stanger mill effluent and ponds; some urban impacts in lower reaches.	
RU MV 7	U40H-04091	Pambela	2	Non-Flow: Sedimentation, overgrazing, trampling.	1. Riparian veg 2. Instream biota 3. Water quality	Sedimentation	Turbidity
	U40H-04117	Nsuze		Non-Flow: Sedimentation, overgrazing, trampling.			
	U40H-04133	Nsuze		Non-Flow: Sedimentation, overgrazing.			

Table 2.14 Lovu (U7) River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU Priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
IUA U7-1							
MRU Lovu A	U70A-04609	Lovu	2	Forestry, road crossing.	1. Riparian veg 2. Instream biota		
	U70A-04685	Lovu		Ext forestry, roads.			
RU L1	U70A-04599	Serpentine	2	Sml plantation, roads, cultivation.			
	U70A-04618			Ext forestry, roads.			
MRU Lovu B	U70B-04655	Lovu	3WQ	Forestry, instr dam in upper reach, roads, urban (Richmond and township), WWTW, dams in tribs, cultivation, AIP in riparian zone, lower reach rural.	1. Water quality 2. Riparian veg (level 2) 3. Instream biota (level 2)	Urban and industrial (Richmond and Ndaleni), incl. Richmond WWTW - at upper end of MRU; intensive agriculture.	Nutrients, salts, toxics, faecal coliforms.

a	b	c	d	e	f	g	h
RU	SQ	River	RU Priority	Comments	Biota, habitat and WQ component indicators	WQ users	WQ variables
RU L2	U70C-04710	Mgwahumbe	2	Ext forestry in upper reach, instr dams, roads.	1. Riparian veg 2. Instream biota		
	U70C-04724			Ext forestry, road.			
	U70C-04732			Forestry, instream dam.			
MRU Lovu D	U70C-04859 Lo_R_EWR1	Lovu	3	Rural, roads.	All	Settlements; subsistence agriculture; sedimentation (overgrazing and trampling).	Turbidity
RU L3	U70D-04800	Nungwane	2	Cultivation, AIP, subs farming, roads, large instr dam - water abstraction, rural villages, instr weirs.			
IUA 7 CC							
RU CC 1	U70E-04942	Umsimbazi	2	Rural, roads, cultivation, lower reach is estuarine.	1. Riparian veg 2. Instream biota		
	U70E-04974	uMgababa		Rural, cultivation, roads, instr dam (Umbagaba), lower reach is estuarine.			
RU CC 2	U70F-04845	aManzimtoti	3WQ	Cultivation, dense rural communities, over-grazing, lower reach is estuarine.	Water quality (river section)	Extensive settlements and urban impacts, incl Kingsburgh WWTW	Nutrients, faecal coliforms
	U70F-04893	Little aManzimtoti River		Dense rural communities, roads, lower reach is estuarine.			
	U80F-05258	Mtwalume		Cultivation, road crossings, rural villages.			
	U80F-05301	uMngeni		Cultivation, roads.			

Table 2.15 U3, 5, 6 and 8 River Systems: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RU	SQ	River	RU priority	Comments	Biota, habitat and WQ component indicators	WQ users	WQ variables
IUA U3-1							
RU U3.1	U30A-04228	uMdloti	3WQ	Sugarcane at top, rural settlements, erosion.	1. Riparian veg 2. Instream biota	Dispersed settlements; sand-mining; Ogungini WWTW some	Turbidity, nutrients, faecal coliforms, toxics
	U30A-04363	Mwangala		Rural settlement, erosion.			
	U30A-04360	uMdloti		Rural settlement, sand mining in upper and lower reaches, bass in system, bottom of reach in Hazelmere Dam. Brick	Water quality		

a RU	b SQ	c River	d RU priority	e Comments	f Biota, habitat and WQ component indicators	g WQ users	h WQ variables
				works below dam, industries (Bayer chemicals).		distance from the river; Hazelmere WWTW; Bayer Chemicals downstream dam.	
IUA U3-2							
RU U3.2	U30B-04465	Black Mhlashini	3WQ	Sugarcane, landfill site, quarry, informal settlements, abandoned lands.	Water quality	Settlements; quarry	Turbidity, faecal coliforms
IUA U3-3							
RU U3.3	U30C-04227	uThongathi	2	Rural settlements, AIP in riparian zone, erosion, sand mining, dryland sugarcane.	1. Ripairan veg 2. Instream biota		
	U30C-04272	Mona		Rural settlements road crossings, AIP in riparian zone.			
IUA 3 NC							
RU NC.1	U30E-04207	Mhlali	3WQ	Dryland sugarcane, erosion, extensive sand mining in lower reaches, quarry, WWTW discharges, hyacinths, AIP in riparian zone.	1. Water quality 2. Instream biota (Level 2) 3. Riparian veg (Level 2)	Sand-mining; erosion; wastewater discharges	Nutrients, turbidity, faecal coliforms
IUA 5 NC							
RU NC.2	U50A-04018	Zinkwazi	2	Dryland sugarcane, sml instr dam.	1. Ripairan veg 2. Instream biota		
	U50A-04021	Nonoti		Dryland sugarcane, AIP, road crossings, instr dams			
	U50A-04141	Mdlotane		Dryland sugarcane, AIP, road crossings, oxidation ponds.			
IUA U6-1							
RU U6.1	U60A-04533	uMlazi	3WQ	Forestry, Baynesfield piggery, irrigation, instr dams, urban (Hopewell), dams in tribs	1. Instream biota 2. Riparian veg 3. Water quality	Irrigation; Mpumalanga WWTW; urban discharges (Hopewell, Mpumalanga); Baynesfield Piggery and associated ponds; intensive agriculture and veg production; extensive poultry	Nutrients, salts, toxics, faecal coliforms, turbidity
	U60B-04614	Mkuzane		Forestry, irrigation, abandoned lands			
	U60C-04555	uMlazi		WWTW from Hopewell? Instr dam (Thorn-Lee Dam), irrigation, dams in tribs, chicken farm, semi urban settlements, WWTW return flows	Water quality		

a RU	b SQ	c River	d RU priority	e Comments	f Biota, habitat and WQ component indicators	g WQ users	h WQ variables
						farming; sand-mining	
RU U6.2	U60C-04556	Sterkspruit	3WQ	Hammersdale - industrial, WWTW return flows - mainly industrial effluent, Hammersdale Dam, Rainbow chickens abattoir, chicken farms, quarry, low density settlements, sand mining, Shongweni Dam at confluence with uMlazi	Water quality	Cato Ridge WWTW; Old Hammarsdale sludge disposal (incl Hg and Sn waste); urban and industrial discharges from Hammarsdale; extensive poultry farming in upper part of RU; sand-mining; Sterkspruit quarry; textile industries	Nutrients, toxics, salts, turbidity, faecal coliforms
RU U6.3	U60C-04613	Wekeweke	3WQ	Sugarcane, instr dam	Water quality	Irrigation; Shongweni hazardous waste site	Nutrients, toxics
IUA U6-2							
RU U6.4	U60D-04661	uMlazi	3WQ	Mgoshongweni River not digitised. Hazardous landfill site in upper reaches of tributary, downstream Shongweni Dam, AIP in riparian zone, low density settlements, number of WWTW, lower reach more dense settlements (Mlazi Township), into canal (estuary)	Water quality	Old KwaNdengezi and Dassenhoek WWTW; hazardous landfill; dense settlements incl. informal settlements and Umlazi; sand mining	Nutrients, salts, toxics, turbidity, faecal coliforms
IUA U6-3							
RU U6.5	U60E-04714	Mbokodweni	2	Sugarcane in upper reaches	1. Ripairan veg 2. Instream biota		
	U60E-04795	Bivane		Road crossings, subsistence farming, low density settlements			
RU U6.6	U60E-04792	Mbokodweni	3WQ	WWTW discharges, AIP in riparian zone, dense settlements in lower reaches, stormwater runoff, into estuary. Isipingo River not digitised	Water quality	aManzimtoti WWTW; Izimbokodweni	Nutrients, toxics, salts, faecal coliforms

a	b	c	d	e	f	g	h
RU	**SQ**	**River**	**RU priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
						wastewater pump station; dense settlements so urban impacts	
IUA 6 CC							
RU CC	U60F-04597	Mhlatuzana	3WQ	WWTW discharge (Hillcrest) and other lower down the river, sugarcane, AIP in riparian zone, residential, industrial development, township, PPC quarry, estuary channelised	Water quality	Umbilo and Umhlatuzana WWTW; dense settlements and urban areas; large quarry	Nutrients, salts, toxics, faecal coliforms, turbidity
	U60F-04632	Umbilo		Residential (Pinetown), industrial area, Paradise Valley Nature Reserve, AIP in riparian zone, quarry, into estuary. Mkhumbane River not digitised.			
IUA 8 SC							
RU SC3	U80G-05097	Fafa	2	Rural villages, roads, cultivation, plantations, instr weir, lower reach is estuarine.	1. Instream biota (level 2) 2. Riparian veg (level 2)		
RU SC4	U80H-05109	Mzinto	2	Cultivation, instream dam, Vernon Crook's Nature Reserve, instr weir, roads, lower reach is estuarine.	1. Instream biota (level 2) 2. Riparian veg (level 2)		
RU SC5	U80J-04979	Mpambanyoni	2	Forestry, roads.	1. Instream biota 2. Riparian veg		
	U80J-05043	Ndonyane		Forestry, roads, cultivation.			
RU SC6	U80K-04952	Mpambanyoni	2	Rural, roads, cultivation, instr weir, lower reach is estuarine.	1. Riparian veg 2. Instream biota		
RU SC7	U80L-05020	aMahlongwa	2	Rural communities, roads, sml sand mining, lower reach is estuarine.	1. Riparian veg 2. Instream biota		
IUA U8-1							
RU U8.1	U80B-05145	Mzumbe	2	Forestry in upper reach, roads, cultivation.	1. Riparian veg 2. Instream biota		
	U80B-05161	Mhlabatshane		Few road crossings.			
	U80C-05231	Mzumbe		Rural villages, subs farming, roads, over-grazing - sediments.			
	U80C-05329	Kwa-Malukaka		Rural villages, roads.			
IUA U8-2							
RU U8.2	U80E-05028	Mtwalume	2	Extensive cultivation, numerous instream dams, dams in tributaries, roads, instr weir.	1. Instream biota 2. Riparian veg		
RU U8.3	U80E-05212	Quha	2	Rural, subs farming, roads.	1. Instream biota		

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*
RU	**SQ**	**River**	**RU priority**	**Comments**	**Biota, habitat and WQ component indicators**	**WQ users**	**WQ variables**
	U80F-05258	Mtwalume		Cultivation, road crossings, rural villages.	2. Riparian veg		
	U80F-05301	uMngeni		Cultivation, roads.			

3 APPROACH

3.1 BIOTA AND HABITAT ECOSPECS, TPCs AND RQOs

For the purpose of RQO determination, the following differentiation is made between biota and habitat EcoSpecs and RQOs.

EcoSpecs are associated with the Ecological Reserve process and are usually provided at EWR sites. As explained in Chapter 2, EWR sites are situated in hotspots and high priority RUs and detailed RQOs must be provided. EcoSpecs are seen as detailed RQOs as they are quantifiable, measurable, verifiable and enforceable to ensure protection of all components of the resource, which make up ecological integrity (DWA, 2009a). Therefore, EcoSpecs are numerical and can be used for monitoring. TPCs are upper and lower levels along a continuum of change in selected environmental indicators and are used and interpreted according to the following guidelines (Rogers and Bestbier, 1997) and are linked to EcoSpecs. When setting EcoSpecs, the work is usually based on field work that has been undertaken, a monitoring baseline is therefore available and monitoring to determine whether the specifications are being achieved (or Ecological Category) can be undertaken.

Biota and habitat RQOs are usually determined for the Moderate Priority RUs (Level 2) rather than EcoSpecs. The requirements for Moderate Priority RUs are that the RQOs should be broader or less detailed than High Priority RUs and this is inherently the case as fieldwork has not been undertaken. A monitoring baseline is therefore also not available and EcoSpecs cannot be determined. Monitoring at Moderate Priority RUs will be of lower priority than at EWR sites in High Priority RUs. As sufficient data is not available to set specifications, broad objectives for the EC are provided only. RQOs in this format cannot be used in monitoring as is. It therefore follows that if monitoring must be undertaken for some or other reason at some stage, then the objectives must be translated into EcoSpecs based on field surveys and the establishment of a monitoring baseline.

3.2 WATER QUALITY

3.2.1 General Approach

The water quality RQOs were generated following the approach shown in Figure 3.1. Note that water quality RQOs were generated as EcoSpecs for the EWR sites as part of the Reserve process (i.e. objectives for aquatic ecosystems), and UserSpecs for the following users (DWAF, 1996a-e):

- Domestic use; assumes primary treatment, i.e. water for drinking, laundry, cooking and personal hygiene.
- Agriculture - Stock watering and Irrigation.
- Aquaculture.
- Industrial.
- Faecal coliforms/*Escherichia coli*: Full or partial contact recreational and other uses (Risk level guidelines used by the National Microbial Monitoring Programme (NMMP) of South Africa).

Where objectives for aquatic ecosystems were not available from a Reserve study and the Reserve water quality manual (DWAF, 2008b), water quality guidelines were used (DWAF, 1996c).

Note that guidelines are not linked to an Ecological Cateory, but rather a level of protection, e.g. a Target Water Quality Range (which is equivalent to an A category).

The approach followed for setting water quality RQOs can be seen as Steps 1 - 5 on Figure 3.1. Steps 1 to 3, particularly data collected regarding users and driving variables for which RQOs should be set, were tested at two Technical Working Group (TWG) meetings held in Durban (September 2014 (U1 and U4 catchments) and January 2015 (rest of study area)). Invaluable data were collected at and after these meetings, and RQOs set according to the agreed set of variables for the priority RUs.

- Use information from stakeholder workshops to identify driving variables.
- Set water quality RQOs that are immediately applicable ONLY where monitoring data are available for comparative purposes.
- Set monitoring recommendations and provisional RQOs for identified driving variables for which RQOs are not immediately applicable, but for which a database needs to be developed.
- Once an adequate dataset has been produced, evaluate the provisional RQOs provided and set the RQOs for the driving variables identified during this Classification study.

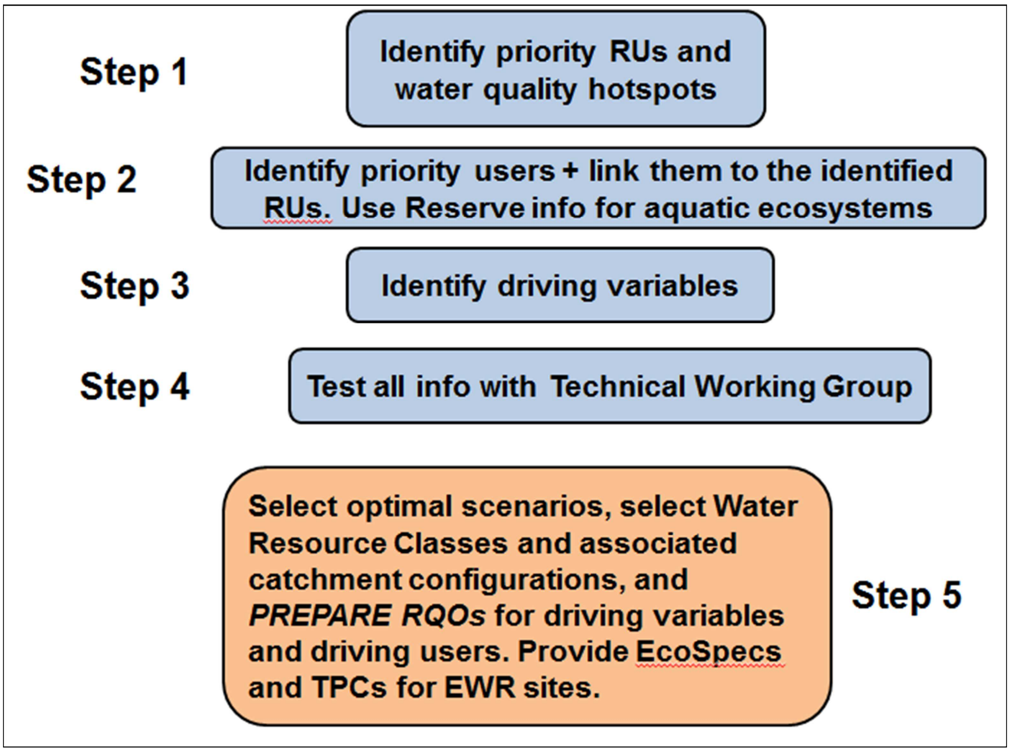
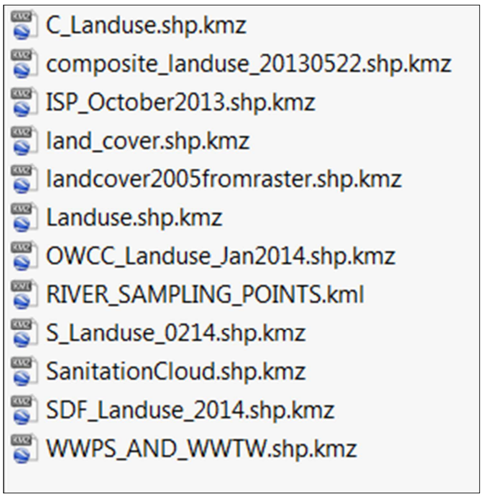


Figure 3.1 Approach followed to generate water quality RQOs

Mention must be made of extensive input received from the following sources:

- Umgeni Water: data from monitoring sites were used for the water quality assessment at EWR sites, and a detailed Google Earth (GE) layer of users used to inform the RQO report.
- eThekwini Municipality: Some water quality data were provided, as well as data required for the development of the following GE layers, used to inform the RQO report:



Data were also received from a number of other stakeholders, e.g. the Duzi uMngeni Conservation Trust (DUCT), post-matric students from Treverton College working on the uMkhomazi, and numerous literature sources.

3.2.2 Setting numerical and narrative RQOs

Numerical and narrative RQOs were therefore produced using all existing data sources, including the preliminary water quality objectives produced by DWS Water Quality Planning (DWA, 2012b-k). Objectives were produced using data from identified monitoring points, and for a range of identified users.

Preliminary water quality objectives were expressed in terms of Ideal, Acceptable and Tolerable categories for a range of water quality variables. During the Planning study, the most sensitive user was identified per variable and the preliminary objective set in terms of that user's requirements. This approach was followed during this study for setting water quality RQOs for identified reaches. Note that Reserve data available as A-F categories were converted to Ideal to Tolerable categories, as follows:

Categories A and A/B: Ideal
Categories B, B/C and C: Acceptable
Categories C/D and D: Tolerable

To summarize, user water quality state per relevant RU and IUA was evaluated by determining the <u>driving</u> water quality variables linked to the <u>primary</u> water quality user(s). Note that although the aquatic ecosystem is the **resource base** rather than a "user", it was grouped and evaluated with other users for purposes of this step of the classification process. The driving user and set of variables were identified and the water quality RQOs set accordingly.

Note that RQOs that are *immediately applicable* (and will therefore be gazetted) are only for those sites and variables where monitoring is currently taking place. Other RQOs are *provisional* and can only be evaluated and confirmed once adequate monitoring data are available.

3.2.3 Priority levels

Water quality RQOs were set for Moderate (Level 2) priority sites where identified as an indicator, and all High (Level 3) Priority sites. Note that Level 3WQ sites were also identified, which are sites where water quality only is considered a high priority.

The water quality component of developing Level 2 and 3 RQOs was undertaken as follows:

Moderate (Level 2) Priority RQOs: No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a, DWS, 2014c; DWAF, 1996a-d) were used. GE layers of land use from Umgeni Water and eThekwini Municipality were also used to provide information.

High (Level 3 WQ) Priority RQOs: Detailed RQOs were produced for water quality using any existing information as these are high priority water quality sites. Note that a water quality assessment was normally not available for these sites, unless also an EWR site or monitoring has been conducted and were available to the study.

High (Level 3) Priority RQOs: Detailed water quality assessments have been conducted for Reserve studies using methods such as Tool for Ecological Aquatic Chemical Habitat Assessment (TEACHA) and Physico-chemical Driver Assessment Index (PAI models) (DWAF, 2008b). Historical Reserve assessments were used (DWAF, 1999b; DWA, 2011c).

3.2.4 Completing water quality RQOs

Background information was provided under the following headings per relevant SQ. An example is provided below:

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). A GE layer of land use from Umgeni Water was also used to provide information.
Model: PAI model (DWAF, 2008b).
Users: Sedimentation (overgrazing and trampling).
Water quality issues: Turbidity, nutrients.
Narrative and numerical: Details for MRU Mvoti C are provided in Tables 22.1 and 22.2. Data used for water quality assessments should be collected from UW site RHB001.

3.2.5 Assumptions/rules when setting RQOs

The following set of assumptions and rules were developed and followed when setting RQOs. Rules were tested and developed further with stakeholders at the TWG meetings in September 2014 and January 2015.

a) Dams
RQOs were not set for dams.

b) Inter-Basin Transfers
The impact of IBTs were not evaluated as RQOs were set for RUs within the study area specifically, and not the source water.

c) Format of values used for setting RQOs

Values used for setting RQOs were linked to standard DWS methods and procedures, i.e. the manner in which variables are analysed and curated on DWS's Water Management System (WMS) database (e.g. NO_2 and NO_3-N and PO_4-P), and Reserve methods for water quality in rivers (DWAF, 2008b). It is acknowledged that different ways of evaluating nutrients are available (e.g. Total Phosphate), but standard DWS approaches were followed.

d) Data availability

RQOs were set based on real data where available and used for assessing water quality state at EWR sites, i.e. monitoring data available and verified at the time of writing the reports. Note that monitoring data to be collected for measurement against RQOs that are immediately applicable and gazetted, should be collected from the monitoring sites as identified in the water quality Reserve documentation. Umgeni Water sites are almost always recommended as they monitor for a wide range of variables, including turbidity.

Where data were not available (e.g. at Priority Level 2 or 3WQ sites), extrapolation from real data were undertaken where possible, or land-use and all other available information sources used. It is acknowledged that these RQOs are PROVISIONAL will only become applicable once a database of information has been set up through monitoring, to evaluate whether the RQO is valid and appropriate, or needs adjusting.

As previously mentioned, the RWQOs set up by Water Quality Planning were evaluated for use. The phosphate (PO_4-P) guidelines in particular seem very conservative, compared to present state at a number of sites. The recommended RQO has been set using benchmark categories as defined in DWAF (2008b) standard methods, and linked to the current phosphate values and the associated water quality category for the Tareget Ecological Category (TEC).

e) Data quality

Standard DWS methods (e.g. DWAF, 2008b) have been followed for the analysis of water quality data and preparation of RQOs. Although the use of percentiles is acceptable practise, it is necessary to define data quality and length of an acceptable data record when calculating percentiles. When compliance to a percentile is evaluated, it is important to know the associated statistical confidence of the data, and therefore the confidence in the result. The following guidelines regarding data frequency and hence quality are taken from DWAF (2008b).

The general rule for data selection is the following:
*Select the RC (or Reference Condition/natural state) data as the **first** 3-5 yrs (**minimum of 60 data points for high confidence, 25 samples for moderate confidence and 12 samples for low confidence**) of the data record, and the PES as the **last** 3 - 5 years of data (again a minimum of 60, 25 or 12 data points for difference confidence levels). The monitoring point suitable for Reference Condition must therefore either be in an unimpacted tributary (this can be in an adjacent catchment, but in the same Level II EcoRegion) or a very early data record (e.g. from the 1960s – early 1980s). It is possible to use the same monitoring point for Reference Condition and PES data, if the appropriate data record is available.*

Note that although a low confidence desktop assessment can be run using 12 data points, these points should preferably be spread across the hydrological cycle. Alternatively, weekly monitoring over a 60 day period can be undertaken.

It is difficult to specify a time window of observation, as the frequency of monitoring would be dependent on the implementing agent undertaking and financing the monitoring, but it is acceptable to say that at least 12 data records over differenta range of hydrological regimes should be available to test percentiles against with any level of confidence (which would be low confidence, in this instance). Note that DWAF (2008b) states the following regarding confidence in water quality data for conducting a Reserve assessment in High or Very High EIS systems. The same rule should apply to testing compliance against RQOs at EWR sites.

Note: If inadequate data exists for an assessment in a *High / Very High* EIS area **(i.e. n<25)**, recommend monitoring is initiated (preferably over one hydrological cycle) before a Reserve can be determined, including at the Desktop level. This constraint may be waived if sufficient biological monitoring and site-specific information is available.

Note that data collected for compliance monitoring at EWR sites must be taken from the same site used for the Reserve study. In most instances in this study area, data should be collected from Umgeni Water monitoring points, as they routinely analyze for a wide range of variables (including turbidity). Data used for the derivation of percentiles could include baseline monitoring data, as the sampled time windows then increase, with an associated increase in statistical power. Of course a smaller data set would be more sensitive to short-term variation, and would have a shorter "memory" for historic non-compliance than that for a larger data set. However, a smaller data set is more prone to be affected by natural variation, and sampling and laboratory error. In contrast, a larger monitoring data set will comprise samples drawn from a longer time frame. Together with the greater statistical power implicit in a larger sample size, such a larger data set will amalgamate data over a longer time frame and, in this way, the impact of short term variations in water quality will be decreased (Griffin and Palmer, 2011).

f) Microbial compliance targets

Although microbial compliance targets for WWTW should be specified in the water use license for the discharge, an objective for *E. coli* and faecal coliforms was set below each WWTW, town and large settlement.

Due to the large areas of non-compliance to full-contact guidelines (e.g. swimming, DWAF (1996a)) for faceal coliforms and *E. coli* (i.e. 0 - 130 counts/ml), an alternative approach had to be followed. Contact was made with the NMMP of South Africa (Mogakabe, DWS, *pers. comm*., April 2015). The NMMP measures *E. coli*, pH and turbidity at a number of sites across the country, based on a site prioritization system (Kühn *et al*., 2000). Although turbidity does not of itself have direct health effects, it is one of the indicators of microbiological water quality. Depending on the nature of the origin of the suspended matter causing the turbidity, there may be associated health effects. Suspended day particles, often a major contributor to turbidity in surface waters, provide large surfaces for colonisation by bacteria and other micro-organisms.

As a clear relationship has been reported between the concentration of *E. coli* in a particular water sample and the probability of gastroenteritis symptoms in humans exposed to the water through drinking or full-contact recreation, *E. coli* is used as a microbial indicator organism. Furthermore soils are the only environmental source of *E. coli*. As a result, the influence of environmental contributions to the measured concentrations of *E. coli* at a given sampling site will be negligible, i.e., providing a clear understanding of the faecal contamination at a given sampling site (Luyt *et al*., 2012).

The following NMMP objectives were used for this study, largely due to the dearth of information on what recreational or other activity is taking place where in the WMA, and the very wide range of faceal coliform and *E. coli* values across the study area. It is also accepted that a phased approach may be necessary in many areas to improve faecal coliform and *E. coli* conditions. RQOs for faecal coliforms and *E. coli* have therefore been written as an evaluation again potential health risk rather than achieving absolute values. A risk warning and acknowledgement of risk is considered an appropriate first step to improving coliform state.

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

Run-of-river objectives for *E. coli* and faecal coliforms are therefore focused on *partial* e.g. angling, or *full-contact recreational and other uses*, e.g. swimming and boating, and not water used for drinking. Full contact use has been expanded to include full-body immersions, e.g. baptisms. It is assumed that run-of-river water is not used for domestic use UNLESS primary treatment has been undertaken. Objectives for domestic use, such as drinking untreated water from the river, are therefore not covered in the water quality RQOs.

g) Ingonyama Tribal Lands

The issue of inadequate sanitation structures in Ingonyama Tribal Lands and their influence on instream water quality was highlighted by eThekwini Water and Sanitation. This type of situation is problematic as eThekwini is unable to administer any conventional controls over development in these areas, and can therefore not control the impacts on water quality. Until conditions in the Ingonyama Tribal Lands are regulated, which cover large portions of rural eThekwini, RQOs in these areas may be difficult or impossible to achieve.

h) Toxics

Broad numerical guidelines for *toxics* are not suitable for areas where specific information on toxics are not available, or where the identity of contaminants are not known. In certain areas where reference condition data are not available, and values of metals could not be quantified, biotic response and biological monitoring are used to indicate toxicity. Due to the complexity and range of water quality issues across the area, known elevated toxics values are shown as follows in the text (for example):

Narrative RQO	Numerical RQO
Ensure that toxics are within Ideal limits or A categories.*	95^{th} percentile of the data must be within the Target Water Quality Range (TWQR) for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	**See specified biota requirements.**

*** Note that ammonia (NH_3-N), aluminium and mercury already exceed Acceptable levels for aquatic ecosystems, although background levels (natural state) are not available. See biotic requirements for improvement to a D Category.**

OR

* It is expected that a number of toxics will already exceed Tolerable levels. It is recommended that a biological monitoring point be instituted at the lower end of the RU and that toxics monitoring be dependent on biotic response.

The default state should be to eliminate toxics from rivers, but again it is acknowledged that this may require a phased approach, and that the first step is to be aware of instances where toxics are, or seem to be, problematic.

i) Aquatic ecosystems driver

It can be seen from the detailed RQOs in the report that the driver is often *aquatic ecosystems*. This seems suitable as often the water quality data is linked to the maintenance or reaching of a particular water quality category, which is part of a specific EC, catchment configuration and Water Resource Class.

j) Water quality EcoSpecs and TPCs

Detailed EcoSpecs and TPCs are provided for the EWR sites, as available from the Reserve studies of 2011 (DWA, 2011c) and 2014 (DWS, 2014b). Note the following points:

- A distinction must be made between RQOs and the Reserve template for water quality, i.e. both that for the ecological component and that for basic human use; particularly for salts. Aggregated salts are provided as objectives for the ecology in the Ecological Reserve template (where available and generated from ions using TEACHA), while salts appear as ions for basic human use in the Basic Human Needs part of the Reserve template. These standards are enforced through the licensing process and are a measure for managing water quality state IN ADDITION to RQOs.
- Issues related to the use of TEACHA, data storage, and the use of salts data (i.e. ions vs salts vs Electrical Conductivity), are issues related to Reserve methodology and not to the development of RQOs.
- It is assumed that the official using TEACHA to produce aggregated salts will be a DWS water quality or Reserve practitioner that is conducting the water quality component of the Reserve monitoring. Reporting regarding EcoSpecs, TPCs and monitoring for the water quality part of the Ecological Reserve always specifies that someone trained in water quality will have to conduct this component.
- Note that TEACHA is not operational at present (i.e. from 2013 onwards), but as it is the only tool to generate aggregated salts and was used during the Reserve studies, it is referred to in this document.

k) Immediately applicable vs. provisional RQOs

As previously mentioned, not all RQOs mentioned in this report are linked to a current monitoring programme or can be immediately applicable. The tables below list the Immediately applicable RQOs for sites and variables linked to current monitoring programmes; for both EWR sites and High Priority water quality sites. The first step with all other RQOs listed in this report is to assess whether sites are part of a monitoring programme and whether the variable of interest is being monitored by that programme. If not, or if insufficient data are available to test compliance, a monitoring database must be developed before the RQO can be evaluated and applied.

Component/ Indicator	TEC	RQO
IUA T4-1: MTAMVUNA		
RU EWR MT_R_EWR1 (T40E-05601, T40C-05520, T40D-05537, 05584, 05707)		
Water quality	**A/B**	Maintain the target EC (>88%). Ensure that **turbidity or clarity levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
IUA U1-2: MIDDLE uMKHOMAZI		
RU MK_I_ EWR 1 DS (U10F-04528 DS)		
Water quality	**A/B**	Maintain the target EC (>88%). Ensure that **turbidity or clarity levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
IUA 1-3: uMKHOMAZI GORGE		
RU MK_I_ EWR 2 (U10J-04679, U10JH-04638, 04675)		
Water quality	**A/B**	Maintain the target EC (>88%). Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
		Ensure that **electrical conductivity (salt) levels** are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
IUA U1-4: LOWER uMKHOMAZI		
RU MK_I_ EWR 3 (U10M-04746, U10J-04807, 04799, 04833, U10K-04838)		
Water quality	**A/B**	Maintain the target EC (>88%). Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
		Ensure that **electrical conductivity (salt) levels** are within Acceptable limits: 95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).
IUA 2-1: uMNGENI UPSTREAM MIDMAR DAM		
RU Mg_R_ EWR 1 (U20A-04253, U20C-04275)		
Water quality	**B**	Maintain the target EC (>82%). Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
		Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
IUA 2-2: uMNGENI, MIDMAR TO ALBERT FALLS		
RU Mg_I_ EWR 2 (U20E-04243, U20E-04221)		
Water quality	**C/D**	Maintain the target EC (>58%). Ensure that **nutrient levels (phosphate)** are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).
		Ensure that **nutrient levels (Total Inorganic Nitrogen; TIN)** are within Acceptable limits: 50th percentile of the data must be less than 0.85 mg/L TIN-N (Aquatic ecosystems: driver).
		Ensure that **electrical conductivity (salt) levels** are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
		Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
RU Mg_R_ EWR 3 (U20E-04170)		

Component/ Indicator	TEC	RQO
Water quality	B	Maintain the target EC (>82%). Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
IUA 2-5: uMNGENI DS uMNSUNDUZE CONFLUENCE TO INANDA DAM		
RU Mg_I_ EWR 5 (U20L-04435, U20M-04396)		
Water quality	C/D	Maintain the target EC (>58%). Ensure that **nutrient levels (phosphate and Total Inorganic Nitrogen; TIN)** are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). 50th percentile of the data must be less than or equal to 4.0 mg/L TIN-N (Aquatic ecosystems: driver).
		Ensure that **electrical conductivity (salt) levels** are within Acceptable limits: 95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).
		Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
IUA 4-1 AND 4-2: MVOTI		
RU MV_I_ EWR 1 (U40B-03770, HEINESSPRUIT)		
Water quality	C	Maintain the target EC (>62%). Ensure that **nutrient levels (phosphate and Total Inorganic Nitrogen; TIN)** are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L PO_4-P (Aquatic ecosystems: driver). 50th percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).
		Ensure that **electrical conductivity (salt) levels** are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
		Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
IUA 4-3: LOWER MVOTI		
RU MV_I_ EWR 2 (U40H-04064)		
Water quality	C	Maintain the target EC (>62%). Ensure that **nutrient levels (phosphate)** are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L PO_4-P (Aquatic ecosystems: driver).
IUA 7-1: LOVU		
RU LO_R_ EWR 1 (U70C-04859)		
Water quality	B/C	Maintain the target EC (>78%). Ensure that **turbidity or clarity levels** stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads (Aquatic ecosystems: driver).

* Note that all river faecal coliform and *E. coli* targets for full and partial contact are presented in terms of SA NMMP guidelines and health risks in terms of counts/100 ml, as follows:

Low	Medium	High
< 600	600 - 2 000	> 2 000

Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

RU	SQ	Water quality RQOs
IUA T5-2: UMZIMKULU		
MRU MzA	MzEWR2i T51C-04760	Ensure that **electrical conductivity (salt) levels** are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver). Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
MRU MzB	MzEWR3i T52C-04960 T52D-04948 T52D-05137	Ensure that **electrical conductivity (salt) levels** are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver). Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
IUA U2-3: uMNGENI		
RU uMn7	U20F-04131 U20F-04204 U20F-04224 U20G-04194 U20G-04215	Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver). Ensure that **turbidity/clarity or TSS levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff event (Aquatic ecosystems: driver). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial

RU	SQ	Water quality RQOs
		contact) use*.
MRU uMnC	U20G-04240 U20G-04259 U20G-04385	Ensure that **nutrient levels (phosphate)** are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). Ensure that **turbidity/clarity or TSS levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff event (Aquatic ecosystems: driver). Ensure that **toxics (ammonia, iron, manganese)** are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics (DWAF, 1996c) or the upper limit of the A category in DWAF (2008b). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
IUA 2-4: UMNSUNDUZE		
RU uMn8	U20J-04461 U20J-04488	Ensure that **turbidity/clarity or TSS levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff event (Aquatic ecosystems: driver). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
MRU Duze D	U20J-04459	Ensure that **turbidity/clarity or TSS levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff event (Aquatic ecosystems: driver). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
IUA U2-6: uMNGENI		
RU uMn10	U20M-04625 U20M-04639 U20M-04642 U20M-04649 U20M-04653 U20M-04659 U20M-04682	Ensure that **nutrient levels (phosphate)** are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
IUA U3-1: uMDLOTI		
RU U3.1	U30A-04228 U30A-04363 U30A-04360	Ensure that **turbidity/clarity or TSS levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff event (Aquatic ecosystems: driver). Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
IUA U4-1 AND U4-2: MVOTI		
RU Mv1	U40B-03708 U40B-03740 U40B-03832	Ensure that **nutrient levels (phosphate)** are within Acceptable limits: 50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver). Ensure that **electrical conductivity (salt) levels** are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
IUA U6-1: UPPER UMLAZI		
RU U6.1	U60A-04533 U60B-04614 U60C-04555	Ensure that **turbidity/clarity or TSS levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff event (Aquatic ecosystems: driver). Ensure that **nutrient levels (phosphate)** are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). Ensure that **electrical conductivity (salt) levels** are within Tolerable limits: 95th percentile of the data must be less than or equal to 85 mS/m (Aquatic ecosystems: driver). Ensure that **toxics (ammonia)** are within Tolerable categories: 95th percentile of the data must be within the D category according to DWAF (2008). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
RU U6.2	U60C-04556	Ensure that **turbidity/clarity or TSS levels** stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff event (Aquatic ecosystems: driver). Ensure that **nutrient levels (phosphate)** are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.
IUA U6-3: MBOKODWENI		

RU	SQ	Water quality RQOs
RU U6.6	U60E-04792	Ensure that **electrical conductivity (salt) and toxics levels** are within appropriate limits for intended use, e.g. industrial use: Numerical limits can be found in DWAF (1996e) (Industrial use: driver). Meet **faecal coliform and *E. coli* targets** for recreational / other (full or partial contact) use*.

* Note that all river faecal coliform and *E. coli* targets for full and partial contact are presented in terms of SA NMMP guidelines and health risks in terms of counts/100 ml, as follows:

Low	Medium	High
< 600	600 - 2 000	> 2 000

Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

3.3 FISH

High priority rating (3) RUs: The RQOs and EcoSpecs as developed during the Reserve Determination studies (Afridev, 2006a; DWA, 2010) was primarily used during this process. The information was adapted and simplified where possible and all other available and relevant information (e.g. PES (11)[2]) was used to update and expand the descriptions to be relevant for the EWR reach as well as the entire management unit. RQOs and EcoSpecs were described for different metrics, such as Ecological Status (PES), species richness, migratory requirements, alien species and for specific habitat features (such as fast shallow habitats, rocky substrates). Indicator species were identified for all these various metrics and primary indicator species (that would best provide indication of potential concern, especially in terms of flow and flow related water quality) was then highlighted.

The following codes are used in the fish EcoSpec table and are applicable for all tables:

- *FREQUENCY OF OCCURRENCE (FROC):
    - 0=absent
    - 1=present at very few sites (<10%)
    - 2=present at few sites (>10 - 25%)
    - 3=present at about >25 -50 % of sites
    - 4=present at most sites (>50 - 75%)
    - 5=present at almost all sites (>75%)
- #Indicator: Primary species or variable used as indicator for relevant metric.
- ##Migratory guilds
    - **Catadromous** – Fishes which spend most of their lives in freshwater and migrate to the sea (or saline reaches of estuaries) to breed as adults (e.g. eels) (Catchment scale migrations).
    - **Potamodromous**: Truly migratory species whose entire life cycle is completed within freshwater and that undertake migrations within freshwater zones (between SQ reaches) of rivers for a variety of reasons, such as for spawning, feeding, dispersion after spawning, colonisation after droughts, for over-wintering, etc.

Moderate priority rating (2) RUs: The available information, as provided in the PES (11) assessment (DWS, 2014c) was used as the primary fish information source for RUs with a level 2 priority rating. This information, together with other relevant available information was used to determine the expected species that may occur in the reach/es under present ecological condition. Based on this information, species richness, primary and secondary indicator species were

[2] Desktop Present Ecological State (PES) and Ecological Importance (EI) - Ecological Sensitivity (ES) (DWS, 2014c) assessment (referred to PES (11)).

identified and used to describe the narrative and numerical RQOs for each of this sub component indicators for the reach.

3.4 MACRO-INVERTEBRATES

High priority rating (3) RUs: For the macro-invertebrate component of the study, EcoSpecs and TPCs were provided only for the EWR sites, and the detail of the approach and methodology is available from the Reserve study of 2009 (DWA, 2010).

By using the taxa preference data in the Macro Invertebrate Response Assessment Index (MIRAI) sheets (Thirion, 2007), the indicator taxa for different criteria were selected. These sheets indicate the habitat value and preference (1 - 5) for each taxa related to the different variables (flow, water quality and habitat). The physical and hydraulic-habitat criteria are considered to be those relevant to the indicator taxa per reach or site:

- Preference for fast-flowing water.
- Optimal substrate types.
- Integrity of marginal vegetation habitats.
- Moderate to good water quality.

The actual setting of EcoSpecs and TPCs was guided by the data described above. South African Scoring System version 5 (SASS5) and MIRAI scores also integrate these habitat parameters, thus these scores are also translated into EcoSpecs. Macro-invertebrate EcoSpecs are described for each criterion, and once the EcoSpecs are described, TPCs are then derived for each of the selected criteria for the EWR site, supplying measurable biotic TPCs.

Measurable reaction (presence/absence or population trends) of the sensitive or key taxa to changes in the system, will indicate the integrity of the river reach, and should be quantifiable with the specific TPC.

The following data was used for determining EcoSpecs and TPCs:

- Data collected during the EWR site visits;
- Relevant historic data and observations from surveys in the catchment.

Moderate priority rating (2) RUs: The reach was examined by using Google Earth images of the node and the dominant habitat types were identified. Historical data or extrapolated data (obtained from the PES (11) data (DWS, 2014c)) was used to list the expected macro-invertebrate taxa.

By linking the habitat information and the macro-invertebrate taxa expected, the key species per habitat are used as an EcoSpec for the most sensitive habitat as listed below:

- Rapid velocities: >0.6 m/s in the SIC (SIC) biotope
- Moderate velocities: 0.3 - 0.6 m/s in the SIC biotope.
- Suitable marginal vegetation or sand/gravel habitat.
- Acceptable water quality (Moderate - Good).

3.5 RIPARIAN VEGETATION

High priority RUs

The following vegetation components, when assessed together, satisfactorily describe the overall state of the riparian zone:

- Invasion by perennial (and in some cases annual) alien species.

- Terrestrialisation (the disproportionate abundance of terrestrial species within the riparian zone).
- General vegetation structure and composition as shown by proportions of riparian woody species, reeds and non-woody species (grasses, sedges and dicotyledonous forbs).

Please note the hypotheses that underpin the RQOs need to be refined by the Decision Support System (DSS) (ideally each hypothesis should be tested in a research environment).

Invasion of the riparian zone by alien species

The hypothesis relating aerial cover of alien species to the EC of the riparian zone is shown in Table 3.1. Data from the Crocodile and Sabie rivers were used to establish the hypothesis. The relation of the EC (as determined by an overall approach using the Vegetation Response Assessment Index (VEGRAI – Kleynhans, *et al*., 2007) of a site/reach to the permissible aerial cover of perennial alien species is a general rule of acceptance rather than a deterministic relationship, since the overall EC is a function of multiple deviations from the reference condition, and not merely the abundance of alien species.

Table 3.1 Hypothesis for the acceptance levels (% aerial cover) of perennial alien species within the riparian zone, given the overall EC of the zone

EC	% Cover (perennial aliens)
A	0
A/B	1-5
B	5-10
B/C	10-15
C	15-20
C/D	20-30
D	30-50
D/E	50-60
E	60-70
E/F	70-80
F	>80

Terrestrialisation

Terrestrialisation is the disproportionate abundance, density or occurrence of terrestrial species within the riparian zone. Under reference conditions woody terrestrial species are not expected in the marginal zone, are expected to be transient (if any) in the lower zone due to frequent flooding disturbance, and are expected to occur in the upper zone in numbers concurrent with natural flooding frequency, magnitude and duration for the reach (i.e. hydrologically controlled abundance). In cases where RQOs were set for the riparian obligate/terrestrial species mix, it was always for the upper zone since this is the area where terrestrialization first manifests. Table 3.2 outlines the hypothesis used to relate the degree of terrestrialisation to the EC.

Table 3.2 Hypothesised relationship between degree of terrestrialisation and EC for different sub-zones within the riparian zone

Class	Marginal Zone	Lower Zone	Upper Zone	Note
A	0	0	0 - 5	This hypothesis is based on the phenomenon that terrestrial species occur naturally in the riparian zone, but are
A/B	0	0	5 - 10	
B	0	0	10 - 15	

Class	Marginal Zone	Lower Zone	Upper Zone	Note
B/C	0	1 - 5	15 - 20	reduced in cover and abundance by increased flooding disturbance. Data of terrestrial:riparian plant ratios (on the Sabie River) showed a distinct reduction in terrestrial individuals with increasing exposure to flooding disturbance.
C	0	5 - 10	20 - 30	
C/D	0	10 - 15	30 - 40	
D	1 - 5	15 - 20	40 - 50	
D/E	5 - 10	20 - 30	50 - 60	
E	10 - 15	30 - 40	60 - 70	
E/F	15 - 20	40 - 50	70 - 80	
F	> 20	> 50	> 80	

Indigenous riparian woody species cover

The hypothesis of expected aerial cover of indigenous riparian woody vegetation is applicable to sites/reaches where the climax community of the macro-channel bank and alluvial bars is dominated by woody riparian obligates (Table 3.3). In the absence of unnatural disturbance the proportion (% cover) will tend to increase to values as high as 70 or 100% of suitable habitat.

This hypothesis is for Lowveld Bushveld rivers (generalised) and is based on a dynamic whereby riparian vegetation in the lower and upper zones will always tend towards increased woody cover with diminishing non-woody cover (including reeds), this being "reset" by large flood events. "Reset" here refers to the removal of woody plants by floods, the resulting open space being available for quick colonising non-woody species (including reeds). The hypothesis assumes that if woody cover increases beyond a given value and remains high, that the flooding regime has been changed so that large floods are smaller or less frequent or both.

Table 3.3 Hypothesis relating EC to expected aerial cover of indigenous riparian woody vegetation in different sub-zones of the riparian zone

EC	Marginal Zone	Lower Zone	Upper Zone
A	10 - 20	20 - 40	40 - 50
A/B	20 - 40		
B	40 - 60; 5 - 10	10 - 20; 40 - 60	30 - 40; 50 - 60
B/C	60 - 70		60 - 70
C	70 - 80; 1 - 5	5 - 10; 60 - 70	20 - 30; 70 - 80
C/D			80 - 90
D	>80; 0	<5; 70 - 80	10 - 20; >90
D/E			
E		>80	5 - 10
E/F			
F			<5

Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs)

The hypothesis of expected aerial cover of indigenous non-woody vegetation is shown in Table 3.4.

Table 3.4 Hypotheses for expected indigenous non-woody cover in relation to EC

EC	Non - woody indigenous cover (grasses, sedges and dicotyledonous forbs)
A	70 - 80
A/B	60 - 70
B	50 - 60; 80 - 90

EC	Non - woody indigenous cover (grasses, sedges and dicotyledonous forbs)
B/C	40 - 50
C	30 - 40; >90
C/D	
D	20 - 30
D/E	
E	10 - 20
E/F	
F	<10

***Phragmites* (reeds) cover**

In both VEGRAI and Rapid Habitat Assessment Method (RHAM) (DWA, 2009b), reeds are classified as non-woody, and although they are a grass, their importance in riparian structure and function warrants their separate assessment in terms of RQOs, EcoSpecs and TPCs. The expectations for aerial cover of reeds in relation to EC are shown in Table 3.5. This hypothesis for Lowveld Bushveld rivers (generalised) is a corollary to the riparian woody cover hypothesis i.e. it is based on a dynamic whereby riparian vegetation will always tend towards increased woody cover with diminishing reed cover, this being "reset" by large flood events. "Reset" here refers to the removal of woody plants by floods, the resulting open space being available for quick colonising reeds. The hypothesis assumes that reeds will colonise open alluvium (similar to the pioneer species concept) created by floods, and will increase in cover until slowly replaced by woody vegetation as shading occurs. A natural flow regime will create a patch mosaic of woody versus reed areas, thus a mix is always expected (in the absence of very infrequent extreme events); an increase in reed cover beyond a specified value is seen to be a loss of riverine diversity and as such will begin to reduce the EC. Reeds would decrease with increasing proportions of bedrock, hence in bedrock anastomosing sites all values would have to be decreased before application.

Table 3.5 Hypotheses for expected *Phragmites* (reed) cover in relation to sub-zones within the riparian zone and EC

EC	Marginal Zone	Lower Zone	Upper Zone
A	60 - 80	40 - 60	20 - 30
A/B	40 - 60	60 - 70	
B	30 - 40; >80	30 - 40; 70 - 80	<20; 30 - 40
B/C	20-30	20-30	
C	10 - 20	10 - 20; 80 - 90	40 - 50
C/D			
D	1 - 10	1 - 10; >90	50 - 60
D/E	0	0	
E			60 - 70
E/F			
F			>70

Moderate priority RUs

Data from the PES (11) assessment (DWS, 2014c) were used to develop narrative and numerical RQOs for moderate priority RUs. Where more than a single SQ was included in the RU, data from an SQ with a better EC and farther downstream was used to represent the RU. The following indicators are described below and were used to describe narrative (and where data lend themselves numerical) RQOs.

Dominant vegetation cover

Different types of riparian ecosystems are characterised by different dominant riparian vegetation e.g. grass-dominated Highveld/mountainous streams, tree and shrub-dominated Lowveld/lowland rivers flowing through Bushveld, tall tree-dominated (forest) streams through forested /kloof areas, or mixed vegetation e.g. reed and tree/shrub dominated rivers which are common in the Inkomati catchment. The dominant vegetation type (riparian) is a key component of the structure and function of the riparian zone as a whole.

Presence of alien plant species

Invasion of riparian zones by alien plant species is a major concern and determinant of EC deterioration along almost all South African rivers. As such its consideration and measurement are imperative for effective management. The consideration here makes no distinction of species but does focus on perennial aliens rather than including annuals as well. Alien invasion is expressed as the percentage aerial cover (% of total riparian zone area) of all perennial aliens within the riparian zone area.

Longitudinal riparian zone continuity

Longitudinal riparian zone continuity was an integral factor in the PES (11) assessment (DWS, 2014c) and since it is another important measure of riparian condition within a reach, it was additionally used to define certain riparian RQOs for each reach. Riparian zone continuity is also a characteristic of the riparian zone which lends itself to assessment from satellite imagery and hence is easier and quicker to measure, while remaining meaningful.

Riparian zone fragmentation

The ability of the riparian zone to function as such depends largely on the level of longitudinal and lateral fragmentation. Where fragmentation is high functionality is lost. As such RQOs were developed that relate to fragmentation, but make specific reference to agricultural and forestry activities as these are the most common and dominant reasons for an increase in fragmentation. Since both agricultural and forestry activities were rated in the PES (11) (DWS, 2014c) fact sheets, it is possible to monitor changes over time.

Riparian plant endemism

Based on the observed distribution of riparian species, the PES (11) project (DWS, 2014c) measured the presence of endemic riparian species. These data were used to develop RQOs that highlight the presence of these species within respective RUs.

Threatened riparian species

Based on the observed distribution of riparian species, the PES (11) project (DWS, 2014c) measured the presence of threatened riparian species (those with International Union for Conservation of Nature (IUCN) status other than Least Concern (LC) or Data Deficient (DD). These data were used to develop RQOs that highlight the presence and protection of these species within respective RUs.

Riparian taxon richness

Based on the observed distribution of riparian species, the PES (11) project (DWS, 2014b) measured the presence of riparian species (referred to as taxa). These data were used to develop RQOs that highlight the maintenance of baseline species (riparian) richness within respective RUs.

4 MTAMVUNA (T4): IUA T4-1 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

Quaternary catchment T40A (Mafadobo and Goxe rivers) is subjected to small areas of forestry and low density rural settlements with the primary impacts being non-flow related (sedimentation). T40B has flow and non-flow related impacts, consisting of extensive forestry occurring in the upper reaches, with a timber mill and rural settlements. Subsistence farming, grazing and low density rural settlements occur in T40C. T40D is mostly in a good state which is often due to the protection provided by gorges. Impacts are non-flow related as well as for the rivers further downstream with impacts being primarily non-flow related (rural settlements, subsistence farming, sedimentation and grazing).

The storage regulation in this IUA is low with no noticeable dams located in the area. There is no surface water developments planned in the IUA. The land use activities include extensive forestry in the upper reaches and some cultivation in the lower reaches. The IUA is predominantly rural with a large number of scattered rural and informal settlements supplied from regional water abstractions.

IUA T4-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA T4-1 - MTAMVUNA RIVER CATCHMENT

PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR[1]
IUA T4-1						
RU MT1	T40A-05450	Mafadobo	B	B	B	2
	T40A-05487	Goxe	B/C	B	B	
	T40C-05510	Mtamvuna	B/C	B	B	
RU MT2	T40C-05530	Mtamvuna	B	B	B	2
	T40C-05566	Ludeke	B	B	B	
	T40C-05589	KuNtlamvukazi	B	B	B	
	T40C-05600	Ludeke	B	B	B	
MRU MT B	T40C-05520	Mtamvuna	B/C	B/C	B/C	3
	T40D-05537	Mtamvuna	B	B	B	
	T40D-05584	Mtamvuna	B	B	B	
	T40D-05707	Mtamvuna	C	C	C	
	T40E-05601 Mt_R_EWR1	Mtamvuna	C	C	C	
RU MT3	T40B-05337	Weza	C	C	C	2
	T40D-05615	Tungwana	B	B	B	
	T40D-05643	Gwala	B	B	B	
	T40D-05683	Ntelekweni	B/C	B/C	B/C	
	T40D-05719	Londobezi	B	B	B	
	T40E-05767	Hlolweni	B/C	B	B	

1 Priority Rating

The RQOs are provided below for the catchment configuration as illustrated above.

4.1 RQOs FOR RU MT1 (T40A-05450, 05487, T40C-05510) (MODERATE PRIORITY - 2)

- SQ T40A-05489 requires improvement to achieve the TEC. The actions required are non flow-related:

  - o Catchment management of informal agriculture and overgrazing will be required. It is acknowledged that this will be difficult to achieve.
- SQ T40C-05510) requires improvement to achieve the TEC. The actions required are non flow-related:
  - o Catchment management of informal agriculture and overgrazing will be required. This is likely to be difficult, however alien vegetation can be removed and this should achieve the half category improvement.

4.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: Revised Desktop Reserve Model (RDRM) (Hughes *et al*., 2013), Water Resource Yield Model (WRYM) (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T40A-05450										
B	27.6	26.2	7.34	26.60	10.102	36.60	0.124	0.207	0.159	0.268
T40A-05487										
B	30.0	28.4	7.76	25.9	10.76	35.9	0.144	0.303	0.373	1.464
T40C-05510*										
B	65	61.25	n/a	n/a	27.78	43	0.264	0.126	0.052	0.033

*Extrapolated from Mt_R_EWR1 (C REC).

4.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS (2014c); DWAF, 1996a-d) were used.
Model: N/A.
Users: Settlements.
Water quality issue: Turbidity.

Narrative and numerical details are provided in Table 4.1.

Table 4.1 RU MT1: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity or clarity levels stay within Ideal - Acceptable limits.	Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable (Aquatic ecosystems: driver).

4.1.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 4.2 RU MT1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*Maytenus oleosa; Prionium serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be low (four species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, BNAT, BPAU, and CGAR) of estimated four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BPAU Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Prosopistomatidae Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key species.
Gomphidae Tabanidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

4.2 RQOs FOR RU MT2 (T40C-05530, 05566, 05589, 05600) (MODERATE PRIORITY - 2)

4.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T40C-05566										
B	28.7	28.1	7.56	26.3	10.41	36.2	0.094	0.129	0.213	0.259
T40C-05589										
B	12.2	11.9	3.55	29.1	4.78	39.1	0.049	0.054	0.073	0.116
T40C-05600										
B	14.1	13.6	4.181	29.7	5.57	39.5	0.025	0.038	0.078	0.129
T40C-05530*										
B	95.8	91.46	n/a	n/a	40.9	42.65	0.178	0.060	0.043	0.020

*Extrapolated from Mt_R_EWR1 (C REC).

4.2.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A
Users: Settlements (with Ventilated Improved Pit (VIP) sanitation system) and grazing; erosion.
Water quality issue: Turbidity.

Narrative and numerical details are provided in Table 4.3.

Table 4.3 RU MT2: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).

4.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in below.

Table 4.4 RU MT2: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall	N/A

Indicators	Narrative RQO	Numerical RQO
	not expand or intensify towards or within the riparian zone.	
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*M. oleosa; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be low (four species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, AMOS, BNAT, BPAL, BPAU, CGAR, and TSPA) of estimated seven fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BPAL, BPAU Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 16 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae, Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

4.3 RQOs FOR MRU MT B WITH MT_R_EWR1 (T40E-05601) (HIGH PRIORITY - 3) (INCLUDING T40C-05520, T40D-05537, 05584, 05707)

The TECs are provided below. Note that this site will not be impacted on by any of the proposed scenarios.

Component	PES, REC and TEC
Physico chemical	A/B
Fish	B/C
Invertebrates	B
Instream	B
Riparian vegetation	C/D
EcoStatus	**C**

4.3.1 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC (REC)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	70%	90%	70%
MT_R_EWR1 (T40E-05601)	C	79.22	60.46	44.43	19.1	74.76	32.1	0.33	0.53	1.16	1.61

4.3.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012-2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b).
Model: PAI model (DWAF, 2008b).
Users: Settlements; dryland cultivation; erosion.
Water quality issue: Turbidity.
Narrative and Numerical: Details for MRU MT B are provided in Tables 4.5 and 4.6. Data used for water quality assessments should be collected from T4H001Q01.

Table 4.5 MRU MT B: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 4.6 EWR Mt_R_EWR1: Water quality EcoSpecs and TPCs (PES and TEC: A/B)

River: Mtamvuna		**PES: A/B Category**
Monitoring site: T4H001Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.

River: Mtamvuna Monitoring site: T4H001Q01		PES: A/B Category
Water quality metrics	**EcoSpecs**	**TPC**
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th percentile of the data must be 5.9 – 6.5, and the 95th percentile 7.6 – 8.0.	The 5th percentile of the data must be < 6.1 and > 6.3, and the 95th percentile must be < 7.8 and > 8.2
Temperature(b)	Small deviation from the natural temperature range.	Initiate baseline monitoring for this variable.
Dissolved oxygen(b)	The 5th percentile of the data must be ≥ 7.5 mg/L.	The 5th percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.
Turbidity(b)	Moderate changes to the catchment land-use resulting in temporary unnaturally high sediment loads and high turbidities.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 0.7 mg/L.	The 50th percentile of the data must be 0.55 – 0.7 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.020 mg/L.	The 50th percentile of the data must be 0.016 – 0.020 mg/L.
Response variables		
Chl-*a* phytoplankton(b)	The 50th percentile of the data must be <15 µg/L.	The 50th percentile of the data must be 12 – 15 µg/L.
Chl-*a* periphyton(b)	The 50th percentile of the data must be ≤ 21 mg/m^2.	The 50th percentile of the data must be 17 – 21 mg/m^2.
Toxics(b)		
Toxics	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the Target Water Quality Range (TWQR) as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.

(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

4.3.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 4.7 MRU MT B: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was indicated as a B/C and it should be aimed to maintain this EC in future if the overall TEC is to be reached. The indigenous fish species richness of the EWR site is estimated to be eight species (four species confirmed during EWR study). Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this unit. These species provide valuable indicators that should be used to monitor potential change. The primary indicator fish species for this reach is the semi-rheophilic Natal scaly (BNAT) which is especially a good indicator of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the Longfin eel (AMOS) (longitudinal continuity, substrate quality), Redtail barb (BGUR) (water quality), Bowstripe barb (BVIV) (overhanging vegetation and SS habitats), Chubbyhead barb (instream vegetation) and Mozambique tilapia (OMOS) (water column/slow-deep (SD)).
Invertebrates	The macro-invertebrate community should be representative of a medium foothill stream assemblage with perennial flows. The habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks. There are some deeper water with slower flows and alluvial sandy bottoms. Although the area contains low density rural settlements in middle reaches, small area cultivation in lower reaches, and roads, the EcoSpecs are set to retain some diversity and integrity. The

Component	Narrative RQO
	recommended scenario will remain in a Category B, which is similar to the PES of the river and thus will not impact adversely on the integrity of the river reach.
Riparian vegetation	The overall PES at MT_R_EWR1 (as at August 2013) for riparian vegetation was a Category C/D (61.3%). This is also the REC and TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). As such agricultural activities shall not encroach into the riparian zone or floodplain.

The EcoSpecs and TPCs are provided in the following tables.

Table 4.8 Fish EcoSpec and TPCs (PES and TEC: B/C)

Metric	Indicator#	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	EC	Present ecological status of fish is in a B/C (80.7%).	Decrease of PES into a lower EC (<B/C) than PES.	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	All 8 expected indigenous fish species estimated to be present in the reach under PES.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	**BNAT**	BNAT estimated to occur at a FROC* of 3.5 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	BNAT absent during any survey OR present at FROC of <3.5.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
Fast-Deep (FD) habitats		BNAT estimated to occur at a FROC* of 3.5 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)
FS habitats		BNAT estimated to occur at a FROC* of 3.5 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate	AMOS (especially juveniles and BNAT)	AMOS estimated to occur at a FROC* of 2 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.	AMOS absent during two consecutive survey OR present at FROC of <2.	Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 2 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during two consecutive survey OR present at FROC of <2.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).
Water quality intolerance	BGUR	BGUR estimated to occur at a FROC* of 2 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.	BGUR absent during two consecutive surveys OR present at FROC of <2.	Decreased water quality (especially flow related water quality variables such as oxygen).
Overhanging vegetation	BVIV	BVIV estimated to occur at a FROC* of 1 under PES have a	BVIV absent during three consecutive surveys OR	Significant change in overhanging vegetation

Metric	Indicator#	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	present at FROC of <1.	habitats.
SS habitats		BVIV estimated to occur at a FROC* of 1 under PES have a high requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).
Instream vegetation	BANO	BANO estimated to occur at a FROC* of 1 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.	BANO absent during any survey OR present at FROC of <1.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)
Water column	OMOS	OMOS estimated to occur at a FROC* of 4 under PES have a high requirement for water column as cover and is the most applicable indicator species for this habitat feature.	OMOS absent during three consecutive surveys OR present at FROC of <4.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).
SD habitats		OMOS estimated to occur at a FROC* of 4 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).
Alien fish species	Presence of any alien/introduced spp.	No alien species known or expected to be present in the SQ reach.	Presence of any alien/introduced species.	N/A
Migratory success##	AMOS, BNAT	The catadromous AMOS is still be present, and various potamodromous species (including BNAT) also occurs.	Loss or decreased FROC[1] of catadromous (AMOS) or potamodromous species (such as BMAR). AMOS absent during two consecutive surveys OR BNAT absent during any survey.	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 4.9 Macro-invertebrate EcoSpec and TPCs (TEC (REC) = B)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp., Prosopistomatidae	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae	> 0.6 m/s	SIC biotope	Moderate
3	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
4	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
5	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
6	Coenagrionidae, Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
7	Gomphidae, Tabanidae, Athericidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and Average Score Per Taxon (ASPT) values occur in the following range: SASS5 score: > 170; ASPT value: > 7.0.	SASS5 scores < 180 and ASPT < 7.0.
To ensure that the MIRAI score remains within the range of a B Category (82.01 – 87.4), using the same reference data used in this study.	A MIRAI score of 83% or less.
Presence of at least four of the following five high-scoring taxa: Perlidae, Hydropsychidae 2 spp.,	Three or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples):

Prosopistomatidae, Tricorythidae and Heptagenidae.	Perlidae, Hydropsychidae 2 spp., Prosopistomatidae. Tricorythidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following seven key taxa: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Tricorythidae, Heptagenidae, Leptophlebidae and Elmidae.	Less than five of the seven key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the very fast flow over coarse sediment (VFCS) biotope: Perlidae, Hydropsychidae, Prosopistomatidae, Tricorythidae	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the fast flow over coarse sediment (FFCS) biotope: Heptageniidae, Libellulidae, Leptophlebidae, Elmidae	Any one of these taxa missing for two consecutive surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Atyidae, Coenagrionidae.	Any one of these taxa missing in two consecutive surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae, Athericidae	Any one of these taxa missing in two consecutive surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 4.10 Riparian vegetation EcoSpec and TPCs (PES and TEC: C/D)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Reed cover (% aerial)	Maintain reed cover above 10%.	A decrease in reed cover below 20%.
Lower zones		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 10% or lower.	An increase in perennial alien plant species cover >15%.
Upper zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 25% or lower.	An increase in perennial alien plant species cover >30%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 20% and below 90%.	An decrease in indigenous riparian woody species cover below 20%.
Floodplain		
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial species below 30%	An increase in terrestrial species cover above 40%.
Non-woody indigenous cover (% aerial)	Maintain non-woody indigenous cover above 30%.	An decrease in indigenous non-woody cover below 30%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4) of at least 60%.	A decrease in PES score below 57% (limit of C/D).

4.4 RQOs FOR RU MT3 (T40B-05337, T40D-05615, 05643, 05683, 05719, T40E-05767) (MODERATE PRIORITY - 2)

- SQ T40E-05767) requires improvement to achieve the TEC. The actions required are non flow-related:
  - o Catchment management of informal agriculture and overgrazing will be required. It is acknowledged that this will be difficult to achieve; however, alien vegetation can be removed that should achieve the half category improvement

4.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T40B-05337										
C	74.40	52.60	13.94	18.70	20.37	27.40	0.1	0.12	0.29	0.5
T40D-05615										
B	2.2	2.0	0.65	29.30	0.90	40.40	0.007	0.011	0.013	0.02
T40D-05643										
B	5.6	5.3	1.55	27.70	2.17	38.70	0.024	0.029	0.027	0.039
T40D-05683										
B/C	8.9	8.6	2.04	22.90	2.94	33.00	0.035	0.040	0.031	0.048
T40D-05719										
B	4.6	4.5	1.23	26.70	1.75	37.90	0.020	0.025	0.031	0.041
T40E-05767										
B	22.5	22.3	5.306	23.5	8.117	36	0.055	0.115	0.095	0.148

4.4.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Settlements (rural and urban (Bizana - WWTW)); grazing.
Water quality issue: Turbidity, nutrients, faecal coliforms/*E.coli*.

Narrative and numerical details are provided in Table 4.11.

Table 4.11 RU MT3: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational/other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

4.4.3 Habitat and Biota RQOs (EcoSpecs)

The habitat and biota EcoSPecs are provided for the different components according to the table below.

Table 4.12 RU MT1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry shall not expand or intensify towards or within the riparian zone.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*M. oleosa; P. serratum*; *Syzigium pondoense*).
FISH		
Species richness	Indigenous fish species richness estimated to be thirteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ALAB, AMOS, BGUR, BNAT, BPAL, BPAU, BVIV, CGAR, GCAL, GGIU, OMOS, and TSPA) of estimated thirteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BPAL, BPAU Water column: OMOS Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 15 key taxa to be present. However, due to present day influences (Turbidity, nutrients), fewer key taxa are expected (14). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).

Indicators	Narrative RQO	Numerical RQO
Coenagrionidae Atyidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

5 MTAMVUNA (T4): IUA T4 SC RESOURCE QUALITY OBJECTIVES

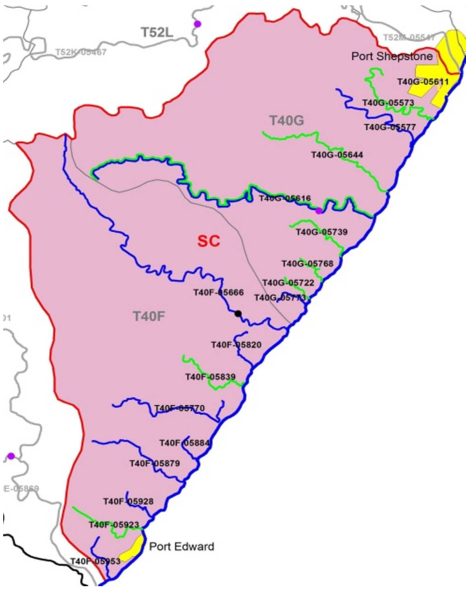
The IUA overview and description is provided below.

These include the coastal strips and immediate hinterland associated with Port Edward, Leisure Crest, Palm Beach, Southbroom, Ramsgate, Margate, Shelly Beach Oslo Beach, South Port, Pumula, Hibberdene, Bazeley Beach, Pennington, Park Rynie, and Palmcliffe. The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. There is no surface water developments planned in the IUA.

Landuse activities in the water resources IUAs generally include cultivation (mostly sugar cane with some orchards) and some forestry plantations slightly inland. Rural settlements are usually located more inland with semi-urban and urban areas towards the coast. Return flows from a number of WWTW enter river systems affecting both the flow and quality of the river system

IUA T4 SC is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA T4-SC - SOUTHERN COASTAL ZONE IN T4



PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
RU SC1	T40F-05666	Mbizana	B	B	B	2
RU SC2	T40G-05616	Vungu	B/C	B	B	3WQ

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

5.1 RQOs FOR RU SC1 (T40G-05666) (MODERATE PRIORITY - 2)

- SQ T40G-05666) requires improvement to achieve the TEC. The actions required are non flow-related:
  - o Water quality improvement of Uvongo needs to change ratings from a 3 to a 2 which will improve instream continuity.

5.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T40F-05666										
B	35.0	34.3	6.43	18.4	11.06	31.6	0.048	0.080	0.159	0.268

5.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Settlements, sand-mining
Water quality issue: Turbidity.

Narrative and numerical details are provided in Table 4.1.

Table 5.1 RU SC1: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).

5.1.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 5.2 RU SC1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Six (6) listed riparian species should remain viable within the RU (*Impatiens flanaganiae; M. oleosa; Mondia whitei; P. serratum; Raspalia trigyna; S. pondoense*).
FISH		
Species richness	Indigenous fish species richness estimated to be twenty-four species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABER, ALAB, AMAR, AMOS, BGUR, BNAT, BPAL, BPAU, BVIV, CGAR, GAES, GCAL, GGIU, LMCR, LRIC, MBRA, MCAP, MCEP, MFLU, OMOS, PPHI, TREN, and TSPA) of estimated twenty-four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to

Indicators	Narrative RQO	Numerical RQO
		facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BPAL, BPAU Water column: OMOS Migration: AMOS (all eels)		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

5.2 RQOs FOR RU SC2 (T40G-05616) (HIGH PRIORITY FOR WATER QUALITY - 3WQ; MODERATE PRIORITY HABITAT AND BIOTA- 2)

5.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T40G-05616										
B	23.2	23.1	5.046	21.8	7.92	34.2	0.37	0.79	0.37	1.46

5.2.2 Water quality RQOs

Source: No detailed water quality assessment conducted, although available monitoring data was evaluated. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.

Users: High density settlements; urban impacts from Uvongo; WWTW (Uvongo and Gamalakhe); sand-mining (quarry).
Water quality issue: Turbidity, nutrients, salts, faecal coliforms/*E.coli*.

Narrative and numerical details are provided in Table 5.3.

Table 5.3 RU SC2: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that electrical conductivity (salt) levels are within Acceptablel limits (B Category).</td><td colspan="3">95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that nutrient levels are within Tolerable limits.</td><td colspan="3">50th percentile of the data must be less than 0.125 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that turbidity or clarity levels stay within Acceptable limits.</td><td colspan="3">A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use.*</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

5.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 5.4 RU SC2: Narrative and numerical habitat and biota RQOs

<table>
<tr><th>Indicators</th><th>Narrative RQO</th><th>Numerical RQO</th></tr>
<tr><td colspan="3">RIPARIAN VEGETATION</td></tr>
<tr><td>Presence of alien plant species in the riparian zone</td><td>The extent of perennial alien plant species within the riparian zone should remain small or decrease.</td><td>Insufficient quantitative data exist to develop numerical RQOs.</td></tr>
<tr><td>Riparian zone continuity</td><td>Modification of riparian zone continuity should remain small, or improve</td><td>N/A</td></tr>
<tr><td>Riparian zone fragmentation</td><td>Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.</td><td>N/A</td></tr>
<tr><td>Threatened riparian species</td><td>Viable populations of riparian plant species with IUCN status should remain within the RU.</td><td>Four (4) listed riparian species should remain viable within the RU (I. flanaganiae; M. oleosa; M. whitei; P. serratum).</td></tr>
<tr><td colspan="3">FISH</td></tr>
<tr><td>Species richness</td><td rowspan="3">Indigenous fish species richness estimated to be twenty-five species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.</td><td>Maintain indigenous species richness (AAEN, ABER, ALAB, AMAR, AMOS, BGUR, BNAT, BPAL, BPAU, BVIV, CGAR, GAES, GCAL, GGIU, LMCR, LRIC, MBRA, MCAP, MCEP, MFLU, OMOS, PPHI, RDEW, TREN, and TSPA) of estimated twenty-five fish species in this RU. Maintain current habitat diversity.</td></tr>
<tr><td>Primary indicator species: BNAT (flow, flow related water quality, substrate condition)</td><td>Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).</td></tr>
<tr><td>Secondary indicator species:
Vegetation: BPAL, BPAU</td><td>Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of</td></tr>
</table>

Indicators	Narrative RQO	Numerical RQO
Water column: OMOS Migration: AMOS (all eels)		these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 15 key taxa to be present. However, due to present day influences (Turbidity, nutrients, salts, flow and barriers), fewer key taxa are expected (14). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for both this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

6 UMZIMKULU (T5): IUA T5-1 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and instream dams. There is no surface water developments planned in the IUA.

This IUA is a mountainous zone which contains several headwater streams. Most SQs are an A or B PES. Low severity impacts that exist are created by small patches of afforestation and other alien vegetation, small dams, tourism, irrigation and rural community use in the form of subsistence farming (grazing and trampling, agricultural lands). A large percentage of the area is protected in various Wilderness areas and the Cobban Nature Reserve (T51D-04404). The towns Underberg and Himeville are also located in the IUA.

IUA T5-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA T5-1 - UPPER UMZIMKULU MOUNTAIN ZONE

PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
RU Mz1	T51A-04431	Mzimkhulu	B	B	B	2
	T51B-04421	Mzimkhulu	B	B	B	
RU Mz2	T51A-04522	Mzimude	B	B	B	2
	T51A-04608		B	B	B	
	T51A-04551	Mzimude	B/C	B	B	
Ru Mz7	T51G-04669	Ndawana	B	B	B	2
	T51G-04751		B	B	B	
RU Mz3	T51D-04404	Pholela	B	B	B	2
RU Mz5	T51F-04566	Boesmans	A	A	A	1
	T51F-04611	Ngwangwane	A	A	A	

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

6.1 RQOs FOR RU Mz1 (T51A-04431, T51B-04421) (MODERATE PRIORITY - 2)

6.1.1 Flow RQOs

Source: DWA (2011c; 2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T51B-04421										
B	246.2	224.3	37.34	15.2	65.33	26.5	0.051	0.091	1.233	2.176

6.1.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 6.1 RU Mz1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain absent.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
FISH		
Species richness	Indigenous fish species richness estimated to be low (three species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, BANO, and BNAT) of estimated three fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae, Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae	Flows should be adequate to ensure	Maintain suitable conditions in moderate

Indicators	Narrative RQO	Numerical RQO
Elmidae	suitable habitats for these moderate flow dependant species.	velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

6.2 RQOs FOR RU Mz2 (T51A-04522, 04608, 04551) (MODERATE PRIORITY - 2)

SQ T51A-04551 requires improvement to achieve the TEC (B/C to a B). The actions required are flow-related.

6.2.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003), RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T51A-04522										
B	43.2	40.8	6.09	14.4	11.2	25.9	0.018	0.022	0.248	0.409
T51A-04608										
B	1.6	1.5	0.24	15.5	0.41	26.0	0.0	0.0	0.003	0.007
T51A-04551										
B	58.8	54.3	10.08	17.1	17.07	29	0.014	0.033	0.284	0.588

6.2.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2012a-j; DWA, 2013a, c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Some irrigation; grazing; trout hatchery.
Water quality issue: Turbidity, nutrients.

Narrative and numerical details are provided in Table 6.2.

Table 6.2 RU Mz2: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).

6.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 6.3 RU Mz2: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
FISH		
Species richness	Indigenous fish species richness estimated to be low (three species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, BANO, and BNAT) of estimated three fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae, Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

6.3 RQOs FOR RU Mz7 (T51G-04751, T51G-04669) (MODERATE PRIORITY - 2)

6.3.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003), RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T51G-04751										
B	3.0	2.5	0.48	15.9	0.8	26.6	0.0	0.0	0.007	0.014

6.3.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Some irrigation; erosion.
Water quality issue: Turbidity, nutrients.

Narrative and numerical details are provided in Table 6.4.

Table 6.4 RU Mz7: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).

6.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 6.5 RU Mz7: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
FISH		

Indicators	Narrative RQO	Numerical RQO
Species richness	Indigenous fish species richness estimated to be low (three species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, BANO, and BNAT) of estimated three fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

6.4 RQOs FOR RU Mz3 (T51D-04404) (MODERATE PRIORITY - 2)

6.4.1 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Irrigation.
Water quality issue: Nutrients, salts.

Narrative and numerical details are provided in Table 6.6.

Table 6.6 RU Mz3: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95^{th} percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems and Domestic Use: drivers).

6.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 6.7 RU Mz1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
FISH		
Species richness	Indigenous fish species richness estimated to be low (three species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, BANO, and BNAT) of estimated three fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for both this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

Indicators	Narrative RQO	Numerical RQO
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

7 UMZIMKULU (T5): IUA T5-2 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

Most of the rivers are in a B/C and C PES. Extensive rural development and associated settlements are the main impacts. Forestry, irrigation, trampling and erosion, dams and alien invasive plants occur. Further downstream, dense human settlements and large townships occur. SQs with a high PES originate in the Ntsikeni Wildlife Reserve and in other areas, are protected by being within steep valleys. The one SQ that is in an E PES is drowned by dams. There are a number of scattered rural villages supplied by regional water supply schemes. The towns Creighton and Umzimkulu are also located in the IUA. The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. A surface water development planned for the area is the Ncwabeni off-channel dam with abstraction from a new weir on the Umzimkulu River for regional water supply, which will have some effect on the flows.

IUA T5-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA T5-2 - Middle Umzimkulu and Mzimkulwana Tributary

RU	SQ	River	PES	REC	TEC	PR
MRU MzA	T51C-04606		C	C	C	1
	MzEWR2i	Mzimkhulu	B	B	B	3
	T51C-04760	Mzimkhulu	MzEWRi			
RU Mz4	T51D-04460	Pholelana	D/E	D	D/E	2
	T51E-04536		C	C	C	
	T51E-04478	Pholela	MzEWR9r			
	MzEWR9r	Pholela	B/C	B/C	B/C	
RU Mz5	T51F-04566	Boesmans	A	A	A	1
	T51F-04611	Ngwangwane	A	A	A	

RU	SQ	River	PES	REC	TEC	PR
Ru Mz6	T51F-04674		C	C	C	2
	T51F-04605	Ngwangwane	MzEWR8r			
	MzEWR8r	Ngwangwane	C	C	C	
	T51G-04722	Ndawana	C	C	C	
	T51J-04747	Ngwangwane	MzEWR8r			
	T51J-04844	Ngwangwane	MzEWR8r			
Ru Mz8	T51H-04828	Gungununu	A/B	A/B	A/B	1
	T51H-04846	Lubhukwini	A	A	A	
	T51H-04808	Gungununu	B	B	B	2
Ru Mz9	T51H-04913	Nonginqa	B/C	B/C	B/C	2
	T51H-04923	Malenge	B/C	B	B	
	T51H-04884	Gungununu	B/C	B/C	B/C	
	T51H-04908	Gungununu	B/C	B/C	B/C	
MRU MzB	MzEWR3i	Mzimkhulu	C	B	B	3
	T52C-04960	Mzimkhulu	B	B	B	
	T52D-04948	Mzimkhulu	C	B	B	
	T52D-05137	Mzimkhulu	B	B	B	
Ru Mz10	T52B-04947	Cabane	B	B	B	2
Ru Mz11	T52C-04880		C	C	C	2
	T52D-05024	Ncalu	B/C	B	B	
	T52D-05061	Mgodi	B/C	B	B	
Ru Mz12	T52E-05053	Upper Bisi	B/C	B	B	2
	T52F-05104	Little Bisi	C	C	C	
	T52F-05190	Mbumba	B/C	B/C	B/C	
	T52F-05139	Little Bisi	B	B	B	
	T52G-05226	uMbumbane	B/C	B/C	B/C	
	T52G-05171	Bisi	B	B	B	
	T52H-05244	Mahobe	B/C	B/ C	B/ C	
	MzEWR14r	Bisi	B/C	B/C	B/C	
MRU Mz D	T52K-05353	Mzimkhulwana	MzEWR17i			3
	T52K-05475	Nkondwana	B/C	B/C	B/C	
	MzEWR17i	Mzimkhulwana	B	B	B	

The RQOs are provided below for the TECs as illustrated above.

7.1 RQOs FOR MRU MzA WITH MZEWR2i (T51C-04582) (HIGH PRIORITY - 3) (INCLUDING T51C-04760, 04606)

The TECs are provided below. Note that this site will not be impacted on by any of the proposed scenarios.

Component	PES, REC AND TEC
Physico chemical	A
Fish	A/B
Invertebrates	B/C
Riparian vegetation	B
EcoStatus	B

7.1.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC (REC)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	70%	90%	70%
MRU MzA MZEWR2i	B	260.8	190.5	32.6	21.5	64.1	24.6	0.329	0.84	1.911	5.317

7.1.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the Mzimkhulu River Catchment Water Resources Study: Riverine Ecological Requirements study (DWA, 2011c). EcoSpecs and TPCs are taken from DWA (2011c).
Model: PAI model (DWAF, 2008b).
Users: Irrigation; erosion.
Water quality issue: Nutrients, salts, turbidity.
Narrative and Numerical: Details for MRU MzA are provided in Tables 7.1 and 7.2. Data used for water quality assessments should be collected from T5H004Q01.

Table 7.1 MRU MzA: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95^{th} percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that turbidity levels stay within Ideal limits.	Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable.
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 7.2 MZEWR2i: Water quality EcoSpecs and TPCs (PES and TEC: A)

River: Umzimkulu		PES: A Category
Monitoring site: T5H004Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Physical variables		
Electrical Conductivity	30 mS/m at 95th percentile.	95th percentile should not exceed 24 mS/m.
pH	pH 6.5 – 8.8: 5th and 95th percentiles must not fall outside of this range.	5th percentile should not be less than 6.7 and the 95th percentile should not be greater than 8.6.
Turbidity	Turbidity should not display more than a small change from natural conditions (i.e. should not exceed rating category 1 of default DWS categories).	As no data is currently available, initiate baseline monitoring of this parameter to establish TPC.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	0.25 mg/L at 50th percentile.	50th percentile value should not exceed 0.2 mg/L
PO_4-P	0.027 mg/L at 50th percentile.	50th percentile value should not exceed 0.022 mg/ L

Note – Due to insufficient data, EcoSpecs and TPCs could not be determined for toxics and response variables. Concerns over the utilisation of DWS data with TEACHA software have also resulted in Electrical Conductivity being used as a surrogate for inorganic salts. Salts are however not anticipated to be a problem in this catchment. No Temperature data is available, though no significant thermal impacts are currently noted in the catchment.

7.1.3 Habitat and Biota RQOs (EcoSpecs

Fish comment: The 2011 EWR report (including fish specialist report) (DWA, 2011c) indicates only two indigenous fish species to be present (reference and PES), namely *Barbus anoplus* (BANO) and *Anguilla mossambica* (AMOS) (very scarce). The recent PES (11) data (DWS, 2014c) includes both these species in this SQ but also indicates the presence of *Labeobarbus natalensis* (BNAT) at a confidence of 3 (Present, moderate confidence). The spp has not been recorded recently in the SQ, but based on the PES and spp. sensitivity it is expected to be present. Where the general PES for the SQ has changed, there are still sections suitable for habitation by the spp.). This species (BNAT) would be a more suitable indicator species than BANO (especially in terms of flow related impacts), and should the presence of this species be confirmed in future, the RQOs and TPCs need to be reviewed. The 2011 EWR Ecospecs report furthermore includes the use of the alien species *Onchorynchus mykiss* (OMYK) in the ecospecs and TPCs for this site. Although of econimic value to the region, it is not advisable to use alien species in setting or monitoring of ecological water requirements, and it was therefore omitted in this report.

The narrative RQOs are provided as follows:

Table 7.3 MRU MzA: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was indicated as an A/B (DWA, 2011c) and it should be aimed to maintain this EC in future if the overall TEC is to be reached. The indigenous fish species richness of the EWR site is estimated to be very low with only two species present (BANO and AMOS). One alien species namely Rainbow trout (OMYK) is also present and it is indicated to be of important economic value to the region. Until the presence of the large semi-rheophilic Labeobarbus natalensis is confirmed, the most applicable indicaor species is the small semi-rheophilic Barbus anoplus. It is not a good indicator of flow modification, but have indicator value for vegetated habitats, water quality alteration and SS habitats. The only other secondary indicator is the Longfin eel (AMOS) (longitudinal continuity, substrate quality), thought to be very rare in this reach.
Invertebrates	The macro-invertebrate community should be representative of a bedrock and bolder dominated pool system and cobble run assemblage with perennial flows. The habitats in the river are dominated by

Component	Narrative RQO
	bedrock pavement sections separating pools with coarse gravel on bed. Vegetation dominated by non-woody plants and the occasional presence of *Salix mucronata*. Although the area contains irrigation practises, instream dams and increased nutrients, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category B/C, which is similar to the PES of the river and thus will not impact adversely on the integrity of the river reach.
Riparian vegetation	The PES at MRU MzA MZEWR2i for riparian vegetation was a Category B. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). As such agricultural and forestry activities shall not encroach into the riparian zone or floodplain.

The EcoSpecs and TPCs are provided in the following tables.

Table 7.4 Fish EcoSpec and TPCs (PES and TEC: A/B)

Metric	Indicator spp.	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	EC	Present ecological status of fish is in a A/B.	Decrease of PES into a lower EC (<A/B) than PES.	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	The two expected indigenous fish species estimated to still be present in the reach under PES (AMOS stated as very rare and few records exist) .	Loss of any indigenous species.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Water quality	**BANO**	12 fish, Electrofishing for 30 – 45 minutes.	BANO absent during any survey OR 15 fish or less per survey on two consecutive surveys	Decreased water quality (especially flow related water quality variables such as oxygen).
Overhanging vegetation				Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).
SS habitats				Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).
Instream vegetation				Significant change in instream vegetation habitats (flow modification, use of herbicides, water quality deterioration, alien invasive macrophytes).
Alien fish species (see fish comment for site)	Presence of any alien/ introduced spp.	OMYK indicated to be present in the SQ reach.	Presence of additional alien/introduced species or increase in abundance of OMYK.	N/A
Migratory success[##]	AMOS	The catadromous AMOS is still present (very rare).	Loss or decreased FROC[1] of catadromous (AMOS) in this reach.	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 7.5 Macro-invertebrate EcoSpec and TPCs (PES and TEC:B/C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae, Philopotamidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Pyralidae	0.3 - 0.6 m/s	Marginal vegetation	Good
6	Coenagrionidae	0.3 - 0.6 m/s	Marginal vegetation	Low
7	Gomphidae, Athericidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 200; ASPT value: > 6.5.	SASS5 scores < 200 and ASPT < 6.5.
To ensure that the MIRAI score remains within the range of a C Category (62.01 – 77.4), using the same reference data used in this study.	A MIRAI score of 75% or less.
Presence of at least five of the following seven high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae, Philopotamidae, and Heptagenidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae, Philopotamidae, and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following eight key taxa: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae, Philopotamidae, Heptagenidae and Leptophlebidae.	Less than seven of the eight key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae and Philopotamidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae and Leptophlebidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae	This taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae and Athericidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 7.6 Riparian vegetation EcoSpec and TPCs (PES and TEC: B)

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	The extent of perennial alien plant species within the riparian zone should remain below 10% (aerial cover).
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A

Indicators	Narrative RQO	Numerical RQO
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	The extent of forestry within the riparian zone shall remain below 10% (aerial cover)
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	The extent of agriculture within the riparian zone shall remain below 20% (aerial cover).
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	One (1) listed riparian species should remain viable within the RU (*Hydrostachys polymorpha)*

7.2 RQOs FOR RU Mz4 (T51D-04460, T51E-04536, 04478, MzEWR9r) (MODERATE PRIORITY - 2)

7.2.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T51D-04460										
D/E	No RQOs set as area dammed and no improvement possible without removing dams.									
T51E-04536										
C	8.6	6.8	1.31	15.1	1.98	22.9	0.003	0.010	0.014	0.045
MzEWR9r										
B/C	110.3	90	20.7	18.7	31.3	28.4	0.289	0.706	1.1	3.052

7.2.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Irrigation; dairy and sheep farming; small WWTW at Pholela Hospital.
Water quality issue: Nutrient, salts, toxics, faecal coliforms/*E. coli*.

Narrative and numerical details are provided in the table below.

Table 7.7 RU Mz4: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that toxics are within Ideal limits or A categories.	95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).

Narrative RQO	Numerical RQO		
	Low	Medium	High
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

7.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 7.8 RU Mz4: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small or improve.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or be reduced.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	One (1) listed riparian species should remain viable within the RU (*H. polymorpha).*
FISH		
Ecological status	The PES based on fish of the EWR site in this unit was indicated as a C (DWA, 2011c) and it should be aimed to maintain this EC in future if the overall TEC is to be reached. Indigenous fish species richness estimated to be low (two to three species) under PES in the unit. Habitats should be maintained to support the requirements of the primary indicator species (BANO). Should future studies confirm the presence of BNAT, flows should be adequate to ensure suitable habitats for this flow dependent indicator species. Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Present ecological status of fish is in a C and any decrease in category (<C) can be seen as a TPC.
Species richness		Maintain indigenous species richness (AMOS, BANO, and BNAT) of estimated three fish species in this RU ((DWS, 2014c)). According to EWR study (DWA, 2011c) only two species, namely BANO and AMOS present at site (BNAT excluded due to downstream waterfall). Maintain current habitat diversity.
Primary indicator species: BANO: Overhanging and instream vegetation, water quality, SS habitats.		BANO present in fair numbers (10 fish per 30-45 minutes electrofishing). TPC indicated to be 15 fish or less on two consecutive surveys.
Secondary indicator species: AMOS: Migration, substrate, SD/water column, undercut banks: BNAT (if present): Fast habitats, substrate, migtration		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement. BNAT: Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).

Indicators	Narrative RQO	Numerical RQO
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

7.3 RQOs FOR RU Mz6 (T51F-04674, 04621(MzEWR8r), T40G-04722) (MODERATE PRIORITY - 2)

7.3.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003), RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T51F-04674										
C	2.8	1.7	0.23	8.1	0.49	17.1	0.0	0.0	0.004	0.008
T51F-04621(MzEWR8r)										
C	116.7	102.3	13.6	11.7	25	21.4	0.16	0.371	1.052	2.206
T40G-04722										
C	91.1	81.3	11.27	12.4	20.66	22.7	0.008	0.008	0.248	0.54

7.3.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Irrigation; settlements and grazing; erosion.
Water quality issue: Nutrients, turbidity, salts, toxics.

Narrative and numerical details are provided in the table below.

Table 7.9 RU Mz6: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95^{th} percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
Ensure that toxics are within Ideal limits or A categories.	95^{th} percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).

7.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 7.10 RU Mz6: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small or improve.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or be reduced.	N/A
FISH		
Ecological status	The PES based on fish of the EWR site in this unit was indicated as a C (DWA, 2011c) and it should be aimed to maintain this EC in future if the overall TEC is to be reached. Indigenous fish species richness estimated to be low (two to three species) under PES in the unit. Habitats should be maintained to support the requirements of the primary indicator species (BANO). Should future studies confirm the presence of BNAT, flows should be adequate to ensure suitable habitats for this flow dependent indicator species. Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Present ecological status of fish is in a C and any decrease in category (<C) can be seen as a TPC.
Species richness		Maintain indigenous species richness (AMOS, BANO, and BNAT) of estimated three fish species in this RU ((DWS, 2014c)). According to EWR study (DWA, 2011c) only two species, namely BANO and AMOS present at site (BNAT excluded due to downstream waterfall). Maintain current habitat diversity.
Primary indicator species: BANO: Overhanging and instream vegetation, water quality, SS habitats		BANO present in fair numbers (8 fish per 30-45 minutes electrofishing). TPC indicated to be 12 fish or less on two consecutive surveys.
Secondary indicator species: AMOS: Migration, substrate, SD/water column, undercut banks: BNAT (if present): Fast habitats, substrate, migtration		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement. BNAT: Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to

Indicators	Narrative RQO	Numerical RQO
		facilitate migration (especially wet season).
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae	The quantity and quality of clean course sediment should be sufficient to support this bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

7.4 RQOs FOR RU Mz8 (T51H-04828, 04846, 04808) LOW (1) and MODERATE PRIORITY (2)

7.4.1 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 7.11 RU Mz8 (T51H-04808): Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small or improve.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain absent.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or be reduced.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	One (1) listed riparian species should remain viable within the RU (*H. polymorpha).*
FISH		
Species richness	Indigenous fish species richness estimated to be low (three species) under PES in the unit.	Maintain indigenous species richness (AMOS, BANO, and BNAT) of estimated three fish

Indicators	Narrative RQO	Numerical RQO
	Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae	Flows should be adequate to ensure suitable habitats for this moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae	The quantity and quality of clean course sediment should be sufficient to support this bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

7.5 RQOs FOR RU Mz9 (T51H-04913, 04923, 04884, 04908) (MODERATE PRIORITY - 2)

T51H-04923 requires improvement from a B/C to a B by reinstatement the riparian buffer.

7.5.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T51H-04913										
B/C	16.7	13.3	2.4	14.6	4.06	24.3	0.008	0.019	0.043	0.090
T51H-04923										
B	27.2	24.3	30.13	11.5	5.72	21.1	0.000	0.009	0.106	0.174

*Flows generated for a B/C rule.

7.5.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Settlements; erosion.
Water quality issue: Nutrients, turbidity.

Narrative and numerical details are provided in the table below.

Table 7.12 RU Mz9: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).

7.5.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 7.13 RU Mz9 Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small or improve.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or be reduced.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	One (1) listed riparian species should remain viable within the RU (*H. polymorpha).*
FISH		
Species richness	Indigenous fish species richness estimated to be low (three species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, BANO, and BNAT) of estimated three fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.

Indicators	Narrative RQO	Numerical RQO
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

7.6 RQOs FOR MRU MzB WITH MZEWR3i (T52A-04690) (HIGH PRIORITY - 3) (INCLUDING T52C-04960, T52D-04948, 05137)

The TECs are provided below. Note that this site will be impacted on the proposed Sc 2.

Component	PES and REC	Sc 2
	Immediately applicable	Target if Sc 2 is implemented
Physico chemical	A/B	A/B
Fish	A/B	B
Invertebrates	B	B
Riparian vegetation	B/C	B/C
EcoStatus	B	B

7.6.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC (REC)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	70%	90%	70%
MRU MzB MZEWR3i	B	870.5	777.8	172.9	19.9	199.8	23	0.633	1.69	3.308	9.747

7.6.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the Mzimkhulu River Catchment Water Resources Study: Riverine Ecological Requirements study (DWA, 2011c). EcoSpecs and TPCs are taken from DWA (2011c).
Model: PAI model (DWAF, 2008b).

Users: Irrigation; grazing; erosion.

Water quality issue: Nutrients, salts, turbidity.

Narrative and Numerical: Details for MRU MzB are provided in Tables 7.13 and 7.14. Data used for water quality assessments should be collected from T5H007Q01.

Table 7.14 MRU MzB: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95^{th} percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that turbidity levels stay within Ideal limits.	Vary by a small to moderate amount from the natural turbidity range; minor silting of instream habitats acceptable.
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 7.15 MZEWR3i: Water quality EcoSpecs and TPCs (PES and TEC:A/B)

River: Umzimkulu		**PES: A/B Category**
Monitoring site: T5H007Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Physical variables		
Electrical Conductivity	30 mS/m at 95^{th} percentile.	95^{th} percentile should not exceed 24 mS/m.
pH	pH 6.5 – 8.8: 5^{th} and 95^{th} percentiles must not fall outside of this range.	5^{th} percentile should not be less than 6.7 and the 95^{th} percentile should not be greater than 8.6.
Turbidity	Turbidity should not display more than a small to moderate change from natural conditions (i.e. should not exceed rating category 2 of default DWA categories).	As no data is currently available, initiate baseline monitoring of this parameter to establish TPC.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	0.25 mg/L at 50^{th} percentile.	50^{th} percentile value should not exceed 0.2 mg/L.
PO_4-P	0.027 mg/L at 50th percentile.	50^{th} percentile value should not exceed 0.022 mg/ L.

Note – Due to insufficient data, EcoSpecs and TPCs could not be determined for toxics and response variables. Concerns over the utilisation of DWS data with TEACHA software have also resulted in Electrical Conductivity being used as a surrogate for inorganic salts. Salts are however not anticipated to be a problem in this catchment. No Temperature data is available, though no significant thermal impacts are currently noted in the catchment.

7.6.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 7.16 MRU MzB: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was indicated as an A/B (DWA, 2011c) and it should be aimed to maintain this EC in future if the overall TEC is to be reached. It was estimated that the fish EC will deteriorate to a Category B under Sc 2. The indigenous fish species richness of the EWR site is estimated to be very low with only two species BNAT and AMOS indicated by (DWA, 2011c). (PES (11) (DWS, 2014c) data indicate potential presence of additional two species namely BANO and CGAR. The primary indicator fish species for this reach is the semi-rheophilic Natal scaly (BNAT) which is especially a good indicator of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the Longfin eel (AMOS) (longitudinal continuity, substrate quality).
Invertebrates	The habitats in the river are dominated by bedrock pavement and narrow channels with fast flowing water. Marginal vegetation consists of Phragmites. Although the area contains extensive farming in upper and middle reaches, community water use, subsistence farming, abandoned lands, erosion and alien and invasive plants, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario

Component	Narrative RQO
	will remain in a Category B, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The PES at MRU MzB MZEWR3i for riparian vegetation was a Category B/C. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). As such agricultural and forestry activities shall not encroach into the riparian zone or floodplain.

The EcoSpecs and TPCs are provided in the following tables.

Table 7.17 Fish EcoSpec and TPCs (PES and TEC: A/B, Long term target: B)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Sc 2 expected changes in EcoSpecs
Ecological status	EC	Present ecological status of fish is in an A/B (EWR, 2011).	Decrease of PES into a lower EC (<A/B) than PES.	Any deterioration in habitat that results in decrease in FROC* of species.	Decrease in PES to B expected.
Species richness	All indigenous species	PES (11) (DWS, 2014c) indicate presence of four species (AMOS, BANO, BNAT and CGAR) while EWR study (2011) only includes two species (AMOS, BNAT). At least these two species are estimated to be present in the reach under PES.	Loss of any indigenous species.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.	No change in species richness expected.
Requirement for flowing water	**BNAT**	EWR (2011): 20 - 30 fish of any size (at least 5 must be > 20 cm in length) when electrofishing. 30 – 45 minutes (All running water habitats should be sampled and pools as well if flows permit).	25 fish or less of any size on each of two consecutive surveys providing that conditions allow for thorough sampling	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).	The lower sediment loads will suit the fish but the reduction in flows will hamper early season spawning activity. Early wet season inputs of local sediment may affect the spawning success of BNAT.
FD habitats				Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)	
FS habitats				Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).	
Substrate				Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.	
Undercut banks	AMOS	AMOS estimated to occur in reach (rare) and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive survey	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).	Uncertain
Alien fish species	Presence of any alien /introduced spp.	No alien species known or expected to be present in the SQ reach.	Presence of any alien/introduced species.	N/A	
Migratory success[##]	AMOS, BNAT	The catadromous AMOS and potamodromous BNAT is present.	Loss or decreased FROC* of catadromous (AMOS) or potamodromous BNAT (see TPC for BNAT above).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).	Uncertain

Table 7.18 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Oligoneuridae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae, Philopotamidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
6	Pyralidae	0.3 - 0.6 m/s	Marginal vegetation	Good
7	Coenagrionidae, Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
8	Gomphidae, Tabanidae, Athericidae	-	Course sediment	Low

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 180; ASPT value: > 6.5.	SASS5 scores < 185 and ASPT < 6.8.
Ensure that the MIRAI score remains within the range of a B Category (82.01 – 87.4), using the same reference data used in this study.	A MIRAI score of 83% or less.
Presence of at least six of the following eight high-scoring taxa: Perlidae, Oligoneuridae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae, Philopotamidae and Heptagenidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Oligoneuridae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae, Philopotamidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following eight key taxa: Perlidae, Oligoneuridae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae, Philopotamidae, Heptagenidae and Leptophlebidae.	Less than seven of the eight key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Oligoneuridae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae, Philopotamidae and Heptagenidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae and Libellulidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Pyralidae, Coenagrionidae, and Atyidae.	This taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae, and Athericidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 7.19 Riparian vegetation EcoSpec and TPCs (PES and TEC: B/C)

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	The extent of perennial alien plant species within the riparian zone should remain below 10% (aerial cover).
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	The extent of forestry within the riparian zone shall remain below 10% (aerial cover)
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	The extent of agriculture within the riparian zone shall remain below 20% (aerial cover).
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; M. oleosa; P. serratum)*

7.7 RQOs FOR RU Mz10 (T52B-04947) (MODERATE PRIORITY - 2)

7.7.1 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 7.20 RU Mz10 Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small or improve.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or be reduced.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; M. oleosa; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be low (four species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in	Maintain indigenous species richness (AMOS, BANO, BNAT, and CGAR) of estimated four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition, fast habitats)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).

Indicators	Narrative RQO	Numerical RQO
Secondary indicator species: Vegetation/SS: BANO Migration: AMOS Water column/SD: CGAR	migration barriers to fish.	Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

7.8 RQOs FOR RU Mz11 (T52C-04880, T52D-05024, 05061) (MODERATE PRIORITY - 2)

SQ	River	PES	REC	Improvements	TEC
T52D-05024	Ncalu	B/C	B	Reduce sedimentation and establish buffer zone (forestry area).	B
T52D-05061	Mgodi	B/C	B	Reduce sedimentation and establish buffer zone (forestry area).	B

7.8.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T52C-04880										
C	12.6	7.0	1.46	11.5	2.65	20.9	0.008	0.017	0.023	0.054
T52D-05024										
B*	4.4	2.7	0.52	11.7	1.09	24.4	0.004	0.011	0.008	0.014
T52C-05061										
B*	5.4	3.4	0.61	11.2	1.3	23.9	0.007	0.014	0.011	0.016

*Flows generated for a B/C rule.

7.8.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Irrigation; urban (T52D-05061; Umzimkulu).
Water quality issue: Nutrients, salts, faecal coliforms/*E. coli*, toxics.

Narrative and numerical details are provided in the table below.

Table 7.21 RU Mz11: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95^{th} percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).		
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that toxics are within Ideal limits or A categories.	95^{th} percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

7.8.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 7.22 RU Mz11 Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small or improve.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should be improved to small or remain absent where it is currently absent.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced to moderate and maintained as such, or better.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or be reduced.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; M. oleosa; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be low (four species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime,	Maintain indigenous species richness (AMOS, BNAT, CGAR, and TSPA) of estimated four fish species in this RU. Maintain current habitat diversity.
Primary indicator species:		Maintain suitable flows to sustain semi-

Indicators	Narrative RQO	Numerical RQO
BNAT (flow, flow related water quality, substrate condition, fast habitats)	catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: TSPA Migration: AMOS Water column/SD: CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

7.9 RQOs FOR RU Mz12 WITH MZEWR14r (T52H-05121) (MODERATE PRIORITY - 2) (INCLUDING T52E-05053, T52F-05104, 05190, 05139, T52G-05226, 05171, 05244)

Note that although this was identified as a high priority due to the presence of the EWR site, the priority is presented as moderate due to the lack of high confidence EcoSpec information. The TECs are provided below. Note that this site will be impacted on the proposed Sc 2.

Component	PES and REC	Sc 2
	Immediately applicable	TEC if Sc 2 is implemented
Fish	B	C
Invertebrates	B/C	B/C
EcoStatus	B/C*	?*

*The EcoStatus in the Reserve study (DWA, 2011c) is an A/B. According to the Kleynhans and Louw (2007) methods, this is impossible. The EcoStatus as determined through the desktop study (DWA, 2014a) of a B/C was therefore kept as more representative. It is even more unlikely with the fish component falling to a C that the EcoStatus will still be maintained as an A/B as according to the Reserve study (DWA, 2011c).

7.9.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).

Model: DRM (Hughes and Hannart, 2003), RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC (REC)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	70%	90%	70%
RU Mz12 MZEWR14i	PES B/C*	194.6	160.9	60.7	31.2	83.3	42.8	Not available			
T52E-05053	B/C	55.5	43.71	9.33	16.8	14.2	25.6	0.035	0.096	0.137	0.259
T52F-05104	C	34.3	22.8	5.41	15.8	8.46	24.7	0.033	0.062	0.117	0.197
T52F-05190	B/C	47.3	35.2	9.38	19.8	13.9	29.4	0.041	0.092	0.152	0.259
T52F-05139	B	96.1	71.8	21.98	22.9	31.72	33	0.144	0.164	0.497	0.898
T52G-05226	B/C	19.2	16.9	3.32	17.3	5.16	26.9	0.026	0.036	0.077	0.129
T52G-05171	B	171.2	131.4	36.47	21.3	53.63	31.3	0.372	0.504	0.995	1.395
T52H-05244	B/C	9.4	8.9	1.05	11.2	2.17	23	0.008	0.016	0.011	0.025

* See star above.

7.9.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Extensive settlements; erosion.
Water quality issue: Nutrients, turbidity, faecal coliforms/*E. coli*.

Table 7.23 RU Mz12: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	Medium	High
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

7.9.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 7.24 RU Mz12: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was indicated as an B (EWR, 2011) and it should be aimed to maintain this EC in future if the overall TEC is to be reached. It was estimated that the fish EC will deteriorate to a Category B/C under Sc 2. DWS (2014c) indicates presence of five species (AMOS, BANO, BNAT, BVIV and TSPA) while DWA (2011c) only includes three species (AMOS, BNAT, and BVIV). At least these three species are estimated to be present in the reach under PES. The primary indicator fish species for this reach is the semi-rheophilic Natal scaly (BNAT) which is especially a good indicator of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the Bowstripe barb (BVIV) (vegetated and slow habitats) and the Longfin eel (AMOS) (longitudinal continuity, substrate quality).
Invertebrates	The instream is dominated by small cobbles and boulders with occasional bedrock and sediments. In all this is an excellent habitat for a variety of organisms. The immediate and upstream catchment is relatively undeveloped although there is forestry in the higher regions. The banks of the river are intact with grassland and occasional woody species found. Although the area contains subsistence farming, community water use, limited erosion, frequent burning and some alien invasive plants, it is fairly natural and the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain

Component	Narrative RQO
	in a Category B/C, which is similar to the PES of the river and thus will not adversely impact on the integrity of the river reach.
Riparian vegetation	The PES at MRU Mz12 with MZ EWR14r for riparian vegetation was a Category B/C. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). As such agricultural and forestry activities shall not encroach into the riparian zone or floodplain.

The EcoSpecs and TPCs are provided in the following tables.

Table 7.25 Fish EcoSpec and TPCs (PES and TEC: C; Sc 2: C)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)	Sc 2 expected changes in EcoSpecs
Ecological status	EC	Present ecological status of fish is in a B (EWR, 2011).	Decrease of PES into a lower EC (<B) than PES.	Any deterioration in habitat that results in decrease in FROC* of species.	Decrease in PES to B/C expected.
Species richness	All indigenous species	PES (11) (DWS, 2014c) indicate presence of five species (AMOS, BANO, BNAT, BVIV and TSPA) while EWR study (2011) only includes three species (AMOS, BNAT, BVIV). At least these three species are estimated to be present in the reach under PES.	Loss of any indigenous species.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.	Fish biomass may be reduced but no species will be lost.
Requirement for flowing water	**BNAT**	EWR (2011): 5 fish (At least 2 must be > 20 cm in length), Electrofishing 30 – 45 minutes. Seine net in pools if flows allow.	8 fish or less on two consecutive surveys. At least 3 fish > 20 cm in length	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).	Increased sedimen-tation and reduced flows if there is new forestry in the catchment. Some loss of feeding substrate. Increased turbidity and sedimentation flows if there is new forestry in the catchment. Some loss of feeding substrate.
FD habitats				Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)	
FS habitats				Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).	
Substrate				Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.	
Overhanging and instream vegetation, slow-habitats	BVIV	10 fish. Electrofishing 30 – 45 minutes. Seine net in pools if flows allow.	15 fish or less on two consecutive surveys	Decrease in vegetated habitats and flow modification impacting on slow habitats.	Uncertain
Undercut banks	AMOS	AMOS estimated to occur in reach (rare) and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive survey	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).	Uncertain
Alien fish species	Presence of any alien/ introduced spp.	No alien species known or expected to be present in the SQ reach.	Presence of any alien/introduced species.	N/A	
Migratory success[##]	AMOS BNAT	The catadromous AMOS and potamodromous *BNAT* is present.	Loss or decreased FROC* of catadromous (AMOS) or potamodromous BNAT (see TPC for BNAT above).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).	uncertain

The PES (11) (DWS, 2014c) study of this reach listed 17 key taxa to be present. However, due to present day influences (moderately modified), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.

Table 7.26 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B/C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp., Psephenidae	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae, Philopotamidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
6	Pyralidae	0.3 - 0.6 m/s	Marginal vegetation	Good
7	Coenagrionidae, Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
8	Gomphidae, Tabanidae, Athericidae	-	Course sediment	Low

EcoSpecs	TPCs
Presence of at least 6 of the following 6 high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Psephenidae, Tricorythidae, Philopotamidae and Heptagenidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Psephenidae, Tricorythidae, Philopotamidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following six key taxa: Perlidae, Hydropsychidae 2 spp., Psephenidae, Tricorythidae, Philopotamidae and Heptagenidae.	Less than five of the six key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp., Psephenidae, Tricorythidae and Philopotamidae	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae, and Libellulidae	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Pyralidae, Coenagrionidae and Atyidae.	Any one of these taxa missing for two consecutive surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae and Athericidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 7.27 Riparian vegetation EcoSpec and TPCs (PES and TEC: B/C)

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain absent.	The extent of perennial alien plant species within the riparian zone should remain below 5% (aerial cover).

Indicators	Narrative RQO	Numerical RQO
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	No increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	The extent of forestry within the riparian zone shall remain below 5% (aerial cover)
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	The extent of agriculture within the riparian zone shall remain below 10% (aerial cover).
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*Eugenia simii; M. oleosa; P. serratum)*

7.10 RQOs FOR MRU MzD WITH MZEWR17i (T52K-05467) (HIGH PRIORITY - 3) (INCLUDING T52K-05353, 05475)

The TECs are provided below. Note that this site will be impacted on the proposed Sc 2.

Component	PES and REC	Sc 2
	Immediately applicable	TEC if Sc 2 is implemented
Physico chemical	B	B
Fish	A/B	B
Invertebrates	B	B
Riparian vegetation	B	B
EcoStatus	B	B

7.10.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	70%	90%	70%
MRU MZ D MZEWR17i	**B (REC)**	42.5	30	10.13	23.8	12.6	29.6	0.143	0.441	0.295	0.803

7.10.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the Mzimkhulu River Catchment Water Resources Study: Riverine Ecological Requirements study (DWA, 2011c). EcoSpecs and TPCs are taken from DWA (2011c).
Model: PAI model (DWAF, 2008b).
Users: Irrigation.
Water quality issue: Nutrients, salts.
Narrative and Numerical: Details for MRU MzD are provided in Tables 7.13 and 7.14. Data used for water quality assessments should be collected from T5H012Q01.

Table 7.28 MRU MzD: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 7.29 MzEWR17i: Water quality EcoSpecs and TPCs (PES and TEC: A/B - B)

River: Umzimkulu		**PES: A/B – B Category**
Monitoring site: T5H0124Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Physical variables		
Electrical Conductivity	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a small to moderate change from natural – i.e. 55 mS/m at 95th percentile	TPC calculated based on default tables – 44 mS/m. Initiate baseline monitoring for this variable.
pH	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a small to moderate change from natural, i.e. pH 5.9 at 5th percentile and 8.8 at 95th percentile.	TPC calculated based on default tables – 6.25 at 5th percentile and 8.36 at 95th percentile. Initiate baseline monitoring for this variable.
Turbidity	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a small to moderate change from natural (as assessed in the default tables).	No quantitative classes exist for this variable – TPC is meaningless to assess. Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a small to moderate change from natural – i.e. 0.7 mg/L at 50th percentile	TPC calculated based on default tables – 0.56 mg/L. Initiate baseline monitoring for this variable.
PO_4-P	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a moderate change from natural – i.e. 0.015 mg/L at 50th percentile	TPC calculated based on default tables – 0.012 mg/L. Initiate baseline monitoring for this variable.

Note – Due to an absence of data for this section of the river, baseline conditions at this site could not be assessed and thus EcoSpecs and TPCs could not be determined. Values have been calculated based on the default rating table according to the overall assessed PES rating at this site.

7.10.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 7.30 MRU MzD: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was indicated as an A/B (EWR, 2011c) and it should be aimed to maintain this EC in future if the overall TEC is to be reached. It was estimated that the fish EC will deteriorate to a Category B under scenario 2. PES (11) data (DWS, 2014c) indicate presence of five species (AMAR, AMOS, BNAT, BPAL and TSPA) while DWA (2011c) includes four species (AMOS, BNAT, BVIV, CGAR). At least these four species are estimated to be present in the reach under PES.The primary indicator fish species for this reach is the semi-rheophilic Natal scaly (BNAT) which is especially a good indicator of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the Bowstripe barb (BVIV) (vegetated and slow habitats) and the Longfin eel (AMOS) (longitudinal continuity, substrate quality).
Invertebrates	There is a wide diversity of habitats available at this site and it is reasonably unimpacted. The channel morphology consists of a fixed boulder bed channel with smaller material moving through, but very high roughness. While the immediate catchment is in pristine condition, barring the tarred access

Component	Narrative RQO
	road, the catchment upstream of the gorge is well developed with timber, sugar and rural settlements covering most of the landscape. Despite these impacts, the site is fairly natural and the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category B, which is similar to the PES of the river and thus will not adversely impact on the integrity of the river reach.
Riparian vegetation	The PES at MRU MzD with MZEWR17i for riparian vegetation was a Category B. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). As such agricultural and forestry activities shall not encroach into the riparian zone or floodplain.

The EcoSpecs and TPCs are provided in the following tables.

Table 7.31 Fish EcoSpec and TPCs (PES and TEC: A/B; Sc 2: B)

No Ecospecs and TPCs provided by EWR study (DWA, 2011c) for this site.

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)	Sc 2 expected changes in EcoSpecs
Ecological status	EC	Present ecological status of fish is in a A/B (DWA, 2011c).	Decrease of PES into a lower EC (<A/B) than PES.	Any deterioration in habitat that results in decrease in FROC* of species.	Decrease in PES to B expected.
Species richness	All indigenous species	PES (11) (DWS, 2014c) indicate presence of five species (AMAR, AMOS, BNAT, BPAL and TSPA) while EWR study (DWA, 2011c) includes four species (AMOS, BNAT, BVIV, and CGAR). At least these four species are estimated to be present in the reach under PES.	Loss of any indigenous species.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.	Fish biomass may be reduced but no species will be lost.
Requirement for flowing water	**BNAT**	EWR study (DWA, 2011c): All the anticipated fish species were found and in good numbers.	None provided by 2011 EWR study. Baseline levels need to be established.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).	There may be increased sedimentation and turbidity as well as reduced flows as a result of new forestry in the catchment. Consequently, there may be some loss of feeding substrate.
FD habitats				Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)	
FS habitats				Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).	
Substrate				Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates. Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.	
Overhanging and instream vegetation, slow-habitats	BVIV	EWR study (DWA, 2011c): All the anticipated fish species were found and in good numbers.	None provided by 2011 EWR study. Baseline levels need to be established.	Decrease in vegetated habitats and flow modification impacting on slow habitats.	Uncertain.
Undercut banks	AMOS	EWR study (DWA, 2011c): All the anticipated fish species were found and in good numbers.	None provided by 2011 EWR study. Baseline levels need to be established.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).	Uncertain.
Alien fish species	Presence of any alien/introduced spp.	No alien species known or expected to be present in the SQ reach.	Presence of any alien/introduced species.	N/A	
Migratory success[##]	AMOS BNAT	The catadromous AMOS and potamodromous BNAT is present.	Loss or decreased FROC* of catadromous (AMOS) or potamodromous BNAT (see TPC for BNAT above).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).	Uncertain.

Table 7.32 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp., Psephenidae	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae, Philopotamidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
6	Pyralidae	0.3 - 0.6 m/s	Marginal vegetation	Good
7	Coenagrionidae, Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
8	Gomphidae, Tabanidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 160; ASPT value: > 7.0.	SASS5 scores < 165 and ASPT < 7.0.
Presence of at least four of the following six high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Psephenidae, Tricorythidae, Philopotamidae and Heptagenidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Psephenidae, Tricorythidae, Philopotamidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following seven key taxa: Perlidae, Hydropsychidae 2 spp., Psephenidae, Tricorythidae, Philopotamidae, Leptophlebidae and Heptagenidae.	Less than five of the seven key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp., Psephenidae, Tricorythidae and Philopotamidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae, and Libellulidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Pyralidae, Coenagrionidae and Atyidae.	This taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae and Tabanidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 7.33 Riparian vegetation EcoSpec and TPCs (PES and TEC: B)

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or improve.	The extent of perennial alien plant species within the riparian zone should remain below 10% (aerial cover).
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be	N/A

Indicators	Narrative RQO	Numerical RQO
	no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	The extent of forestry within the riparian zone shall remain below 5% (aerial cover)
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	The extent of agriculture within the riparian zone shall remain below 10% (aerial cover).
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*E. simii; M. oleosa; P. serratum)*

8 UMZIMKULU (T5): IUA T5-3 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The SQs are all in a B PES. The good state of especially the main Umzimkulu in this area is attributed to the protection provided by a large gorge section. Impacts in this area is primarily non-flow related, related to small scale subsistence farming, grazing, limited forestry, erosion and sedimentation of instream habitats. A lime stone mining plant is also present in the lower Umzimkulu River reach but does not impact notably on the present status of this zone.

The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The upstream development of the Cwabeni off-channel dam with abstraction from a new weir on Umzimkulu for regional water supply will have some effect on the flows.

The land use activities include extensive forestry and sugar cane, Oribi Gorge Nature Reserve, natural areas with grazing, and run of river abstraction or regional water supply to rural villages. The town Harding is also located in the IUA. Industrial activities include limestone mining and the Illovo Umzimkulu sugar mill in the lower reach, which abstracts water directly from the Umzimkulu River just upstream of the estuary.

IUA T5-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA T5-3 - UMZIMKULU

PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
MRU MzC	MzEWR5i	Mzimkhulu	MzEWR6i			3
	MzEWR6i T52J-05276	Mzimkhulu				
Ru Mz13	T52H-05295	Magogo	B	B	B	2
	T52H-05178	Bisi	MzEWR14r			
	T52H-05189	Bisi	MzEWR14r			

The RQOs are provided below for the TEC as illustrated above.

8.1 RQOs FOR MRU MzC WITH MzEWR6i (T52J-05276) (HIGH PRIORITY - 3) (INCLUDING T52D-05155)

The TECs are provided below. Note that this site will not be impacted on by any of the proposed scenarios.

Component	PES, REC and TEC
Physico chemical	A/B
Fish	B
Invertebrates	B
Riparian vegetation	A/B
EcoStatus	A/B

8.1.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC (REC)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
MRU MzC MZEWR6i	A/B	1384	1184	352.9	25.5	417.7	30.2	3.294	13.704	10.514	48.582

8.1.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the Mzimkhulu River Catchment Water Resources Study: Riverine Ecological Requirements study (DWA, 2011c). EcoSpecs and TPCs are taken from DWA (2011c).
Model: PAI model (DWAF, 2008b).
Users: Erosion; urban impacts (Harding, including WWTW discharging into the Mzimkhulwana River).
Water quality issue: Nutrients, salts, turbidity, toxics, faecal coliforms/*E.coli*.
Narrative and Numerical: Details for MRU MzC are provided in the tables below. Data used for water quality assessments for MzEWR5i were taken from T5H007Q01. There are no monitoring stations in the lower Mzimkhulu.

Table 8.1 MzEWR6i: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95^{th} percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).		
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that turbidity levels stay within Acceptable limits.	Small to moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Ensure that toxics are within Ideal limits or A categories.	95^{th} percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWA (2008b).		
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use.*	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	Medium	High
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

Table 8.2 MRU MzC (MzEWR6i): Water quality EcoSpecs and TPCs (PES and TEC: A/B)

River: Umzimkulu		PES: A/B Category
Monitoring site: none		
Water quality metrics	**EcoSpecs**	**TPC**
Physical variables		
Electrical Conductivity	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a small to moderate change from natural – i.e. 55 mS/m at 95th percentile	TPC calculated based on default tables – 44 mS/m. Initiate baseline monitoring for this variable.
pH	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a small to moderate change from natural, i.e. pH 5.9 at 5th percentile and 8.8 at 95th percentile.	TPC calculated based on default tables – 6.25 at 5th percentile and 8.36 at 95th percentile. Initiate baseline monitoring for this variable.
Turbidity	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a small to moderate change from natural (as assessed in the default tables).	No quantitative classes exist for this variable – TPC is meaningless to assess. Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a small to moderate change from natural – i.e. 0.7 mg/L at 50th percentile	TPC calculated based on default tables – 0.56 mg/L. Initiate baseline monitoring for this variable.
PO_4-P	No baseline data exists for this section of the river. Values should however not exceeds the default threshold for a moderate change from natural – i.e. 0.015 mg/L at 50th percentile	TPC calculated based on default tables – 0.012 mg/L. Initiate baseline monitoring for this variable.

Note – Due to an absence of data for this section of the river, baseline conditions at this site could not be assessed and thus EcoSpecs and TPCs could not be determined. Values have been calculated based on the default rating table according to the overall assessed PES rating at this site.

8.1.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 8.3 MzEWR6i: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was indicated as a B (EWR, 2011) and it should be aimed to maintain this EC in future if the overall TEC is to be reached. PES (11) data (DWS, 2014c) indicate presence of twelve species (AAEN, AMAR, AMOS, BANO, BGUR, BNAT, BPAL, BVIV, CGAR, MCEP, OMOS, and TSPA) while EWR study (DWA, 2011c) include eight species (AMOS, BNAT, CGAR, OMOS, TREN, BVIV, MCAP, and GCAL). At least these species are estimated to be present in the reach under PES (2011) (DWS, 2014c). The primary indicator fish species for this reach is the semi-rheophilic Natal scaly (BNAT) which is especially a good indicator of flow modification (fast flowing habitats), rocky substrate condition, flow related water quality and longitudinal continuity. Secondary indicators include the Longfin eel (AMOS) (longitudinal continuity, substrate quality), Bowstripe barb (BVIV) (vegetated and slow habitats), Sharptooth catfish (CGAR) (SD and water column) and Glossogobius callidus (GCAL) (SS and substrate).
Invertebrates	The instream is dominated by bedrock pavement, forming low islands separated by deep pools with fast flow in the middle of the channel. Some boulders also form islands. Banks reed dominated with sediment deposits and shallow pools present at channel edge. Although the area contains extensive forestry and sugarcane, alien invasive plants, the Town of Harding and abstraction from run-of-river, it is fairly natural (Category B) and the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category B, which is similar to the PES of the river and thus will not adversely impact on the integrity of the river reach.
Riparian vegetation	The PES at MRU MzC with MZEWR6i for riparian vegetation was a Category A/B. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). As such agricultural and forestry activities shall not encroach into the riparian zone or floodplain.

The EcoSpecs and TPCs are provided in the following tables.

Table 8.4 Fish EcoSpec and TPCs (PES and TEC: B)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	EC	PES of fish is in a B (DWA, 2011c).	Decrease of PES into a lower EC (B) than PES.	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	PES (11) data (DWS, 2014c) indicate presence of twelve species (AAEN, AMAR, AMOS, BANO, BGUR, BNAT, BPAL, BVIV, CGAR, MCEP, OMOS, and TSPA) while EWR study (DWA, 2011c) include eight species (AMOS, BNAT, CGAR, OMOS, TREN, BVIV, MCAP, and GCAL). At least these species are estimated to be present in the reach under PES (2011).	Loss of any indigenous species.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	**BNAT**	DWA (2011c): 12 fish At least 4 must be > 20 cm in length. Electrofishing 30 – 45 minutes Seine net in pools if flows allow.	EWR (2011): 15 fish or less on two consecutive surveys. 5 fish > 20 cm in length.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
FD habitats				Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).
FS habitats				Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate				Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.
Vegetated and slow habitats	BVIV	DWA (2011c): 20 fish, Electrofishing 30 – 45 minutes Seine net in pools if flows allow.	25 fish or less on two consecutive surveys.	Significant change in vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).
SD and water column	CGAR	DWA (2011c): 5 fish At least 2 must be > 25 cm in length, Electrofishing 30 – 45 minutes Seine net in pools if flows allow.	8 fish on every survey At least 2 must be > 25 cm in length.	Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats). Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).
SS, substrate	GCAL	DWA (2011c): 5 fish of any size, Electrofishing 30 – 45 minutes Seine net in pools if flows allow.	7 fish of any size on every survey.	Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).
Undercut banks	AMOS	AMOS estimated to occur in reach (rare) and is the most	AMOS absent during three consecutive survey.	Significant change in undercut bank and

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		applicable indicator species for this habitat feature.		rootwads habitats (e.g. bank erosion, reduced flows).
Alien fish species	Presence of any alien/ introduced spp.	No alien species known or expected to be present in the SQ reach.	Presence of any alien/introduced species.	N/A
Migratory success[##]	AMOS, BNAT	The catadromous AMOS and potamodromous BNAT is present.	Loss or decreased FROC* of catadromous (AMOS) or potamodromous BNAT (see TPC for BNAT above).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 8.5 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp.	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae, Philopotamidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
6	Pyralidae	0.3 - 0.6 m/s	Marginal vegetation	Good
7	Coenagrionidae, Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
8	Gomphidae, Tabanidae	-	Course sediment	Low

EcoSpecs	TPCs
Presence of at least five of the following five high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae, Philopotamidae and Heptagenidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Tricorythidae, Philopotamidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following five key taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae, Philopotamidae and Heptagenidae.	Less than four of the five key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp., Tricorythidae and Philopotamidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae and Libellulidae	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Pyralidae, Coenagrionidae and Atyidae.	Any one of these taxa missing for two consecutive surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae and Tabanidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 8.6 Riparian vegetation EcoSpec and TPCs (PES and TEC: A/B)

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or improve.	The extent of perennial alien plant species within the riparian zone should remain below 10% (aerial cover).
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	No increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	The extent of forestry within the riparian zone shall remain below 1% (aerial cover)
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	The extent of agriculture within the riparian zone shall remain below 10% (aerial cover).
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Five (5) listed riparian species should remain viable within the RU (*E. simii; I. flanaganiae; M. oleosa; M. whitei; P. serratum)*

8.2 RQOs FOR RU Mz13 (T52H-05295) (MODERATE PRIORITY - 2)

8.2.1 Flow RQOs

Source: DWA (2011c, 2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
T52H-05295										
B	5.8	4.8	0.95	16.2	1.56	26.7	0.0	0.0	0.011	0.020

8.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 8.7 RU Mz13: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The absence of perennial alien plant species within the riparian zone should be maintained.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or be reduced.	N/A

Indicators	Narrative RQO	Numerical RQO
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*E. simii; M. oleosa; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be low (six species) under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, BANO, BNAT, BVIV, CGAR, and TSPA) of estimated six fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition, fast habitats)		Maintain suitable flows to sustain semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, BVIV, TSPA Migration: AMOS Water column/SD: CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

9 uMKHOMAZI (U1): IUA U1-1 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The Rivers are mostly in an A, A/B and B PES category. The few impacts that exist are created by small patches of afforestation and other alien vegetation, small dams and trout farms, tourism, and rural community use in the form of subsistence farming (cattle trampling, erosion, roads, and agricultural lands). A large percentage of the area is protected in nature reserves (Lotheni, Vergelegen, and uMkhomazi). The two B/C PES SQs are due to an increase in subsistence farming which leads to an increase in abandoned lands, roads, trampling and erosion.

The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The proposed Smithfield Dam site is located at the lower end of the IUA and is likely to be developed in the future. The DWS has completed a feasibility study for the uMkhomazi River Development Project (Smithfield Dam) and the purpose of the project is to augment the uMngeni River supply area. The construction of Smithfield Dam will have a noticeable effect on the river flows downstream of the dam.

The middle to upper reach of the IUA is mainly a mountainous area, where nature reserves (Lotheni, Vergelegen, Kamberg, Highmore Nature Reserves, and uMkhomazi National Park) and the Sani Pass Tourism area are located. There is some agriculture and community water use. The main activities in the middle to lower end of the IUA underlain by the Middelveld Karoo groundwater region include forestry, cultivation, irrigation, grazing, and community water use from low density rural settlements. Bulwer Town is located in the lower end of the IUA. In general there are few impacts on the river systems and the water quality can be regarded as good.

IUA U-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U1-1 - uMKHOMAZI MOUNTAIN ZONE PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
RU Mk4	U10A-04115	Lotheni	A/B	A/B	A/B	2
	U10A-04202	Nhlathimbe	B	B	B	
	U10A-04301	Lotheni	B	B	B	
MRU uMkhomazi A	U10B-04239	uMkhomazi	B	B	B	2
	U10B-04337	uMkhomazi	B	B	B	
RU Mk1	U10B-04274	Nhlangeni	A	A	A	1
	U10B-04251	uMkhomazi	A	A	A	
RU Mk2	U10B-04343	Mqatsheni	B	B	B	2
RU Mk3	U10C-04347	Mkhomazan a	B	B	B	2
RU MK5	U10D-04199	Nzinga	A	A	A	2
	U10D-04222	Rooidraai	B	B	B	
	U10D-04298	Nzinga	B/C	B	B	
MRU uMkhomazi B.1	U10D-04349	uMkhomazi	MK_I_EWR1US			3b
	U10D-04434	uMkhomazi				

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

9.1 RQOs FOR RU MK4 (U10A-04115, 04202, 04301) (MODERATE PRIORITY - 2)

9.1.1 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10A-04202										
B	43.5	43.5	8.33	19.1	12.73	29.3	0.026	0.066	0.22	0.372
U10A-04301										
B	208.9	208.2	41.22	19.7	62.34	29.8	0.135	0.439	0.93	1.977

9.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Giants Castle WWTW.
Water quality issue: Nutrients, faecal coliforms/*E. coli*.

Narrative and numerical details are provided in Table 9.1.

Table 9.1 RU MK4: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

9.1.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 9.2 RU MK4: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A

Indicators	Narrative RQO	Numerical RQO
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain low or decrease.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*Geranium natalense; H. polymorpha*).
FISH		
Species richness	Indigenous fish species richness estimated to be four species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, and BNAT) of estimated four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

9.2 RQOs FOR RU MRU uMKHOMAZI A (U10B-04239, 04337) (MODERATE PRIORITY - 2)

9.2.1 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from Umgeni Water.
Model: N/A.

Users: Settlements.
Water quality issue: Turbidity, nutrients, faecal coliforms/*E. coli*.

Narrative and numerical details are provided in Table 9.3.

Table 9.3 MRU uMkhomazi A: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels are within Acceptable limits.</td><td colspan="3">50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that turbidity or clarity levels stay within Acceptable limits.</td><td colspan="3">A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

9.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 9.4 MRU uMkhomazi A: Narrative and numerical habitat and biota RQOs

<table>
<tr><th>Indicators</th><th>Narrative RQO</th><th>Numerical RQO</th></tr>
<tr><td colspan="3">RIPARIAN VEGETATION</td></tr>
<tr><td>Presence of alien plant species in the riparian zone</td><td>The extent of perennial alien plant species within the riparian zone should remain low or decrease.</td><td>Insufficient quantitative data exist to develop numerical RQOs.</td></tr>
<tr><td>Riparian zone continuity</td><td>Modification of riparian zone continuity should remain moderate, or improve</td><td>N/A</td></tr>
<tr><td>Riparian zone fragmentation</td><td>Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.</td><td>N/A</td></tr>
<tr><td>Extent of forestry within the riparian zone</td><td>The extent of forestry within the riparian zone shall remain low or decrease.</td><td>N/A</td></tr>
<tr><td>Threatened riparian species</td><td>Viable populations of riparian plant species with IUCN status should remain within the RU.</td><td>One (1) listed riparian species should remain viable within the RU (H. polymorpha).</td></tr>
<tr><td colspan="3">FISH</td></tr>
<tr><td>Species richness</td><td rowspan="3">Indigenous fish species richness estimated to be four species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.</td><td>Maintain indigenous species richness (AMOS, ANAT, BANO, and BNAT) of estimated four fish species in this RU. Maintain current habitat diversity.</td></tr>
<tr><td>Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)</td><td>Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).</td></tr>
<tr><td>Secondary indicator species:
Vegetation: BANO
Migration: AMOS</td><td>Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.</td></tr>
</table>

Indicators	Narrative RQO	Numerical RQO
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

9.3 RQOs FOR RU MK2 (U10B-04343) (MODERATE PRIORITY - 2)

9.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10B-04343										
B	37.3	36.3	7.57	20.3	11.34	30.4	0.022	0.061	0.186	0.353

9.3.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 9.5 RU MK2: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species (Wattle) within the riparian zone should remain low or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be	N/A

Indicators	Narrative RQO	Numerical RQO
	no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain low or decrease.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	One (1) listed riparian species should remain viable within the RU (*H. polymorpha*).
FISH		
Species richness	Indigenous fish species richness estimated to be four species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (ANAT, BANO, and BNAT) of estimated three fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition, migration)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

9.4 RQOs FOR RU MK3 (U10C-04347) (MODERATE PRIORITY - 2)

9.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10C-04347										
B	96.1	91.7	18.79	19.6	28.51	29.7	0.086	0.117	0.444	0.793

9.4.2 Water quality RQOs

Source: Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d), including a GE layer of land use from Umgeni Water.
Model: N/A.
Users: Urban/tourism; agriculture.
Water quality issue: Turbidity, nutrients, salts, faecal coliforms/*E. coli*.

Narrative and numerical details are provided in Table 9.6.

Table 9.6 RU MK3: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95th percentile of the data must be less than or equal to 55 mS/m (Domestic use: driver).		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

9.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 9.7 RU MK3: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain low or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the	One (1) listed riparian species should remain viable within the RU (*H. polymorpha*).

Indicators	Narrative RQO	Numerical RQO
	RU.	
FISH		
Species richness	Indigenous fish species richness estimated to be four species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, and BNAT) of estimated four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (16). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

9.5 RQOs FOR RU MK5 (U10D-04199, 04222, 04298) (MODERATE PRIORITY - 2)

SQ U10D-04298 requires improvement to achieve the **TEC (B/C to a B)**. The actions required are non flow-related but will be difficult to achieve as catchment management would be required to amongst others manage sedimentation.

9.5.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10D-04222										
B	13.4	12.9	2.70	20.2	4.05	30.4	0.013	0.023	0.061	0.136
U10D-04298										
B	82.4	80.4	15.91	19.3	24.3	29.4	0.076	0.182	0.388	0.711

9.5.2 Water quality RQOs

Source: Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from Umgeni Water.
Model: N/A.
Users: Dryland commercial agriculture (incl. Nzinga commercial community agriculture); trout fishing (U10D-04199); Nzinga WWTW (U10D-04298).
Water quality issue: Turbidity, nutrients, salts, faecal coliforms/*E. coli*.

Narrative and numerical details are provided in Table 9.8.

Table 9.8 RU MK5: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95th percentile of the data must be less than or equal to 55 mS/m (Domestic use: driver).		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

9.5.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 9.9 RU MK5: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species (Wattle and Bramble) within the riparian zone should remain low or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A

Indicators	Narrative RQO	Numerical RQO
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha*).
FISH		
Species richness	Indigenous fish species richness estimated to be four species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, and BNAT) of estimated four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (16). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

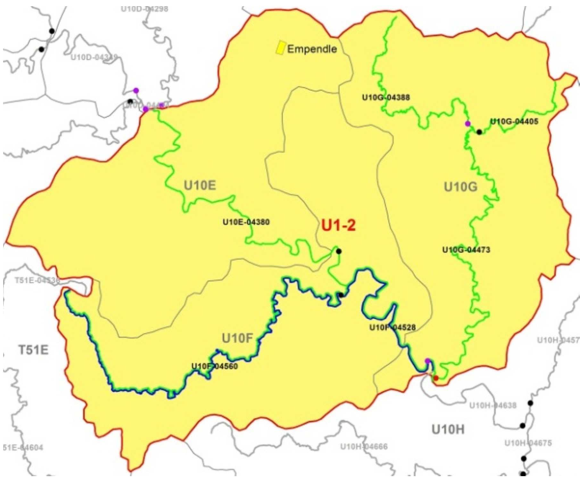
10 uMKHOMAZI (U1): IUA U1-2 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

All SQs are in a C PES. The uMkhomazi and Luhane rivers are dominated by non-flow related impacts (mainly forestry and rural settlements with informal agriculture), while the Elands and its tributaries is dominated by both flow (mainly small dams and some irrigation) and non-flow related (mainly forestry and rural settlements with informal agriculture) impacts. The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The land use activities in the IUA include forestry, cultivation, irrigation, some sugar cane, cattle farming, and community water use from low density rural settlements. The small town Ixopo is also located in the IUA.

IUA U-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U1-2 - MIDDLE UMKHOMAZI



PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
MRU uMkhomazi B.2	U10E-04380 Mk_I_EWR1US	uMkhomazi	C	C	C	3a
	U10F-04528US	uMkhomazi	MK_I_EWR1US			
MRU uMkhomazi B.3	U10F-04528DS Mk_I_EWR1DS	uMkhomazi	C	C	C	3a
RU6	U10F-04560	Luhane	B/C	B/C	B/C	2
RU7	U10G-04388	Elands	C	B	B	2
	U10G-04405		C	C	C	
	U10G-04473	Elands	C	B	B	

The RQOs are provided below for a ***Water Resource Class II*** and the catchment configuration as illustrated above.

10.1 RQOs FOR MRU uMKHOMAZI B.2 WITH MK_I_EWR1 US (U10E-04380) (HIGH PRIORITY - 3) (INCLUDING U10F-04528US)

The TECs are provided for this EWR site below. Note that this site represents the reach upstream of the proposed Smithfield Dam and will not be impacted on by any scenarios.

Component	PES, REC and TEC
Physico chemical	A/B
Geomorphology	A/B
Fish	B
Invertebrates	B/C
Instream	B/C
Riparian vegetation	C
EcoStatus	C

All RQOs, EcoSpecs and TPCs are as for the REC, i.e. RQOs immediately applicable, in MRU uMkhomazi B.3 in Section 10.2 and will not be repeated in this section.

10.2 RQOs FOR MRU uMKHOMAZI B.3 WITH MK_I_EWR1 DS (U10F-04528DS) (HIGH PRIORITY - 3)

The TECs are provided for this EWR site below. Note that this site represents the reach downstream of the proposed Smithfield Dam and as such will be impacted by the scenarios. The short term WRC recommendation is to maintain the PES/REC. The medium to long term Water Resource Class recommendation is with Smithfield Dam and the downstream operation associated with Sc 21. Where the TEC differs for the two short and medium term, these will be indicated and the expected changes in RQO from the present day indicated.

Component	PES and REC	Sc 21
	RQOs immediately applicable	RQOs applicable if Sc 21 is implemented
Physico chemical	A/B	A/B
Geomorphology	A/B	B/C
Fish	B	B/C
Invertebrates	B/C	B/C
Riparian vegetation	C	C
EcoStatus	C	C

10.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a,b).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
MK_I_EWR1	REC: C	683.17	660.72	123.707	18.1	186.07	27.2	0.89	1.42	4.13	5.54
MK_I_EWR1 (DS of dam)	Sc 21: C	683.17	660.72	206.9	30.2	540.5	79.1	2.339	2.82	16.12	35.22

10.2.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). Source data includes a GE layer of land use information from Umgeni Water.
Model: PAI model (DWAF, 2008b).
Users: Some agriculture; extensive erosion.
Water quality issue: Turbidity.
Narrative and numerical: Details for MRU uMkhomazi B.2 are provided in Tables below. Data used for water quality assessments should be collected from Umgeni Water (UW) site RMK002 or U1H005Q01.

Table 10.1 MRU uMkhomazi B.2: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 10.2 MRU uMkhomazi B.2: Water quality EcoSpecs and TPCs (PES and TEC: A/B)

River: uMkhomazi		**PES: A/B Category**
Monitoring site: RMK002 or U1H005Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th percentile of the data must be 5.9 – 6.5, and the 95th percentile 8.0 – 8.8.	The 5th percentile of the data must be < 6.1 and > 6.3, and the 95th percentile must be < 8.2 and > 8.6.
Temperature[(b)]	Natural temperature range.	Initiate baseline monitoring for this variable.
Dissolved oxygen[(b)]	The 5th percentile of the data must be ≥ 7.5 mg/L.	The 5th percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.
Turbidity[(b)]	Changes in turbidity are related to minor man-made modifications. Some silting of habitats are expected.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 0.25 mg/L.	The 50th percentile of the data must be 0.2 – 0.25 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.015 mg/L.	The 50th percentile of the data must be 0.012 – 0.015 mg/L.
Response variables		
Chl-*a* phytoplankton[(b)]	The 50th percentile of the data must be < 15 µg/L.	The 50th percentile of the data must be 12 – 15 µg/L.
Chl-*a* periphyton[(b)]	The 50th percentile of the data must be ≤ 12 mg/m^2.	The 50th percentile of the data must be 10 – 12 mg/m^2.
Toxics		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.044 mg/L.	The 50th percentile of the data must be 0.035 – 0.044 mg/L.
Mercury	The 95th percentile of the data must be ≤ 0.001 mg/L.	The 95th percentile of the data must be 0.000 8 – 0.001 mg/L.
Other toxics	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category

River: uMkhomazi		PES: A/B Category
Monitoring site: RMK002 or U1H005Q01		
Water quality metrics	**EcoSpecs**	**TPC**
		boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

10.2.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 10.3 MRU uMkhomazi B.2: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category B and it should be aimed to maintain this EC in future if the overall TEC is to be reached. A slight deterioration (Category B/C) is expected in the fish EC under Sc 21. The indigenous fish species richness of the EWR site is estimated to be four species (three species confirmed during EWR study) and should remain the same under Sc 21. The primary indicator fish species for this reach (especially in terms of flow-modification) is the rheophilic Natal mountain catfish (ANAT), and to a lesser extent the semi-rheophilic Scaly (BNAT). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the Longfin eel (AMOS) (longitudinal continuity, substrate quality) and Chubbyhead barb (BANO) (vegetation and slow habitats). The abundance and FROC of ANAT and BNAT are expected to decrease slightly under Sc 21.
Invertebrates	The macro-invertebrate community should be representative of a medium-sized mountain stream assemblage with perennial flows. The habitats in the river are dominated by good SIC with moderate marginal vegetation overhanging the stream banks. There are some deeper water with slower flows and rocky bottoms. This site represents the reach downstream of the proposed Smithfield Dam. Although the area contains Forestry, alien and invasive plants (wattle, mauritius thorn), agricultural lands, community water use, grazing, degraded grassland, subsistence farming and erosion due to these practices, the EcoSpecs are set to retain some diversity and integrity. The REC and the TEC (Sc 21) will remain in a Category B/C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The overall PES at MK_I_EWR1 (as at August 2013) for riparian vegetation was a Category C (71.2%). This is also the REC and TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone on a whole, as well as within each sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate (especially Wattle). Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). As such agricultural activities shall not encroach into the riparian zone or floodplain and current levels of overgrazing and trampling by livestock shall not increase within the riparian zone.

The EcoSpecs and TPCs are provided in the following tables.

Table 10.4 Fish EcoSpec and TPCs (PES and TEC: B; Sc 21 = B/C)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)	Sc 21 expected changes in EcoSpecs
Ecological status	PES	PES of fish is in a B (83.47%).	Decrease of PES into a lower EC than PES (<B)	Any deterioration in habitat that results in decrease in FROC* of species.	Deterioration in overall PES to a Category B/C expected.
Species richness	All indigenous species	All four of the expected 4 indigenous fish species estimated to be present.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.	No change in species richness.
Requirement for flowing water	**ANAT (BNAT)**	ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	ANAT absent during any survey OR present at FROC of <2.5.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).	Slight reduction in abundance and FROC as a result of flow modification by dam.
FD habitats		ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for FD habitats and are the most applicable indicator species		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)	
FS habitats		ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for FS habitats and is the most applicable indicator species.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).	
Substrate		ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.	
Water quality intolerance		ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.		Decreased water quality (especially flow related water quality variables such as oxygen).	
Overhanging vegetation	BANO	BANO estimated to occur at a FROC* of 2 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BANO absent during any survey OR present at FROC of <2.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)	No notable change expected.
Instream vegetation		BANO estimated to occur at a FROC* of 2 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.		Significant change in instream vegetation flow modification, use of herbicides, nutrient enrichment)	
SD habitats		BANO estimated to occur at a FROC*		Significant change in SD habitat suitability	

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)	Sc 21 expected changes in EcoSpecs
		of 2 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.		(i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).	
SS habitats		BANO estimated to occur at a FROC* of 2 under PES have a high requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).	
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 1.5 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive surveys OR present at FROC of <1.5.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).	No notable change expected downstream of dam.
Water column	BNAT	BNAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for water column as cover and is the most applicable indicator species for this habitat feature.	BNAT absent during any survey OR present at FROC of <2.5.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).	The FROC and abundance of this potamodromous species may decrease due to migration barrier impact (dam wall) as well as other impacts (flow modification, altered sediment regime and flushing by floods).
Alien fish species	Presence of any alien/ introduced spp.	MSAL known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A	No change expected.

Table 10.5 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B/C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae, Philopotamidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Coenagrionidae	0.3 - 0.6 m/s	Marginal vegetation	Low
6	Gomphidae, Tabanidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 180; ASPT value: > 6.5.	SASS5 scores < 185 and ASPT < 6.8.
To ensure that the MIRAI score remains within the range of a B/C Category (>77.4 and <82.01), using the same reference data used in this study.	A MIRAI score of 80% or less.
Presence of at least four of the following six high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae and Philopotamidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae and Philopotamidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following eight key taxa: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenida, Tricorythidae, Philopotamidae, Heptagenidae and Leptophlebidae.	Less than seven of the eight key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Psephenidae, Tricorythidae and Philopotamidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae and Leptophlebidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa Coenagrionidae.	This taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae and Tabanidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 10.6 Riparian vegetation EcoSpec and TPCs (PES and TEC: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 80%.	An absence of indigenous riparian woody species OR an increase in cover above 80%.

Assessed Metric	EcoSpec	TPC
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 30%.	A decrease in non-woody cover (% aerial) below 20%.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 5% or lower.	An increase in perennial alien plant species cover >10%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 5% or lower.	An increase in terrestrial woody species cover above 10%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 70%.	An absence of indigenous riparian woody species OR an increase in cover above 70%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 35%.	A decrease in non-woody cover (% aerial) below 25%.
Reed cover (% aerial)	Maintain reed cover above 5%.	An absence of reeds.
Upper zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 20% or lower.	An increase in perennial alien plant species cover >25%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 25% or lower.	An increase in terrestrial woody species cover above 30%
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 10% and below 80%.	An decrease in indigenous riparian woody species cover below 10% or an increase above 90%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 35%.	A decrease in non-woody cover (% aerial) below 25%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 65% for the riparian zone and at least 80% for both the marginal and lower zones when assessed separately.	A decrease in PES score below 62% (limit of C) for the riparian zone, or below 80% for the marginal or lower zones.
Dominant vegetation type	The dominant vegetation type within the riparian zone shall remain grass, which shall comprise at least 40% of all riparian vegetation.	Reduced proportion of grass cover below 40%.

10.3 RQOs FOR RU MK 6 (U10F-04560) (MODERATE PRIORITY - 2)

10.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10F-04560										
C	36.3	33.1	4.86	13.4	8.28	22.8	0.02	0.053	0.034	0.157

10.3.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from Umgeni Water.
Model: N/A.
Users: Urban incl. WWTW; subsistence farming; erosion.
Water quality issue: Turbidity, nutrients, salts, faecal coliforms/*E. coli*.

Narrative and numerical details are provided in Table the tables below.

Table 10.7 RU MK6: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95th percentile of the data must be less than or equal to 55 mS/m (Domestic use: driver).		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

10.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 10.8 RU MK6: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain large at the most, or decrease.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; Kniphofia latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be four species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain	Maintain indigenous species richness (AMOS, ANAT, BANO, and BNAT) of estimated four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality,		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and

Indicators	Narrative RQO	Numerical RQO
substrate condition)	adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 16 key taxa to be present. However, due to present day influences (turbidity, dams), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

10.4 RQOs FOR RU MK7 (U10G-04388, 04405, 04473) (MODERATE PRIORITY - 2)

SQ	River	PES	REC (target)	Requirement
U10G-04388	Elands	C	B	Target improvement especially in the lower reach. Buffer zone, alien removal, water quality practices. As none of the scenarios are relevant to this SQ, the improvement is valid irrespective of the recommended scenario.
U10G-04473	Elands	C	B	Target improvement especially in the upper reach. Buffer zone, alien removal, water quality practices. Also flow improvements but should be able to reach at least a B/C without any improvement in flow.

10.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).

Model: DRM (Hughes and Hannart 2003), RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10G-04388										
B	18.9	16.6	3.95	20.9	6.01	31.8	0.016	0.031	0.029	0.136
U10G-04405										
C	8.7	6.9	1.52	17.5	2.32	26.8	0.005	0.015	0.01	0.05
U10D-04473										
B	67.1	59.5	12.88	19.2	20.51	30.5	0.048	0.111	0.089	0.272

10.4.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, , including a GE layer of land use from UW.
Model: N/A.
Users: Commercial agriculture; waste ponds from dairy farming on a tributary.
Water quality issue: Nutrients, salts, faecal coliforms/*E. coli*.

Table 10.9 RU MK7: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95th percentile of the data must be less than or equal to 55 mS/m (Domestic use: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	Medium	High
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

10.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 10.10 RU MK7: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain large at the most, or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate at the most, or decrease.	N/A
Threatened riparian	Viable populations of riparian plant species	Three (3) listed riparian species should remain

Indicators	Narrative RQO	Numerical RQO
species	with IUCN status should remain within the RU.	viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be five species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, BNAT, and TSPA) of estimated five fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO, TSPA Migration: AMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c)of this reach listed 18 key taxa to be present. However, due to present day influences (water quality), fewer key taxa are expected (17). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

11 uMKHOMAZI (U1): IUA U1-3 RESOURCE QUALITY OBJECTIVES

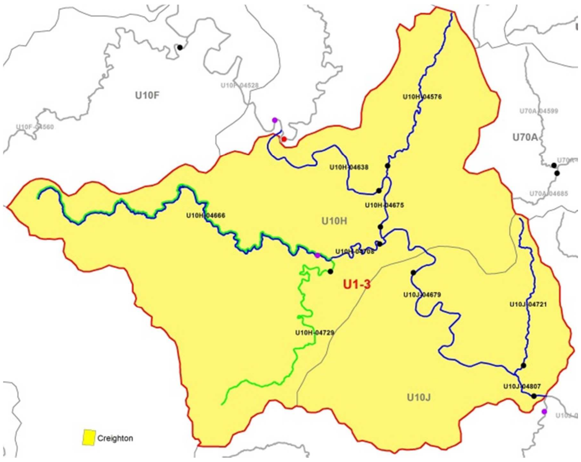
The IUA overview and description is provided below.

The IUA is dominated by a B PES with one C and one B/C PES SQ. These reaches are impacted by both flow and non-flow related activities, consisting primarily of forestry, subsistence farming and sugar cane agriculture, resulting in instream sedimentation, riparian zone modification and flow alterations

The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The land use activities are predominantly community water use from low density rural settlements.

IUA U-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U1-3 - UMKHOMAZI GORGE ZONE



PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
RU8	U10H-04576	Tholeni	B	B	B	2
RU9	U10H-04666	Ngudwini	B/C	B	B	2
	U10H-04708	Ngudwini	B	B	B	
	U10H-04729	Mzalanyoni	C	C	C	
MRU uMkhomazi B.4	U10H-04638	uMkhomazi	Mk_I_EWR2			3b
	U10H-04675	uMkhomazi				
MRU uMkhomazi C	U10J-04679 Mk_I_EWR2	uMkhomazi	B	B	B	3
RU10	U10J-04721	Pateni	B	B	B	2

The RQOs are provided below for a ***Water Resource Class I*** and the catchment configuration as illustrated above.

11.1 RQOs FOR RU MK 8 (U10H-04567) (MODERATE PRIORITY - 2)

11.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10H-04567										
B	14.1	10.7	2.57	18.3	4.15	29.5	0.012	0.019	0.036	0.061

11.1.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 11.1 RU MK8: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry activities into the riparian zone and existing forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate at the most, or decrease.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Four (4) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be seven species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, BGUR, BNAT, CGAR, and TSPA) of estimated seven fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO, TSPA Migration: AMOS Water column/SD: CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s),

Indicators	Narrative RQO	Numerical RQO
	flow dependant species.	low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

11.2 RQOs FOR RU MK9 (U10H-04666, 04708, 04729) (MODERATE PRIORITY - 2)

SQ	River	PES	REC (target)	Requirement
U10H-04666	Ngudwini	B/C	B	Address erosion to reduce sedimentation (overgrazing, forestry, informal agriculture). As none of the scenarios are relevant to this SQ, the improvement is valid irrespective of the recommended scenario.

11.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: DRM (Hughes and Hannart, 2003), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10H-04666										
B	20.4	13.2	2.48	12.2	4.57	22.5	0.002	0.002	0.045	0.073
U10H- 04708										
C	47.2	35.6	7.02	14.9	12.4	26.3	0.007	0.012	0.122	0.204
U10H-04729										
B	23.0	19.6	4.4	19.1	7.01	30.5	0.016	0.038	0.031	0.093

11.2.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from Umgeni Water.
Model: N/A.
Users: Cattle (irrigated pastures); dairy waste ponds.
Water quality issue: Nutrients, turbidity, faecal coliforms/*E. coli*.

Table 11.2 RU MK9: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

11.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 11.3 RU MK9: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate at the most, or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate at the most, or decrease.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Four (4) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia; P. serratum*)
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, BGUR, BNAT, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO, TSPA Migration: AMOS Water column/SD: CGAR, OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 18 key taxa to be present. However, due to present day influences (instream dams, flows and water quality), fewer key taxa are expected (14). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and

Indicators	Narrative RQO	Numerical RQO
	sensitive species.	good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

11.3 RQOs FOR MRU uMKHOMAZI C WITH MK_I_EWR2 (U10J-04679) (HIGH PRIORITY - 3) (INCLUDING U10JH-04638, 04675)

The TECs is provided for this EWR site below. Note that this site represents the reach downstream of the proposed Smithfield Dam and as such will be impacted by the scenarios. The short term WRC recommendation is to maintain the PES. The medium to long term Water Resource Class recommendation is with Smithfield Dam and the downstream operation associated with Sc 21. Where the TEC differs for the two short and medium term, these will be indicated and the expected changes in RQO from the present day indicated.

Component	PES and REC	Sc 21
	RQOs immediately applicable	RQOs applicable if Sc 21 is implemented
Physico chemical	A/B	A/B
Geomorphology	B	C
Fish	B	C
Invertebrates	B	B/C
Riparian vegetation	B	B
EcoStatus	B	B

11.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a,b).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
MK_I_EWR2	REC: B	890.91	838.35	151.2	14.2	241.5	35.8	1.551	2.869	5.991	10.488
	Sc 21: B	890.91	838.35	262.1	29.4	677	76	2.743	2.37	18.125	46.35

11.3.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). Source data includes a GE layer of land use information from Umgeni Water.
Model: PAI model (DWAF, 2008b).
Users: Agriculture.
Water quality issue: Nutrients, salts.

Narrative and numerical: Details for MRU uMkhomazi C are provided in the tables below. Data used for water quality assessments should be collected from UW site RMK004.

Table 11.4 MRU uMkhomazi C: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 11.5 MRU uMkhomazi C: Water quality EcoSpecs and TPCs (PES and TEC: A/B)

River: uMkhomazi		PES: A/B Category
Monitoring site: RMK004		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th and 95th percentiles of the data must range from 6.5 to 8.0.	The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.
Temperature[(b)]	Natural temperature range.	Initiate baseline monitoring for this variable.
Dissolved oxygen[(b)]	The 5th percentile of the data must be ≥ 7.5 mg/L.	The 5th percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.
Turbidity[(b)]	Changes in turbidity are related to minor man-made modifications. Some silting of habitats are expected.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 0.25 mg/L.	The 50th percentile of the data must be 0.2 – 0.25 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.015 mg/L.	The 50th percentile of the data must be 0.012 – 0.015 mg/L.
Response variables		
Chl-*a* phytoplankton[(b)]	The 50th percentile of the data must be < 15 µg/L.	The 50th percentile of the data must be 12 – 15 µg/L.
Chl-*a* periphyton[(b)]	The 50th percentile of the data must be ≤ 12 mg/m^2.	The 50th percentile of the data must be 10 – 12 mg/m^2.
Toxics		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.073 mg/L.	The 50th percentile of the data must be 0.058 – 0.073 mg/L.
Lead (moderate /	The 95th percentile of the data must be ≤ 0.005	The 95th percentile of the data must be 0.004 –

River: uMkhomazi		PES: A/B Category
Monitoring site: RMK004		
Water quality metrics	**EcoSpecs**	**TPC**
hard water)	mg/L.	0.005 mg/L.
Other toxics	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

11.3.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 11.6 MRU uMkhomazi C: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category B and it should be aimed to maintain this EC in future if the overall TEC is to be reached. A deterioration (Category C) is expected in the fish EC under Sc 21. The present indigenous fish species richness of the EWR site is estimated to be seven species (two species confirmed during EWR study) and it is estimated to remain the same under Sc 21. The primary indicator fish species for this reach (especially in terms of flow-modification) is the rheophilic Natal mountain catfish (ANAT), and to a lesser extent the large semi-rheophilic Scaly (BNAT). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the eels (AMOS/AMAR) (longitudinal continuity, undercut banks, SD habitats), Chubbyhead barb (BANO) (instream vegetation) and Bowstripe barb (BVIV) (overhanging vegetation and SS habitats). The abundance and FROC of most species (especially ANAT and BNAT) are expected to decrease slightly under Sc 21.
Invertebrates	The macro-invertebrate community should be representative of a lowland river assemblage with perennial flows. The habitats in the river are dominated by good SIC, boulders and bedrock habitat, with a scanty marginal vegetation fringe. This site represents the reach downstream of the proposed Smithfield Dam. Higher dry season flows will benefit the instream habitats, while the lower wet flows will not impact too much in the form of erosion (sediment hungry water out of the dam). Good lateral connectivity and favourable water quality result in an EC slightly lower than the PES/REC. Thus a deterioration (Category B/C) is expected in the macro-invertebrates EC under Sc 21. Sediment scouring might impact on the course sediment habitats, and this might impact on the bottom-dwelling taxa.
Riparian vegetation	The overall PES at MK_I_EWR2 (as at August 2013) for riparian vegetation was a Category B (85.9%). This is also the REC and TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone on a whole, as well as within each sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). As such agricultural activities shall not encroach into the riparian zone or floodplain.

The EcoSpecs and TPCs are provided in the following tables.

Table 11.7 Fish EcoSpec and TPCs (PES and TEC: B; Sc 21: C)

Metric	Indicator spp.[1]	PES EcoSpecs	PES TPC (Biotic)	PES TPC (Habitat)	Sc 21 expected changes in EcoSpecs
Ecological status	PES	PES of fish is in a B (82.1%).	Decrease of PES into a lower EC than PES (<B)	Any deterioration in habitat that results in decrease in FROC* of species.	EC estimated to deteriorate to a Category C.
Species richness	All indigenous species	All seven of the expected 7 indigenous fish species estimated to still be present in the reach under PES.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.	No change in species richness expected.
Requirement for flowing water	**ANAT (BNAT)**	ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	ANAT absent during any survey OR present at FROC of <2.5.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).	Slight decrease in abundance and FROC of ANAT (and BNAT) as a result of decreased availability of fast habitats (flow modification from dam).
FD habitats		ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)	
FS habitats		ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).	
Substrate		ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.	
Water quality intolerance		ANAT estimated to occur at a FROC* of 2.5 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.		Decreased water quality (especially flow related water quality variables such as oxygen).	
Overhanging vegetation	BVIV	BVIV estimated to occur at a FROC* of 1.5 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BVIV absent during two consecutive surveys OR present at FROC of <1.5.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)	Slight decrease in abundance and FROC due to change in vegetated and SS habitats as a result of flow modification by dam.
SS habitats		BVIV estimated to occur at a FROC* of 1.5 under PES have a high requirement for SS habitats and is the most applicable indicator species for this		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).	

Metric	Indicator spp.[1]	PES EcoSpecs	PES TPC (Biotic)	PES TPC (Habitat)	Sc 21 expected changes in EcoSpecs
		velocity-depth category.			
Instream vegetation	BANO	BANO estimated to occur at a FROC* of 1 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.	BANO absent during two consecutive surveys OR present at FROC of <1.	Significant change in instream vegetation habitats (flow modification, use of herbicides)	Slight decrease in abundance and FROC due to change in vegetated habitats as a result of flow modification by dam.
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 2.8 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive surveys OR present at FROC of <2.8.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).	Slight decrease in abundance and FROC due to change in undercut bank habitats as a result of flow modification by dam.
Water column	BNAT	BNAT estimated to occur at a FROC* of 4 under PES have a high requirement for water column as cover and is the most applicable indicator species for this chabitat feature.	BNAT absent during any survey OR present at FROC of <4.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).	Slight decrease in abundance and FROC of BNAT as a result of decreased availability of water column as cover due to flow modification from dam.
SD habitats	AMAR	AMAR estimated to occur at a FROC* of 0.8 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.	AMAR absent during three consecutive surveys OR present at FROC of <0.8.	Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).	Slight decrease in abundance and FROC due to loss of SD habitats as a result of flow modification by dam.
Alien fish species	Presence of any alien/introduced spp.	MSAL and CCAR known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A	
Migratory success[##]	AMAR AMOS BNAT	It is estimated that the catadromous AMAR and AMOS may still be present, and some potamodromous species (including BNAT) also occurs.	Loss or decreased FROC* of catadromous (AMOS/AMAR) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).	Due to distance from site dam not expected to imapct notably oin migration (except decreased depth in low flows may limit movement of larger species to some extent).

Table 11.8 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B; Sc 21: B/C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp.	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
6	Pyralidae	0.3 - 0.6 m/s	Marginal vegetation	Good
7	Coenagrionidae	0.3 – 0.6 m/s	Marginal vegetation	Low
8	Paleomonidae	0.3 - 0.6 m/s	SIC biotope	Low
9	Gomphidae, Tabanidae, Athericidae	-	Course sediment	-

EcoSpecs	TPCs	Sc 21 expected changes in EcoSpecs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 170; ASPT value: > 6.5.	SASS5 scores < 170 and ASPT < 6.5.	To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 150; ASPT value: > 6.0.
To ensure that the MIRAI score remains within the range of a B Category (82.01 – 87.4), using the same reference data used in this study.	A MIRAI score of 83% or less.	To ensure that the MIRAI score remains within the range of a B/C Category (>77.4 and <82.01), using the same reference data used in this study.
Presence of at least three of the following four high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae and Heptagenidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Tricorythidae and Heptagenidae.	Presence of at least three of the following four high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following five key taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae Heptagenidae and Leptophlebidae.	Less than four of the five key taxa listed.	Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following four key taxa: Hydropsychidae 2 spp., Tricorythidae, Heptagenidae and Leptophlebidae.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp., Tricorythidae.	Any one of these taxa missing for two consecutive surveys.	Maintain suitable flow velocity(maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Hydropsychidae 2 spp. And Tricorythidae.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae and Libellulidae.	Any one of these taxa missing during surveys.	Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae and Libellulidae.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Pyralidae and Coenagrionidae.	Any one of these taxa missing for two consecutive surveys.	Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa Coenagrionidae.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae and Athericidae.	Any one of these taxa missing for two consecutive surveys.	Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae and Athericidae.
Maintain suitable conditions in the SIC habitat and no migration barriers for this migrational species, Paleomonidae.	This taxa missing during surveys.	This taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.	Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B

abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.		abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.

Table 11.9 Riparian vegetation EcoSpec and TPCs (REC and TEC: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 80%.	An absence of indigenous riparian woody species OR an increase in cover above 80%
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 30%.	A decrease in non-woody cover (% aerial) below 20%.
Reed cover (% aerial)	Maintain reed cover above 10%.	An absence of reeds.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 10% or lower.	An increase in perennial alien plant species cover >15%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 5% or lower.	An increase in terrestrial woody species cover above 10%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 70%.	An absence of indigenous riparian woody species OR an increase in cover above 70%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Reed cover (% aerial)	Maintain reed cover above 15%.	An absence of reeds.
Upper zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 20% or lower.	An increase in perennial alien plant species cover >25%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 30% or lower.	An increase in terrestrial woody species cover above 40%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 10% and below 80%.	An decrease in indigenous riparian woody species cover below 10% or an increase above 90%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 82% for the riparian zone.	A decrease in PES score below 80% for the riparian zone.
Dominant vegetation type	The dominant vegetation type shall remain non-woody in the marginal and lower zones, and woody in the upper zone.	Reduced proportion of non-woody cover below 50% in the marginal or lower zones; reduced proportion of woody cover below 40% in the upper zone.

11.4 RQOs FOR RU MK 10 (U10J-04721) (MODERATE PRIORITY - 2)

11.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10J-04721										
B	6.2	4.0	1.43	22.9	2.13	34.3	0.008	0.017	0.014	0.045

11.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in the table below.

Table 11.10 RU MK10: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced to moderate at the most.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small at the most, or decrease.	N/A
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Four (4) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia; P. serratum*)
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, BGUR, BNAT, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation: BANO, TSPA Migration: AMOS Water column/SD: CGAR, OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.

Indicators	Narrative RQO	Numerical RQO
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

12 uMKHOMAZI (U1): IUA U1-4 RESOURCE QUALITY OBJECTIVES

This IUA include one SC forming part of IUA 1-4 (U10J-04820).

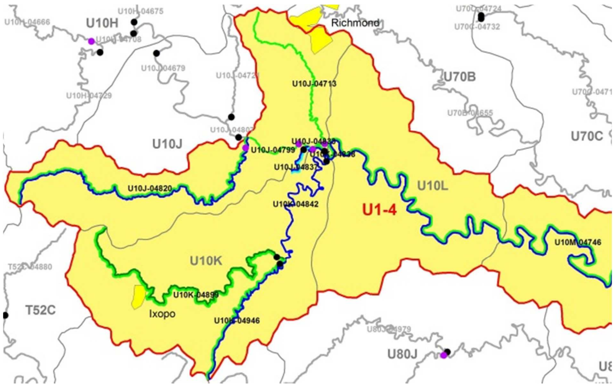
The IUA overview and description is provided below.

The dominant PES is C and B/C. The Xobho River is a D PES (main impacts being dams, forestry and agriculture). The uMkhomazi River in U10L and M is a B/C PES with the predominant impacts being overgrazing.

The storage regulation in this IUA is low with no dams located in the IUA. The development of the upstream uMkhomazi River Development Project (Smithfield Dam) will have a significant impact on the uMkhomazi River in the water resource IUA. The landuse activities are predominantly community water use from low density rural settlements.

IUA U-4 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U1-4 - LOWER uMKHOMAZI



PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
RU11	U10J-04820	Lufafa	B/C	B	B	2
MRU uMkhomazi D	U10J-04807	uMkhomazi	Mk_I_EWR3			3
	U10J-04799	uMkhomazi				
	U10J-04833	uMkhomazi				
	U10K-04838	uMkhomazi				
	U10M-04746 Mk_I_EWR3	uMkhomazi	C	C		
RU12	U10J-04713	Mkobeni	C	B	B	2
	U10K-04842	Nhlavini	B	B	B	
	U10K-04899	Xobho	C/D	C/D	C/D	
	U10K-04946	Nhlavini	B/C	B/C	B/C	

The RQOs are provided below for a ***Water Resource Class II*** and the catchment configuration as illustrated above.

12.1 RQOs FOR RU MK 11 (U10J-04820) (MODERATE PRIORITY - 2)

SQ	River	PES	REC (target)	Requirement
U10J-04820	Lufafa	B/C	B	Erosion control, riparian buffer. Due to the catchment scale of the problem, this is deemed to be difficult.

12.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10J-04820										
B	26.1	21.5	4.26	16.3	6.94	26.6	0.023	0.04	0.057	0.094

12.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Agriculture. (Note: Sappi Forests plantation near T52D 05061 and T52C 04880 only. All riparian zones delineated according to the DWS delineation guidelines. Weed control in riparian areas done as part of the integrated weed plan (S van Zyl, Sappi, *pers. comm*., March 2015)).
Water quality issue: Nutrients, salts.

Table 12.1 RU MK11: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95^{th} percentile of the data must be less than or equal to 55 mS/m (Domestic use: driver).

12.1.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in the table below.

Table 12.2 RU MK11: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate at the most, or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Four (4) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water	Maintain indigenous species richness (AMOS, ANAT, BANO, BGUR, BNAT, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow,		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large

Indicators	Narrative RQO	Numerical RQO
flow related water quality, substrate condition)	quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, TSPA Migration: AMOS Water column/SD: CGAR, OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 18 key taxa to be present. However, due to present day influences (water quality, dams), fewer key taxa are expected (14). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

12.2 RQOs FOR MRU uMKHOMAZI D WITH MK_I_EWR3 (U10M-04746) (HIGH PRIORITY - 3) (INCLUDING U10J-04807, 04799, 04833, U10K-04838)

The TECs are provided for this EWR site below. Note that this site represents the reach downstream of the proposed Smithfield Dam and as such will be impacted by the scenarios. The short term WRC recommendation is to maintain the PES. The medium to long term Water Resource Class recommendation is with Smithfield Dam and the downstream operation associated with Sc 21. Where the TEC differs for the two short and medium term, these will be indicated and the expected changes in RQO from the present day indicated.

Component	PES and REC	Sc 21
	RQOs immediately applicable	RQOs applicable if Sc 21 is implemented
Physico chemical	A/B	A/B
Geomorphology	B	B/C
Fish	B	B/C
Invertebrates	B	B/C
Riparian vegetation	D	D
EcoStatus	C	C

12.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a,b).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
MK_I_EWR3	REC: C	1068.6	983.23	223.42	21.2	332.8	31.1	1.532	2.203	5.589	7.668
	Sc 21: C	1068.6	983.23	308.6	28.9	813.5	76.1	2.743	3.383	19.944	48.722

12.2.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). Source data includes a GE layer of land use information from Umgeni Water.
Model: PAI model (DWAF, 2008b).
Users: Intensive agriculture; poultry farming (also in lower end of tributary U10J-04837); some settlements.
Water quality issue: Nutrients, salts, faecal coliforms/*E. coli*.
Narrative and numerical: Details for MRU uMkhomazi D are provided in the tables below. Data used for water quality assessments should be collected from U1H009Q01 (just downstream EWR site) or U1H006Q01 (approximately 5km downstream).

Table 12.3 MRU uMkhomazi D: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels are within Acceptable limits.</td><td colspan="3">50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that electrical conductivity (salt) levels are within Acceptable limits.</td><td colspan="3">95th percentile of the data must be less than or equal to 55 mS/m (Domestic use: driver).</td></tr>
<tr><td>Ensure water quality state maintains biotic requirements as specified by RQOs for biota.</td><td colspan="3">See specified biota requirements</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

Table 12.4 MRU uMkhomazi D: Water quality EcoSpecs and TPCs (PES and TEC: A/B)

River: uMkhomazi		**PES: A/B Category**
Monitoring site: U1H009Q01 or U1H006Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 55 mS/m.	The 95th percentile of the data must be 44 – 55 mS/m.
pH	The 5th percentile of the data must be 5.9 – 6.5, and the 95th percentile 7.6 – 8.8.	The 5th percentile of the data must be < 6.1 and > 6.3, and the 95th percentile must be < 7.8 and > 8.6
Temperature[(b)]	Natural temperature range.	Initiate baseline monitoring for this variable.
Dissolved oxygen[(b)]	The 5th percentile of the data must be ≥ 7.5 mg/L.	The 5th percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.
Turbidity[(b)]	Changes in turbidity are related to minor man-made modifications. Some silting of habitats are expected.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 0.25 mg/L.	The 50th percentile of the data must be 0.2 – 0.25 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.015 mg/L.	The 50th percentile of the data must be 0.012 – 0.015 mg/L.
Response variables		
Chl-*a* phytoplankton[(b)]	The 50th percentile of the data must be < 15 µg/L.	The 50th percentile of the data must be 12 – 15 µg/L.
Chl-*a* periphyton[(b)]	The 50th percentile of the data must be ≤ 12 mg/m^2.	The 50th percentile of the data must be 10 – 12 mg/m^2.
Toxics		
Other toxics	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

12.2.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 12.5 MRU uMkhomazi D: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category B and it should be aimed to maintain this EC in future if the overall TEC is to be reached. A slight deterioration (Category B/C) is expected in the fish EC over the long-term under Sc 21. The present indigenous fish species richness of the EWR site is estimated to be twenty-three species (two species confirmed during EWR study) and it is estimated to remain the same under Sc 21. The primary indicator fish species for this reach (especially in terms of flow-modification) is the large semi-rheophilic Scaly (BNAT). This species is a good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the eels (longitudinal continuity, undercut banks, SD habitats), Freshwater goby (AAEN) (substrate quality). Redtail barb (BGUR) (water quality) and Bowstripe barb (BVIV) (vegetated and SS habitats). The abundance and FROC of especially BNAT are expected to decrease slightly under Sc 21.
Invertebrates	The macro-invertebrate community should be representative of a large lowland river assemblage with perennial flows. The habitats in the river are dominated by alluvial runs and pools with good SIC controls; the marginal vegetation are well-developed. This site represents a reach downstream of the proposed Smithfield Dam. Water quality to remain in current state, however marginal vegetation may experience some inundation stress in dry season will reduce reed cover. Very large floods will be reduced. None of these stresses will be very high and the slight late wet season flows, together with slight reduced marginal vegetation influences and reduced large floods will impact marginally on the macro-invertebrate population structure. The change in marginal vegetation might impact on the associated taxa.
Riparian vegetation	The overall PES at MK_I_EWR 3 (as at August 2013) for riparian vegetation was a Category D (54.5%). This is also the REC and TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone on a whole, as well as within each sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c).

The EcoSpecs and TPCs are provided in the following tables.

Table 12.6 Fish EcoSpec and TPCs (PESC and TEC: B; Sc 21: C)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)	Sc 21 expected changes in EcoSpecs
Ecological status	PES	Present ecological status of fish is in a B (83.4%).	Decrease of PES into a lower EC than PES.	Any deterioration in habitat that results in decrease in FROC* of species.	EC estimated to deteriorate to a Category B/C.
Species richness	All indigenous species	All 23 expected indigenous fish species estimated to still be present in the reach under PES.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.	No change in species richness expected.
Requirement for flowing water	BNAT	BNAT estimated to occur at a FROC* of 4 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	BNAT absent during any survey OR present at FROC of <4.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, and altered seasonality).	Slight decrease in abundance and FROC of BNAT as a result of decreased availability of fast habitats (flow modification from dam).
FD habitats		BNAT estimated to occur at a FROC* of 4 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).	
FS habitats		BNAT estimated to occur at a FROC* of 4 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).	
Substrate	AAEN	AAEN estimated to occur at a FROC* of 1.5 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.	AAEN absent during two consecutive surveys OR present at FROC of <1.5.	Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.	No notable change.
Water quality intolerance	BGUR	BGUR estimated to occur at a FROC* of 0.5 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.	BGUR absent during two consecutive surveys OR present at FROC of <0.5.	Decreased water quality (especially flow related water quality variables such as oxygen).	No notable change.
Overhanging and instream vegetation	BVIV	BVIV estimated to occur at a FROC* of 1.5 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BVIV absent during any survey OR present at FROC of <1.5.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).	No notable change.
SS (SS) habitats		BVIV estimated to occur at a FROC* of 1.5 under PES have a high		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality,	

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)	Sc 21 expected changes in EcoSpecs
		requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		increased sedimentation of slow habitats).	
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 2.5 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive surveys OR present at FROC of <2.5.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).	No notable change.
SD habitats (water column)	TREN	TREN estimated to occur at a FROC* of 0.5 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.	TREN absent during two consecutive surveys OR present at FROC of <0.5.	Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).	No notable change.
Alien fish species	Presence of any alien/ introduced spp.	CCAR known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A	No notable change.
Migratory success[##]	Eels (AMOS, AMAR, ALAB), BNAT	It is estimated that the catadromous eels (AMOS, AMAR, ALAB) may still be present, and various potamodromous species (including BNAT) also occurs.	Loss or decreased FROC1 of catadromous (eels) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).	No notable change in migration (due to distance from proposed dam).

Table 12.7 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B; Sc 21: B/C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp., Prosopistomatidae	> 0.6 m/s	SIC biotope	Good
2	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
3	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
4	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
5	Pyralidae	0.3 - 0.6 m/s	Marginal vegetation	Good
6	Coenagrionidae, Atyidae	0.3 – 0.6 m/s	Marginal vegetation	Low
7	Paleomonidae	0.3 - 0.6 m/s	SIC biotope	Low
8	Gomphidae, Tabanidae, Athericidae	-	Course sediment	-

EcoSpecs	TPCs	Sc 21 expected changes in EcoSpecs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 200; ASPT value: > 7.0.	SASS5 scores < 210 and ASPT > 7.0.	To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 190; ASPT value: > 6.5.
To ensure that the MIRAI score remains within the range of a B Category (82.01 – 87.4), using the same reference data used in this study.	A MIRAI score of 85% or less.	To ensure that the MIRAI score remains within the range of a B/C Category (>77.4 and <82.01), using the same reference data used in this study.
Presence of at least five of the following seven high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Tricorythidae, Pyralidae, Athericidae and Heptagenidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Tricorythidae, Pyralidae, Athericidae and Heptagenidae.	Presence of at least four of the following seven high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Tricorythidae, Pyralidae, Athericidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following seven key taxa: Perlidae, Hydropsychidae 2 spp., Prosopistomatidae, Heptagenidae, Leptophlebidae, Elmidae and Pyralidae.	Less than six of the seven key taxa listed.	Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following five key taxa: Hydropsychidae 2 spp., Prosopistomatidae, Heptagenidae, Leptophlebidae and Elmidae.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp. And Prosopistomatidae.	Any one of these taxa missing for two consecutive surveys.	Maintain suitable flow velocity(maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Hydropsychidae 2 spp. and Prosopistomatidae.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae, Libellulidae and Pyralidae.	Any one of these taxa missing for two consecutive surveys.	Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae, Libellulidae and Pyralidae.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Pyralidae, Coenagrionidae and Atyidae.	Any one of these taxa missing for two consecutive surveys.	Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae and Atyidae.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae and Athericidae.	Any one of these taxa missing for two consecutive surveys.	Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae and Athericidae.
Maintain suitable conditions in the SIC habitat and no migration barriers for this migrational species, Paleomonidae.	This taxa missing during surveys.	This taxa missing during surveys.

Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.	Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.

Table 12.8 Riparian vegetation EcoSpec and TPCs (PES and TEC: D)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 80%.	An absence of indigenous riparian woody species OR an increase in cover above 80%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Reed cover (% aerial)	Maintain reed cover above 10%.	An absence of reeds.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 10% or lower.	An increase in perennial alien plant species cover >15%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 5% or lower.	An increase in terrestrial woody species cover above 10%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 70%.	An absence of indigenous riparian woody species OR an increase in cover above 70%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 30%.	A decrease in non-woody cover (% aerial) below 25%.
Reed cover (% aerial)	Maintain reed cover above 10%.	An absence of reeds.
Upper zone		
Alien invasion (perennial alien species)	Reduce cover (% aerial) of perennial alien plant species to 30% or lower.	An increase in perennial alien plant species cover >35%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 20% or lower.	An increase in terrestrial woody species cover above 30%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 10% and below 80%.	An decrease in indigenous riparian woody species cover below 10% or an increase above 90%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 30%.	A decrease in non-woody cover (% aerial) below 25%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 50% for the riparian zone.	A decrease in PES score below 45% for the riparian zone.

12.3 RQOs FOR RU MK12 (U10J-04713), U10K-04842, 04899, 04946) (MODERATE PRIORITY - 2)

SQ	River	PES	REC (target)	Requirement
U10J-04713	Mkobeni	C	B	Riparian buffer zone in forestry and agricultural areas. Also alien removal. As none of the scenarios are relevant to this SQ, the improvement is valid irrespective of the recommended scenario.

12.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U10J-04713										
B	13.9	11.7	2.86	20.6	4.34	31.5	0.012	0.022	0.024	0.102
U10K-04842										
B	40.2	29.0	6.19	15.4	10.48	26.1	0.012	0.045	0.086	0.286
U10K-04899										
C/D	19.1	11.8	2.05	10.7	3.61	18.9	0.0	0.0	0.014	0.08
U10K-04946										
B/C	6.7	4.5	0.99	14.8	1.65	24.8	0.0	0.0	0.012	0.034

12.3.2 Water quality RQOs (U10K-04842, 04899, 04946 only)

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Agriculture; settlements; urban impacts (incl. Ixopo WWTW; Clover Dairy depot and other dairy waste ponds; hospital in U10K-04899).
Water quality issue: Nutrients, salts, faecal coliforms/*E. coli*, toxics.

Table 12.9 RU MK12: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95th percentile of the data must be less than or equal to 55 mS/m (Domestic use: driver).		
Ensure that toxics are within Ideal limits or A categories.	95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	Medium	High
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

12.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 12.10 RU MK12: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate at most or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate at the most, or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	One (1) listed riparian species should remain viable within the RU (*P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, BGUR, BNAT, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, TSPA Migration: AMOS Water column/SD: CGAR, OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) DATA (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).

Indicators	Narrative RQO	Numerical RQO
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

13 uMNGENI (U2): IUA U2-1 RESOURCE QUALITY OBJECTIVES

The IUA overview and description are provided below.

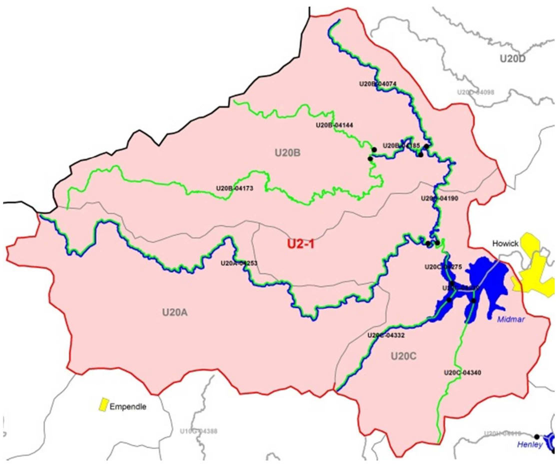
The IUA is mostly in a C and B/C PES. Forestry is not restricted to the higher altitudes, patches occur throughout the area. In between these patches are well-organised commercial farms comprising of irrigation and dry land agriculture. Flow impacts stem from damming and water transfers (Mpofana River), while water quality impacts are associated with irrigation return flows, urban runoff and effluent from different sources (towns, farming, trout dams). A large section of the main stem is also inundated by the Midmar Dam.

The IUA is regulated by the Midmar Dam located at the lower end of the IUA and there are also a number of small farm and instream dams. The interbasin MMTS transfers water from the Mooi River System (Mearns Weir and Spring Grove Dam) to the Midmar Dam catchment (Mpofana River, a tributary of the Lions River that flows into Midmar Dam). This has resulted in increased flows in the effected rivers. Water is abstracted from Midmar Dam to supply uMnsunduze (Pietermaritzburg) and surrounding areas. The proposed commissioning of the Western Aqueduct may affect the yield of Midmar Dam whilst natural growth of demands happens.

The main land use activities in the IUA include forestry, cultivation and irrigation. The Mpophomeni semi-urban is located in the IUA, almost adjacent to the Midmar Dam.

IUA U2-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U2-1 - uMNGENI: UPSTREAM OF MIDMAR DAM



PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
MRU uMnA	U20A-04253 Mg_R_EWR1	uMngeni	C/D	C/D	C/D	3
	U20C-04275	uMngeni	Linked to Mg_R_EWR1			
RU uMn1	U20B-04074	Ndiza	B/C	B	B	2
	U20B-04144 us IBT	Mpofana	C	C	C	
	U20B-04173	Lions	C	B	B	
RU uMn2	U20B-04144 ds IBT	Mpofana	C	C	C	2
	U20B-04185	Lions	B/C	B	B/C	
	U20C-04190	Lions	B/C	B	B	
RU uMn3	U20C-04332	Gqishi	B/C	B	B	3WQ
	U20C-04340	Nguklu	C	C	C	

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

13.1 RQOs FOR MRU uMnA WITH Mg_R_EWR1 (U20A-04253) (HIGH PRIORITY - 3) (INCLUDING U20C-04275)

The TECs are provided for this EWR site below. Note that this reach will not be impacted on by scenarios.

Component	PES and REC
	TEC
Physico chemical	B
Fish	D (C)
Invertebrates	C
Riparian vegetation	C/D
EcoStatus	C/D

13.1.1 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
Mg_R_EWR1	REC: C/D	79.22	60.46	8.013	10.1	17.221	21.7	0.016	0.098	0.179	0.327

13.1.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). Source data includes a GE layer of land use information from Umgeni Water.
Model: PAI model (DWAF, 2008b).
Users: Agriculture; chicken farms; dairy; piggeries; hiking, camping, climbing and fishing in upper reaches.
Water quality issue: Nutrients, faecal coliforms/*E. coli*. [Note that the median *E. coli* values at RMG001 (2008 - 2013; n =60) are 160 counts/100 ml. See expected impacts in DWAF (1996c).]
Narrative and numerical: Details for MRU uMnA are provided in the tables below. Data used for water quality assessments should be collected from UW monitoring site RMG001.

Table 13.1 MRU uMnA: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	Medium	High
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

Table 13.2 MRU uMnA: Water quality EcoSpecs and TPCs (PES and TEC: A/B)

River: uMngeni		PES: A/B Category
Monitoring site: RMG001		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95^{th} percentile of the data must be ≤ 16	The 95^{th} percentile of the data must be 13 – 16

River: uMngeni		PES: A/B Category
Monitoring site: RMG001		
Water quality metrics	**EcoSpecs**	**TPC**
	mg/L.	mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th percentile of the data must be 6.5 – 8.0, and the 95th percentile 8.0 – 8.8.	The 5th percentile of the data must be < 6.3 and > 7.8, and the 95th percentile must be < 8.2 and > 8.6.
Temperature(b)	Small deviation from the natural temperature range.	Initiate baseline monitoring for this variable.
Dissolved oxygen(b)	The 5th percentile of the data must be ≥ 7.0 mg/L.	The 5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.
Turbidity(b)	Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 0.7 mg/L.	The 50th percentile of the data must be 0.55 – 0.7 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.015 mg/L.	The 50th percentile of the data must be 0.012 – 0.015 mg/L.
Response variables		
Chl-*a* phytoplankton(b)	The 50th percentile of the data must be <10 µg/L.	The 50th percentile of the data must be 8 – 10 µg/L.
Chl-*a* periphyton(b)	The 50th percentile of the data must be ≤ 12 mg/m^2.	The 50th percentile of the data must be 10 – 12 mg/m^2.
Toxics		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.1 mg/L.	The 95th percentile of the data must be 0.08 – 0.1 mg/L.
Other toxics(b)	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.

(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

13.1.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows:

Table 13.3 MRU uMnA: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category D and it should be aimed to improve this EC (to a C) in future if the overall TEC is to be reached. A primary impact on the fish at this site is the presence of various predatory alien fish species, which should be addressed if an improvement is to be attained. The present indigenous fish species richness of the EWR site is estimated to be only four species (one species confirmed during EWR study). The primary indicator fish species for this reach (especially in terms of flow-modification) is the small rheophilic Natal mountain catfish (ANAT) and large semi-rheophilic Scaly (BNAT). These species are good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the eel (AMOS) (longitudinal continuity, undercut banks) and Chubbyhead barb (BANO) (vegetated and slow habitats).
Invertebrates	The macro-invertebrate community should be representative of a small foothill stream assemblage with perennial flows. The habitats in the river are dominated by good SIC with scanty marginal vegetation overhanging the stream banks. There are some deeper pools with slower flows and rocky bottoms. Although the area contains trout and bass fishing, instream dams, chicken houses, irrigation in lower reaches, alien invasive plants (brambles) and off-channel dams for irrigation, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The overall PES at Mg_R_EWR 1 (as at August 2013) for riparian vegetation was a Category C/D (60.8%). This is also the REC and TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone on a whole, as well as within each sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c).

The EcoSpecs and TPCs are provided in the following tables.

Table 13.4 Fish EcoSpec and TPCs (PES and TEC: D (C))

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
Ecological status	PES	Present ecological status of fish is in a D (44.9%).	Decrease of PES into a lower EC than PES (<D).	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	All of the expected 4 indigenous fish species estimated to be present in the reach under PES.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	ANAT (BNAT)	ANAT estimated to occur at a FROC* of 2 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	ANAT absent during two consecutive surveys OR present at FROC of <2 (BNAT absent during any survey OR present at FROC of <2).	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
FD habitats		ANAT estimated to occur at a FROC* of 2 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).
FS habitats		ANAT estimated to occur at a FROC* of 2 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate		ANAT estimated to occur at a FROC* of 2 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.
Water quality intolerance		ANAT estimated to occur at a FROC* of 2 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.		Decreased water quality (especially flow related water quality variables such as oxygen).
Overhanging vegetation	BANO	BANO estimated to occur at a FROC* of 1 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BANO absent during two consecutive surveys OR present at FROC of <1.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)
Instream vegetation		BANO estimated to occur at a FROC* of 1 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.		Significant change in instream vegetation habitats (flow modification, use of herbicides, nutrient enrichment, alien invasive plants)
SD habitats		BANO estimated to occur at a FROC* of 1 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).
SS habitats		BANO estimated to occur at a FROC* of 1 under PES have a high requirement for SS habitats and is the most applicable indicator species for this		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
		velocity-depth category.		
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 1 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive surveys OR present at FROC of <1.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).
Water column	BNAT	BNAT estimated to occur at a FROC* of 2 under PES have a high requirement for water column as cover and is the most applicable indicator species for this chabitat feature.	BNAT absent during any survey OR present at FROC of <2.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).
Alien fish species	Presence of any alien/ introduced spp.	MDOL, MSAL, STRU known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A
Migratory success[##]	AMOS BNAT	It is estimated that the catadromous AMOS, may still be present, and potamodromous species (BNAT) also occurs.	Loss or decreased FROC* of catadromous (such as AMOS) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 13.5 Macro-invertebrate EcoSpec and TPCs (PES and TEC: C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Hydropsychidae 2 spp.	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae	> 0.6 m/s	SIC biotope	Moderate
3	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
4	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
5	Leptophlebidae	0.3 - 0.6 m/s	SIC biotope	Moderate
6	Coenagrionidae	0.3 - 0.6 m/s	Marginal vegetation	Low
7	Paleomonidae	0.3 - 0.6 m/s	SIC biotope	Low
8	Gomphidae, Tabanidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 100; ASPT value: > 5.0.	SASS5 scores < 105 and ASPT < 5.0.
To ensure that the MIRAI score remains within the range of a C Category (62.01 – 77.4), using the same reference data used in this study.	A MIRAI score of 66% or less.
Presence of both the following two high-scoring taxa: Hydropsychidae 2 spp., and Tricorythidae.	The following taxa present only as individuals, or any taxa absent altogether: Hydropsychidae 2 spp., and Tricorythidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following four key taxa: Hydropsychidae 2 spp., Tricorythidae, Heptagenidae and Leptophlebidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Hydropsychidae 2 spp. and Tricorythidae.	Any one of these taxa missing during surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Libellulidae and Leptophlebidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae.	This taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae and Tabanidae.	Any one of these taxa missing during surveys.
Maintain suitable conditions in the SIC habitat and no migration barriers for this migrational species: Paleomonidae.	This taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 13.6 Riparian vegetation EcoSpec and TPCs (PES and TEC: C/D)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 40%.	An absence of indigenous riparian woody species OR an increase in cover above 40%.
Non-woody indigenous cover	Maintain non-woody cover (% aerial) above	A decrease in non-woody cover (% aerial)

Assessed Metric	EcoSpec	TPC
(grasses, sedges and dicotyledonous forbs) (% aerial)	40%.	below 30%.
Reed cover (% aerial)	Maintain an absence of reeds.	A presence of reeds.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 5% or lower.	An increase in perennial alien plant species cover >10%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 5% or lower.	An increase in terrestrial woody species cover above 10%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 40%.	An absence of indigenous riparian woody species OR an increase in cover above 40%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Reed cover (% aerial)	Maintain an absence of reeds.	A presence of reeds.
Upper zone		
Alien invasion (perennial alien species)	Reduce cover (% aerial) of perennial alien plant species to 30% or lower.	An increase in perennial alien plant species cover >40%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species below 20%.	An increase in terrestrial woody species cover above 30%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 40%.	An decrease in indigenous riparian woody species cover below 5% or an increase above 40%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 50%.	A decrease in non-woody cover (% aerial) below 40%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 60% for the riparian zone.	A decrease in PES score below 58% for the riparian zone.
Dominant vegetation type	The dominant vegetation type within the riparian zone shall remain non-woody and mostly grass.	Maintain non-woody indigenous cover within the riparian zone at 20% or more.

13.2 RQOs FOR RU uMn1 (U20B-04074, 04144 US OF IBT, 04173) (MODERATE PRIORITY - 2)

SQ	River	PES	REC	Requirement	TEC
U20B-04074	Ndiza	B/C	B	Reinstate riparian zone in forestry.	B
U20B-04173	Lions	C	B	Reinstate riparian zone in forestry and wetland buffers. Address irrigation return flows (water quality) and town runoff.	B

13.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20B-04074										
B	12.3	10.9	2.73	22.2	3.89	31.7	0.011	0.035	0.016	0.068
U20B-04173										
B	39.8	34.3	6.64	16.6	10.11	25.4	0.029	0.142	0.036	0.235

13.2.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Agriculture; dairy and chicken farms; textile industry; micro brewery; WWTW and waste ponding systems; fishing and hiking in upper reaches.
Water quality issue: Nutrients, salts, faecal coliforms/*E. coli*.

Table 13.7 RU uMn1: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95th percentile of the data must be less than or equal to 55 mS/m (Domestic use: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

13.2.3 Habitat and Biota RQOs (EcoSpecs)

Table 13.8 RU uMn1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small at most or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate at the most, or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*G. natalense; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to	Maintain indigenous species richness (AMOS,

Indicators	Narrative RQO	Numerical RQO
	be nine species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	ANAT, BANO, BGUR, BNAT, BVIV, CGAR, OMOS, and TREN) of estimated nine fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, Migration: AMOS Water column/SD: CGAR, OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (dams, water quality, flow reduction), fewer key taxa are expected (13). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

13.3 RQOs FOR RU uMn2 (U20B-04144 DS OF IBT, 04185, U20C-04190) (MODERATE PRIORITY - 2)

SQ	River	PES	REC	Requirement	TEC
U20B-04185	Lions	B/C	B	IBT a given - constant flows, no seasonality	B/C
U20C-04190	Lions	B/C	B	IBT a given - constant flows, no seasonality, but reinstating wetland buffers (off channel) and riparian river zones	B

13.3.1 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.

Model: N/A.

Users: Dairy and chicken farms; commercial agriculture; fishing and hiking in upper reaches (Sappi Forest plantations near U20C-04190 only). Lions River wetland is in the process of being rehabilitated as part of the UEIP programme. Ripearian areas delineated as per the DWS guideline for delineation in forestry. Weed control in ripearian areas done as part of the plantations integrated weed plan (S van Zyl, Sappi, *pers. comm.*, March 2015).
Water quality issue: Nutrients, faecal coliforms/*E. coli*.

Table 13.9 RU uMn2: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels are within Acceptable limits.</td><td colspan="3">50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

13.3.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 13.10 RU uMn2: Narrative and numerical habitat and biota RQOs

<table>
<tr><th>Indicators</th><th>Narrative RQO</th><th>Numerical RQO</th></tr>
<tr><td colspan="3">RIPARIAN VEGETATION</td></tr>
<tr><td>Presence of alien plant species in the riparian zone</td><td>The extent of perennial alien plant species within the riparian zone should remain small or decrease.</td><td>Insufficient quantitative data exist to develop numerical RQOs.</td></tr>
<tr><td>Riparian zone continuity</td><td>Modification of riparian zone continuity should remain small, or improve</td><td>N/A</td></tr>
<tr><td>Riparian zone fragmentation</td><td>Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.</td><td>N/A</td></tr>
<tr><td>Extent of forestry within the riparian zone</td><td>The extent of forestry within the riparian zone shall remain moderate at most or decrease.</td><td>N/A</td></tr>
<tr><td>Extent of agriculture within the riparian zone</td><td>The extent of agriculture within the riparian zone shall remain small at the most, or decrease.</td><td>N/A</td></tr>
<tr><td>Sensitive riparian species</td><td>Viable populations of sensitive riparian plant species should remain within the RU.</td><td>Two (2) listed riparian species should remain viable within the RU (G. natalense; K. latifolia).</td></tr>
<tr><td colspan="3">FISH</td></tr>
<tr><td>Species richness</td><td rowspan="3">Indigenous fish species richness estimated to be nine species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.</td><td>Maintain indigenous species richness (AMOS, ANAT, BANO, BGUR, BNAT, BVIV, CGAR, OMOS, and TREN) of estimated nine fish species in this RU. Maintain current habitat diversity.</td></tr>
<tr><td>Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)</td><td>Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).</td></tr>
<tr><td>Secondary indicator species:</td><td>Ensure the habitat requirements of the secondary indicator species are maintained</td></tr>
</table>

Indicators	Narrative RQO	Numerical RQO
Vegetation/SS: BANO, Migration: AMOS Water column/SD: CGAR, OMOS, TREN		and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (dams, water quality, flow reduction), fewer key taxa are expected (13). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

13.4 RQOs FOR RU uMn3 (U20C-04332, 04340) (HIGH WATER QUALITY PRIORITY - 3WQ)

SQ	River	PES	REC	Requirement	TEC
U20C-04332	Gqishi	B/C	B	Riparian zone buffer to be improved.	B

13.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20C-04332										
B*	15.9	12.9	3.48	21.9	4.91	30.9	0.004	0.023	0.019	0.113
U20C-04340										
C	7.0	5.9	1.35	19.3	1.94	27.7	0.004	0.012	0..011	0.039

* Flows generated for a B/C rule.

13.4.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.

Model: N/A.
Users: Irrigation; quarry; landfill (solid wastes); dysfunctional sewers.
Water quality issue: Turbidity, nutrients, toxics, faecal coliforms/*E. coli*.

Narrative and numerical details are provided in Table 13.10.

Table 13.11 RU uMn3: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels are within Acceptable limits.</td><td colspan="3">50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that turbidity or clarity levels stay within Acceptable limits.</td><td colspan="3">A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that toxics are within Ideal limits or A categories.</td><td colspan="3">95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

13.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 13.12 RU uMn3: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced from large to moderate and maintained as moderate	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent)	Maintain indigenous species richness (AMOS, ANAT, BANO, BNAT, BVIV, CGAR, OMOS, and TREN) of estimated eight fish species in this RU. Maintain current habitat diversity.

Indicators	Narrative RQO	Numerical RQO
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)	indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, Migration: AMOS Water column/SD: CGAR, OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 16 key taxa to be present. However, due to present day influences (Nutrients, toxicity, turbidity, dams), fewer key taxa are expected (10). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for both this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

14 uMNGENI (U2): IUA U2-2 RESOURCE QUALITY OBJECTIVES

The IUA overview and description are provided below.

The IUA SQs are in a C and B/C PES, except the Kusane River which is a D due to a combination of forestry, dams and irrigation impacts. The main stem of the uMngeni River becomes very regulated as 0.9 m^3/s is released constantly from Midmar Dam when the dam is not spilling. All the tributaries between the two dams are also heavily impacted due to forestry, irrigation and dry land agriculture (formal), weirs and dams, and removal of riparian vegetation.

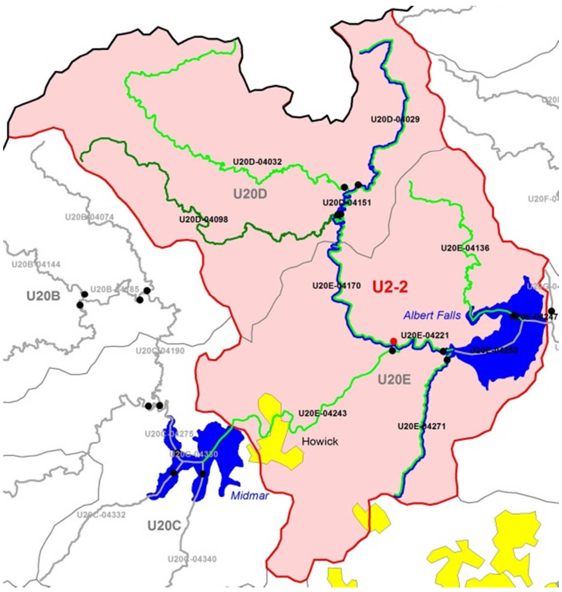
The IUA is regulated by the upstream Midmar Dam, Albert Falls Dam located at the lower end of the IUA and also a number of small farm and instream dams. The IUA is regarded as highly regulated. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. There is no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact on the water resources.

Howick town and industrial area are located in the IUA, just downstream of Midmar Dam. Return flows from the Howick WWTW enter the uMngeni River affecting both the flow and the water quality.

The main land use activities in the IUA include extensive forestry, cultivation (sugar cane and other cash crops) and irrigation.

IUA U2-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U2-2: uMNGENI: MIDMAR DAM TO ALBERT FALLS DAM



PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
RU uMn4	U20D-04029	Yarrow	B/C	B	B	2
	U20D-04098	Kusane	D	D	D	
MRU KarA	U20D-04032	Karkloof	C	C	C	2
MRU KarB	U20D-04151	Karkloof	B/C	B	B	2
MRU KarC	U20E-04170 Mg_R_EWR 3	Karkloof	B	B	B	3
MRU uMnB	U20E-04221	uMngeni	B/C	B/C	B/C	3
	U20E-04243 Mg_I_EWR 2	uMngeni	C	C	C	
RU uMn5	U20E-04136	Nculwane	C	C	C	2
	U20E-04271	Doring Spruit	B/C	B/C	B/C	
RU uMn6	U20F-04011	Sterkspruit	C/D	C/D	C/D	2
	U20F-04095 in IUA U2-3	Mpolweni	C/D	C/D	C/D	

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

14.1 RQOs FOR RU uMn4 (U20D-04029, 04098) (MODERATE PRIORITY - 2)

SQ	River	PES	REC	Requirement	TEC
U20D-04029	Yarrow	B/C	B	Agricultural area - wetland buffers.	B

14.1.1 Flow RQOs

Source: Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20D-04029										
B*	11.6	7.8	2.02	17.5	3.18	27.5	0.006	0.021	0.018	0.063
U20D-04098										
D	16.9	12.5	2.28	13.5	3.48	20.7	0.003	0.012	0.011	0.065

* Flows generated for a B/C rule.

14.1.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in the table below.

Table 14.1 RU uMn4: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should be reduced from large to moderate and remain moderate, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced from large to moderate and maintained as moderate	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate at most, or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be seven species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column	Maintain indigenous species richness (AMOS, ANAT, BANO, BGUR, BNAT, BVIV, and TREN) of estimated seven fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate

Indicators	Narrative RQO	Numerical RQO
	(depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO Migration: AMOS Water column/SD: TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
There is a significant difference between the two sites in RU uMn4, U20D-04029 is a Class B and U20D-04098 is a Category D. For setting the RQO for this reach, the higher scoring site (U20D-04029) will be used. The PES (11) DATA (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (dams), fewer key taxa are expected (16). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

14.2 RQOs FOR MRU KarA (U20D-04032) (MODERATE PRIORITY - 2)

14.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20D-04032										
C	29.72	26.54	n/a	n/a	13.10	44	0.056	0.009	0.010	0.001

*Extrapolated from Mn_R_EWR3 (Karkloof River, B EcoStatus).

14.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in the table below.

Table 14.2 RU MRU KarA: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should be reduced from large to moderate and remain moderate, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced from large to moderate and maintained as moderate	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate at most, or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be seven species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, BGUR, BNAT, BVIV, and TREN) of estimated seven fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, Migration: AMOS Water column/SD: TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (flows, turbidity), fewer key taxa are expected (14). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this

Indicators	Narrative RQO	Numerical RQO
		species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment.

14.3 RQOs FOR MRU KarB (U20D-04151) (MODERATE PRIORITY - 2)

SQ	River	PES	REC	Requirement	TEC
U20D-04151	Karkloof	B/C	B	Reinstate riparian buffer zone and wetland buffers.	B

14.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20D-04151										
B	42.22	35.19	n/a	n/a	18.61	44	0.079	0.012	0.015	0.002

*Extrapolated from Mn_R_EWR3 (Karkloof River, B EcoStatus).

14.3.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 14.3 RU MRU KarB: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit.	Maintain indigenous species richness (AMAR, AMOS, ANAT, BANO, BGUR, BNAT, BVIV,

Indicators	Narrative RQO	Numerical RQO
	Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	and TREN) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO Migration: AMOS/AMAR Water column/SD: TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

14.4 RQOs FOR M KarC WITH Mg_R_EWR3 (U20E-04170) (HIGH PRIORITY - 3)

The TECs are provided for this EWR site below. Note that this reach will not be impacted on by scenarios.

Component	PES and REC
	TEC
Physico chemical	B
Fish	B/C
Invertebrates	B
Riparian vegetation	B
EcoStatus	B

14.4.1 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).

Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
Mg_R_EWR3	REC: B	70.11	56.5	19.111	27.3	30.489	43.5	0.032	0.245	0.203	0.758

14.4.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). A GE layer of land use from Umgeni Water was also used to provide information.
Model: PAI model (DWAF, 2008b).
Users: Irrigation (note Sappi Forest plantations near U20E-04170 only). All riparian zones delineated according to the DWS delineation guidelines. Weed control in riparian areas done as part of the integrated weed plan (S van Zyl, Sappi, *pers. comm*., March 2015).
Water quality issue: Nutrients.
Narrative and numerical: Details for MRU KarC are provided below. Data used for water quality assessments should be collected from U2H006Q01.

Table 14.4 MRU KarC: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements

Table 14.5 Mg_R_EWR3: Water quality EcoSpecs and TPCs (PES and TEC: B)

River: uMngeni		PES: B Category
Monitoring site: U2H006Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th and 95th percentiles of the data must be 6.5 – 8.0	The 5th and 95th percentile of the data must be < 6.7 and > 7.8
Temperature[(b)]	Small deviation from the natural temperature range.	Initiate baseline monitoring for this variable.

River: uMngeni		PES: B Category
Monitoring site: U2H006Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Dissolved oxygen(b)	The 5th percentile of the data must be ≥ 7.0 mg/L.	The 5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.
Turbidity(b)	Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 0.7 mg/L.	The 50th percentile of the data must be 0.55 – 0.7 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.015 mg/L.	The 50th percentile of the data must be 0.012 – 0.015 mg/L.
Response variables		
Chl-*a* phytoplankton(b)	The 50th percentile of the data must be <10 µg/L.	The 50th percentile of the data must be 8 – 10 µg/L.
Chl-*a* periphyton(b)	The 50th percentile of the data must be ≤ 21 mg/m^2.	The 50th percentile of the data must be 17 – 21 mg/m^2.
Toxics		
Toxics(b)	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.

(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

14.4.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 14.6 MRU KarC: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category B/C and it should be aimed to maintain this EC in future if the overall TEC is to be reached. The present indigenous fish species richness of the EWR site is estimated to be eleven species (five species confirmed during EWR study). The primary indicator fish species for this reach (especially in terms of flow-modification) is the small rheophilic Natal mountain catfish (ANAT) and large semi-rheophilic Scaly (BNAT). These species are good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the eel (AMOS) (longitudinal continuity, undercut banks), Bowstripe barb (BVIV) (vegetated and slow habitats) and tilapias (OMOS and TREN) (Instream vegetation, SD, water column).
Invertebrates	The macro-invertebrate community should be representative of a medium-sized foot-hill stream assemblage with perennial flows. The habitats in the river are dominated by good SIC habitat on a steep slope with good marginal vegetation overhanging the stream banks and backwaters. There are some deeper water with slower flows and rocky bottoms. Although the area contains irrigation, forestry, alien invasive plants in the riparian zone and abandoned lands, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category B, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The overall PES at Mg_R_EWR 3 (as at August 2013) for riparian vegetation was a Category B (80.3%). This is also the REC and TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone on a whole, as well as within each sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c)

The EcoSpecs and TPCs are provided in the following tables.

Table 14.7 Fish EcoSpec and TPCs (PES and TEC: B/C)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
Ecological status	PES	Present ecological status of fish is in a B/C (79.4%).	Decrease of PES into a lower EC than PES (<B/C).	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	All eleven expected indigenous fish species estimated to still be present in the reach under PES.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	ANAT (BNAT)	ANAT estimated to occur at a FROC* of 5 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	ANAT absent during any survey OR present at FROC of <5.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
FD habitats		ANAT estimated to occur at a FROC* of 5 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)
FS habitats		ANAT estimated to occur at a FROC* of 5 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate		ANAT estimated to occur at a FROC* of 5 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.
Water quality intolerance		ANAT estimated to occur at a FROC* of 5 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.		Decreased water quality (especially flow related water quality variables such as oxygen).
Overhanging vegetation	BVIV	BVIV estimated to occur at a FROC* of 2 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BVIV absent during two consecutive surveys OR present at FROC of <2.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)
SS habitats		BVIV estimated to occur at a FROC* of 2 under PES have a high requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).
Instream vegetation	TREN	TREN estimated to occur at a FROC* of 1 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.	TREN absent during two consecutive surveys OR present at FROC of <1.	Significant change in instream vegetation habitats (flow modification, use of herbicides, nutrient enrichment, alien plant invasion)
SD habitats		TREN estimated to occur at a FROC* of 1 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 1 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during any survey OR present at FROC of <1.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).
Water column	OMOS	OMOS estimated to occur at a FROC* of 3 under PES have a high requirement for water column as cover and is the most applicable indicator species for this habitat feature.	OMOS absent during two consecutive surveys OR present at FROC of <3.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
Alien fish species	Presence of any alien/ introduced spp.	None known to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A
Migratory success[##]	AMAR, AMOS, BNAT	It is estimated that the catadromous AMAR, AMOS may still be present, and various potamodromous species (including BNAT) also occurs.	Loss or decreased FROC* of catadromous (such as AMOS) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 14.8 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp., Psephenidae	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Coenagrionidae, Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
6	Gomphidae, Athericidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 160; ASPT value: > 7.0.	SASS5 score: < 160; ASPT value: < 7.0.
To ensure that the MIRAI score remains within the range of a B Category (82.01 – 87.4), using the same reference data used in this study.	A MIRAI score of 83% or less.
Presence of at least three of the following five high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Psephenidae, Heptagenidae and Athericidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Psephenidae, Heptagenidae, and Athericidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following seven key taxa: Perlidae, Hydropsychidae 2 spp., Psephenida, Tricorythidae, Heptagenidae, Leptophlebidae and Elmidae.	Less than six of the seven key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp., Psephenidae and Tricorythidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae an Elmidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae and Atyidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae and Athericidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 14.9 Riparian vegetation EcoSpec and TPCs (PES and TEC: B)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 50%.	An absence of indigenous riparian woody species OR an increase in cover above 60%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (%	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.

Assessed Metric	EcoSpec	TPC
aerial)		
Reed cover (% aerial)	Maintain an absence of reeds.	A presence of reeds.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 10% or lower.	An increase in perennial alien plant species cover >10%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 10% or lower.	An increase in terrestrial woody species cover above 15%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 60%.	An absence of indigenous riparian woody species OR an increase in cover above 70%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Reed cover (% aerial)	Maintain an absence of reeds.	A presence of reeds.
Upper zone		
Alien invasion (perennial alien species)	Reduce cover (% aerial) of perennial alien plant species to 10% or lower.	An increase in perennial alien plant species cover >10%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species below 25%.	An increase in terrestrial woody species cover above 30%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 70%.	An decrease in indigenous riparian woody species cover below 5% or an increase above 80%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 25%.	A decrease in non-woody cover (% aerial) below 20%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 82% for the riparian zone.	A decrease in PES score below 80% for the riparian zone.
Dominant vegetation type	The dominant vegetation type within the riparian zone shall remain an approximately equal mixture of woody and non-woody vegetation.	Maintain non-woody indigenous cover within the riparian zone at 30% or more; Maintain woody indigenous cover within the riparian zone at 20% or more.

14.5 RQOs FOR MRU uMnB WITH Mg_I_EWR2 (U20E-04243) (HIGH PRIORITY - 3) (INCLUDING U20E-04221)

The TECs are provided for this EWR site below. Note that this reach could be impacted on by scenarios. None of the scenarios however impact on the PES and REC and some may even improve the situation.

Component	PES and REC
	Short term TEC
Physico chemical	C/D
Fish	*D
Invertebrates	C
Riparian vegetation	C
EcoStatus	C

* This currently falls in an E as no fish was found during surveys. It is possible due to a single event and fish may move back into the reach. It could also be water quality issues.

14.5.1 Flow RQOs

Source: DWA (2014a), DWS (2014a,b).

Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
Mg_I_EWR2	REC: C	228.19	105.4	33.5	14.7	45.61	20.0	0.46	0.81	0.45	0.99

14.5.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). A GE layer of land use from UW was also used to provide information.
Model: PAI model (DWAF, 2008b).
Users: Irrigation; livestock; urban impacts (Howick in U20E-04243) including Howick and Shia Falls WWTW.
Water quality issue: Nutrients, toxics, faecal coliforms/*E. coli*.
Narrative and numerical: Details for MRU uMnB are provided below. Data used for water quality assessments should be collected from UW site RMG008.

Table 14.10 MRU uMnB: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels (phosphate) are within Tolerable limits.</td><td colspan="3">50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that nutrient levels (TIN) are within Acceptable limits.</td><td colspan="3">50th percentile of the data must be less than 0.85 mg/L TIN-N (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that toxics (ammonia, aluminium, lead) are within Tolerable categories.*
Ensure that other toxics monitored are within Ideal limits.</td><td colspan="3">95th percentile of the data must be within the D category for ammonia, aluminium and lead.
Other toxics monitored must be within Ideal limits or A categories (DWAF, 2008b) or the TWQR for toxics in DWAF (1996c).</td></tr>
<tr><td>Ensure water quality state maintains biotic requirements as specified by RQOs for biota.</td><td colspan="3">See specified biota requirements.</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use**.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

*** Note that ammonia (NH_3-N), aluminium and mercury already exceed Acceptable levels for aquatic ecosystems, although background levels (natural state) are not available. See Fish requirements for improvement to a D Category.**
** Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

Table 14.11 Mg_I_EWR2: Water quality EcoSpecs and TPCs (C/D Category PES and TEC)

<table>
<tr><td colspan="2">River: uMngeni</td><td rowspan="2">PES: C/D Category</td></tr>
<tr><td colspan="2">Monitoring site: RMG008</td></tr>
<tr><th>Water quality metrics</th><th>EcoSpecs</th><th>TPC</th></tr>
<tr><td colspan="3">Inorganic salts(a)</td></tr>
<tr><td>$MgSO_4$</td><td>The 95th percentile of the data must be ≤ 16 mg/L.</td><td>The 95th percentile of the data must be 13 – 16 mg/L.</td></tr>
<tr><td>Na_2SO_4</td><td>The 95th percentile of the data must be ≤ 20 mg/L.</td><td>The 95th percentile of the data must be 16 – 20 mg/L.</td></tr>
<tr><td>$MgCl_2$</td><td>The 95th percentile of the data must be ≤ 15 mg/L.</td><td>The 95th percentile of the data must be 12 – 15 mg/L.</td></tr>
<tr><td>$CaCl_2$</td><td>The 95th percentile of the data must be ≤ 21 mg/L.</td><td>The 95th percentile of the data must be 17 – 21 mg/L.</td></tr>
</table>

River: uMngeni		**PES: C/D Category**
Monitoring site: RMG008		
Water quality metrics	**EcoSpecs**	**TPC**
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th percentile of the data must be 6.5 – 8.0, and the 95th percentile 8.0 – 8.8	The 5th percentile of the data must be < 6.3 and > 7.8, and the 95th percentile must be < 8.2 and > 8.6
Temperature(b)	Small deviation from the natural temperature range.	Initiate baseline monitoring for this variable.
Dissolved oxygen(b)	The 5th percentile of the data must be ≥ 7.0 mg/L.	The 5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.
Turbidity(b)	Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 0.85 mg/L.	The 50th percentile of the data must be 0.68 – 0.85 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.075 mg/L.	The 50th percentile of the data must be 0.06 – 0.075 mg/L.
Response variables		
Chl-*a* phytoplankton(b)	The 50th percentile of the data must be <20 µg/L.	The 50th percentile of the data must be 16 – 20 µg/L.
Chl-*a* periphyton(b)	The 50th percentile of the data must be ≤ 52.5 mg/m^2.	The 50th percentile of the data must be 42 – 52.5 mg/m^2.
Toxics		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.1 mg/L.	The 95th percentile of the data must be 0.08 – 0.1 mg/L.
Aluminium	The 95th percentile of the data must be ≤ 0.02 mg/L (Chronic Effects Value (CEV) value for pH > 6.5).	The 95th percentile of the data must be 0.016 – 0.020 mg/L.
Mercury	The 95th percentile of the data must be ≤ 0.000 525 mg/L.	The 95th percentile of the data must be 0.000 42 – 0.000 525 mg/L.
Other toxics(b)	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

14.5.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 14.12 MRU uMnB: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category E and it should be aimed to improve the fish EC to a D in future if the overall TEC is to be attained. The present indigenous fish species richness of the EWR site is estimated to be eight species (no fish species sampled during EWR study). The primary indicator fish species for this reach (especially in terms of flow-modification) is the small rheophilic Natal mountain catfish (ANAT) and large semi-rheophilic Scaly (BNAT). These

	species are good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Secondary indicators include the eels (AMOS/AMAR) (longitudinal continuity, undercut banks), Bowstripe barb (BVIV) (overhanging vegetation and SS habitats), Red breasted tilapia (TREN) (instream vegetation), Mozambique tilapia (OMOS) (water column) and Southern mouthbrooder (PPHI) (undercut banks).
Invertebrates	The macro-invertebrate community should be representative of a foot-slope river assemblage with perennial flows. The habitats in the river are dominated by good SIC with moderate marginal vegetation overhanging the stream banks. Although the area contains the Upper part in Midmar Dam, Howick, industrial area, Howick WWTW, alien and invasive plants in riparian zone, informal areas, dryland agriculture, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The overall PES at Mg_I_EWR 2 (as at August 2013) for riparian vegetation was a Category C (68.6%). This is also the REC and TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone on a whole, as well as within each sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c)

The EcoSpecs and TPCs are provided in the following tables.

Table 14.13 Fish EcoSpec and TPCs (PES and TEC: D)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
Ecological status	PES	Present ecological status of fish is in an E (26.98%).	Decrease of PES into a lower EC than PES.	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	8 of the expected 12 indigenous fish species estimated to be present in the reach under PES.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	ANAT	ANAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	ANAT absent during two consecutive surveys OR present at FROC of <0.5.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
FD habitats		ANAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)
FS habitats		ANAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate		ANAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.
Water quality intolerance		ANAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.		Decreased water quality (especially flow related water quality variables such as oxygen).
Overhanging vegetation	BVIV	BVIV estimated to occur at a FROC* of 2 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BVIV absent during two consecutive surveys OR present at FROC of <2.	Significant change in overhanging vegetation habitats.
SS habitats		BVIV estimated to occur at a FROC* of 2 under PES have a high requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).
Instream vegetation	TREN	TREN estimated to occur at a FROC* of 1 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.	TREN absent during two consecutive surveys OR present at FROC of <1.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)
Undercut banks	PPHI	PPHI estimated to occur at a FROC* of 1.5 under PES have a high requirement for undercut banks and is the most applicable indicator species for this	PPHI absent during two consecutive surveys OR present at FROC of <1.5.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
		habitat feature.		
Water column	OMOS	OMOS estimated to occur at a FROC* of 1.5 under PES have a high requirement for water column as cover and is the most applicable indicator species for this chabitat feature.	OMOS absent during two consecutive surveys OR present at FROC of <1.5.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).
SD habitats	TREN	TREN estimated to occur at a FROC* of 1 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.	TREN absent during two consecutive surveys OR present at FROC of <1.	Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).
Alien fish species	Presence of any alien/ introduced spp.	LMAC, MDOL, MPUN, STRU known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A
Migratory success[2]	AMAR AMOS BNAT	It is estimated that the catadromous AMAR, AMOS, may still be present, and various potamodromous species (including BNAT) also occurs.	Loss or decreased FROC[1] of catadromous (such as AMOS) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 14.14 Macro-invertebrate EcoSpec and TPCs (PES and TEC: C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp.	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
6	Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
7	Gomphidae, Tabanidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score :> 170; ASPT value: > 6.0.	SASS5 scores < 175 and ASPT < 6.0.
To ensure that the MIRAI score remains within the range of a C Category (62.01 – 77.4), using the same reference data used in this study.	A MIRAI score of 75% or less.
Presence of at least three of the following four high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae and Heptagenidae.	One or more of the following taxa present only as individuals, or a taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Tricorythidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following five key taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae, Heptagenidae and Leptophlebidae.	Less than four of the five key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp. and Tricorythidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae and Libellulidae.	Any one of these taxa missing for two consecutive surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Atyidae.	This taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae and Tabanidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.

Table 14.15 Riparian vegetation EcoSpec and TPCs (REC C=TEC)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 50%.	An absence of indigenous riparian woody species OR an increase in cover above 60%
Non-woody indigenous cover	Maintain non-woody cover (% aerial) above	A decrease in non-woody cover (% aerial)

Assessed Metric	EcoSpec	TPC
(grasses, sedges and dicotyledonous forbs) (% aerial)	40%.	below 30%.
Reed cover (% aerial)	Maintain reed cover under 10%	An increase in reed cover above 20%
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 10% or lower.	An increase in perennial alien plant species cover >10%
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 10% or lower.	An increase in terrestrial woody species cover above 15%
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 60%.	An absence of indigenous riparian woody species OR an increase in cover above 70%
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Reed cover (% aerial)	Maintain reed cover under 10%	An increase in reed cover above 20%
Upper zone		
Alien invasion (perennial alien species)	Reduce cover (% aerial) of perennial alien plant species to 10% or lower.	An increase in perennial alien plant species cover >10%
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species below 25%.	An increase in terrestrial woody species cover above 30%
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 70%.	An decrease in indigenous riparian woody species cover below 5% or an increase above 80%
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 65% for the riparian zone.	A decrease in PES score below 62% for the riparian zone.

14.6 RQOs FOR RU uMn5 (U20E-04136, 04271) (MODERATE PRIORITY - 2)

14.6.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20E-04136										
C	14.2	10.7	1.88	13.3	3.19	22.5	0.004	0.016	0.016	0.064
U20E- 04271										
B/C	8.1	6.5	1.60	19.7	2.36	29.1	0.006	0.022	0.014	0.041

14.6.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in the table below.

Table 14.16 RU uMn5: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced to moderate and thereafter be maintained as moderate.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*G. natalense; K. latifolia*)
FISH		
Species richness	Indigenous fish species richness estimated to be eleven species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMAR, AMOS, ANAT, BANO, BGUR, BNAT, BVIV, CGAR, OMOS, TREN, and TSPA) of estimated eleven fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, Migration: AMOS/AMAR Water column/SD: TREN/OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (dams and flow), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water

Indicators	Narrative RQO	Numerical RQO
	species.	quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

14.7 RQOs FOR RU uMn6 (U20F-04011, 04095 (in IUA3)) (MODERATE PRIORITY - 2)

14.7.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20F-04011										
C/D	30.3	13.4	3.33	11.0	5.61	18.5	0.004	0.036	0.017	0.096
U20F-04095										
C/D	17.6	7.8	1.44	8.2	2.83	16.1	0.004	0.017	0.011	0.074

14.7.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Some poultry farming and agricultural activities; Eskom Training Centre WWTW. Note Sappi Forest plantations are near U20F-04095 only. All riparian zones delineated according to the DWS delineation guidelines. Weed control in riparian areas done as part of the integrated weed plan (S van Zyl, Sappi, *pers. comm*., March 2015)].
Water quality issue: Nutrients, faecal coliforms/*E.coli.*
Narrative and numerical: Details for RU uMn6 are provided below.

Table 14.17 RU uMn6: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P.		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

14.7.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 14.18 RU uMn6: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain large, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced to moderate and thereafter be maintained as moderate.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*G. natalense; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be thirteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ALAB, AMOS, ANAT, BANO, BGUR, BNAT, BVIV, CGAR, OMOS, PPHI, TREN, and TSPA) of estimated thirteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, PPHI, TSPA Migration: AMOS/ALAB Water column/SD: TREN/OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (water quality and flow, dams), fewer key taxa are expected (9). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Elmidae	Flows should be adequate to ensure suitable habitats for this moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

Indicators	Narrative RQO	Numerical RQO
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

15 uMNGENI (U2): IUA U2-3 RESOURCE QUALITY OBJECTIVES

The IUA overview and description are provided below.

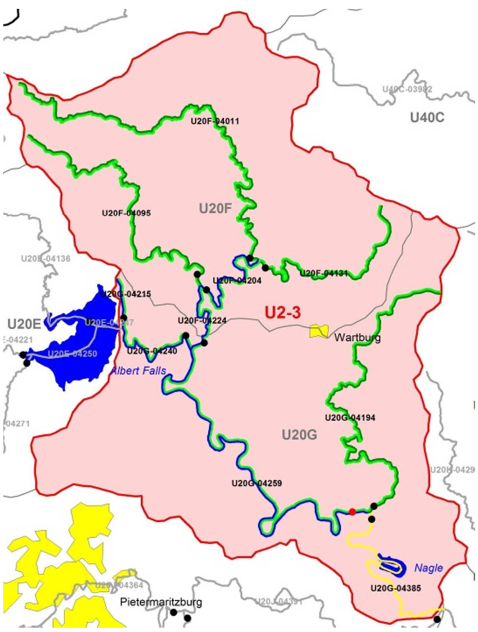
The northern tributaries of the uMngeni have a PES of C/D and three tributaries are in a B/C PES. Impacts are primarily flow (consistent high base flows from Albert Falls Dam) and non-flow related with extensive forestry and formal agriculture (sugar cane) present in this area. Some rural areas and townships with associated non-flow (grazing, subsistence farming) and water quality (runoff) related impacts are also present. The main uMngeni is in a B/C due to protection of steep river valleys. The main impacts are dense rural settlements on higher plateaus and on gentle river slopes as well as impacts due to deforestation, agriculture (erosion, sedimentation etc.). The reach in which Nagle Dam is, is in an E PES due to the presence of the dam and the flow related impacts DS of the dam. There are no releases from Nagle Dam, however the losses from the hydro-power plant serves as releases from the dam.

The IUA is regulated by the upstream Midmar Dam and Albert Falls Dams as well as Nagle Dam located at the lower end of the IUA from where water is abstracted for the eThekwini supply area. Nagle Dam is supported from the upstream dam and the IUA is regarded as highly regulated. There are also a number of small farm and instream dams located in the IUA. There are no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact of the water resources.

Small towns such as New Hannover and Wartburg as well as other scattered rural and informal settlements are located in the IUA. The main land use activities in the IUA include extensive forestry and dry land sugar cane.

IUA U2-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U2-3: uMNGENI DOWNSTREAM OF ALBERT FALLS DAM TO uMNSUNDUZE CONFLUENCE



PRIORITY RATINGS

RU	SQ	River	PES	REC	TEC	PR
RU uMn7	U20F-04131	Mhlalane	C/D	C/D	C/D	3WQ
	U20F-04204	Sterkspruit	B/C	B/C	B/C	
	U20F-04224	Mpolweni	B/C	B/C	B/C	
	U20G-04194	Mkabela	C/D	C/D	C/D	
	U20G-04215	Cramond Stream	B/C	B/C	B/C	
MRU uMnC	U20G-04240	uMngeni	B/C	B/C	B/C	3WQ
	U20G-04259	uMngeni	B/C	B	B/C	
	U20G-04385	uMngeni	B/C	B/C	B/C	

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

15.1 RQOs FOR RU uMn7 (U20F-04131, 04204, 04224, U20G-04194, 04215) (MODERATE PRIORITY – 2; 3WQ)

15.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: DRM (Hughes and Hannart, 2003), RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008C)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20F-041131										
C/D	14.5	6.3	1.52	10.5	2.59	17.9	0.004	0.015	0.011	0.06
U20F-04204										
B/C	48.8	22.4	5.67	11.6	9.61	19.7	0.012	0.065	0.053	0.185
U20F-04224										
B/C	70.7	33.6	9.85	13.9	15.43	21.8	0.015	0.101	0.073	0.336
U20G-04194										
C/D	19.9	16.8	1.6	8.0	3.4	17.1	0.005	0.016	0.013	0.081
U20G-04215										
B/C	0.8	0.7	0.09	11.2	0.17	21.0	0.0	0.0	0.0	0.002

15.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Settlements; irrigation; sawmills and timber processing; AF North and Coolair WWTW; some sand-mining.
Water quality issue: Nutrients, turbidity, faecal coliforms/*E. coli*
Narrative and numerical: Details for RU uMn7 are provided below.

Table 15.1 RU uMn7: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

15.1.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 15.2 RU uMn7: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain large, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall be reduced to large and remain large or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced to moderate and thereafter be maintained as moderate.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*G. natalense; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be fifteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ALAB, AMAR, AMOS, ANAT, BANO, BGUR, BNAT, BPAL, BVIV, CGAR, OMOS, PPHI, TREN, and TSPA) of estimated fifteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, PPHI, TSPA Migration: AMOS/ALAB/AMAR Water column/SD: TREN/OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
There is a significant difference between the sites in RU uMn, varying between ECs of B/C and C/D. For setting the RQO for this reach, the higher scoring site (ECs = B/C) will be used. The PES (11) data (DWS, 2014c) of this reach listed 18 key taxa to be present. However, due to present day influences (dams, water quality and flows), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and

Indicators	Narrative RQO	Numerical RQO
	sensitive species.	good water quality for this species.
LeptophlebidaeElmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

15.2 RQOs FOR MRU uMnC (U20G-04240, 04259, 04385) (MODERATE PRIORITY - 2; 3WQ)

SQ	River	PES	REC	Requirement	TEC
U20G-04259	uMngeni	B/C	B	No change in operation possible.	B/C

15.2.1 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.***Model:*** N/A.

Users: Feedlots; sand-mining; AF South WWTW; timber processing; extensive poultry farming + Argyle Chickens Abattoir; vegetable production and nurseries; crocodile farms.

Water quality issues: Turbidity, nutrients, toxics, faecal coliforms/*E. coli.*

Narrative and numerical: Details for MRU uMn C are provided below.

Table 15.3 MRU uMnC: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels are within Tolerable limits.</td><td colspan="3">50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that turbidity or clarity levels stay within Acceptable limits.</td><td colspan="3">A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that toxics are within Ideal limits or A categories</td><td colspan="3">95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 – 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

15.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 15.4 MRU uMnC: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall be reduced to large and remain moderate or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*G. natalense; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be fifteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ALAB, AMAR, AMOS, ANAT, AMYA, BGUR, BNAT, BPAL, BVIV, CGAR, OMOS, PPHI, TREN, and TSPA) of estimated fifteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: PPHI, TSPA, AMYA Migration: AMOS/ALAB/AMAR Water column/SD: AAEN/TREN/OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
There is a significant difference between the sites in RU uMnC, varying between ECs of B/C and C/D. For setting the RQO for this reach, the higher scoring site (ECs = B/C) will be used. The PES (11) data (DWS, 2014c) of this reach listed 18 key taxa to be present. However, due to present day influences (dams, turbidity, water quality and flows), fewer key taxa are expected (13). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water

Indicators	Narrative RQO	Numerical RQO
	dependant species.	quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

16 uMNGENI (U2): IUA U2-4 RESOURCE QUALITY OBJECTIVES

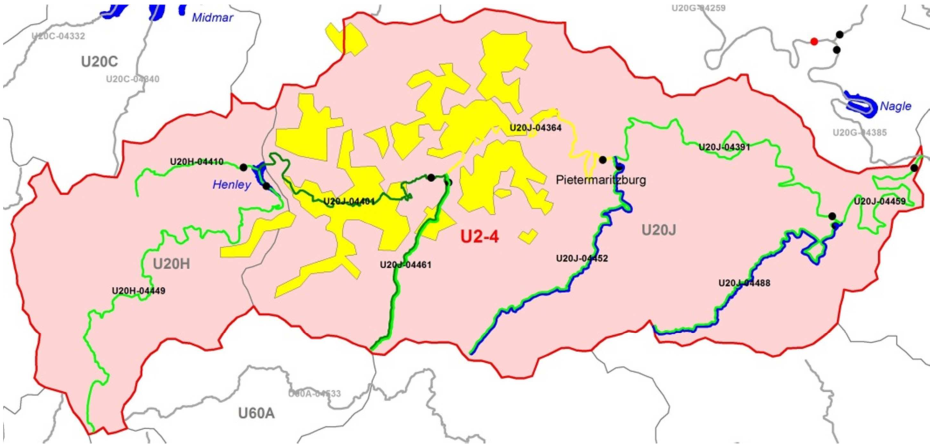
The IUA overview and description are provided below.

Upstream of Henley Dam the PES is a C, with non-flow related impacts (poor water quality, rural settlements, sedimentation, overgrazing, agriculture and alien vegetation). Downstream of Henley Dam through Pietermaritzburg the PES ranges from C to D to E. The E PES is due to poor water quality, canalisation, inundation, instream barriers and high intensity urbanisation. Downstream of the E, the river is impacted by poor water quality, rural settlements, informal agriculture, clearing of vegetation, overgrazing and some erosion. The storage regulation in this IUA is low. Henley Dam is located in the upper reaches of the IUA, which is a relatively small dam when compared to the dams located in the uMngeni System, and there are also a number of small farm and instream dams.

A large portion of the IUA is occupied by the greater Pietermaritzburg urban area and there are also a large number of semi-urban and rural settlements. Discharges from the Darvill WWTW (Pietermaritzburg area) enter the uMnsunduze River and affect the flow and especially the water quality of the river which impacts on the water quality of Inanda Dam. Umgeni Water is currently investigating the potential of re-using effluent from the Darvill WWTW, which could have a future impact on the uMnsunduze River. The possibility of implementing such a project at this stage is uncertain. The main land use activities in the IUA include extensive forestry and dry land sugar cane.

A large portion of the IUA is rural, with scattered rural villages and subsistence farming activities. There are a large number of rural settlements located around the Inanda Dam area. IUA U2-4 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U2-4: uMNSUNDUZE



RU	SQ	River	PES	REC	TEC	PR
RU uMn8	U20H-04410	Nqabeni	C	C	C	2
	U20J-04452	Mpushini	B/C	B	B	
	U20J-04461	Slang Spruit	C/D	C/D	C/D	3WQ
	U20J-04488	Mshwati	B/C	B	B	
MRU Duze A	U20H-04449	uMnsunduze	C	C	C	2
MRU Duze B	U20J-04364 Mg_R_EWR4	uMnsunduze	D/E	D	D	3
	U20J-04401	uMnsunduze	D	D	D	
MRU Duze C	U20J-04391	uMnsunduze	C	C	C	3WQ
MRU Duze D	U20J-04459	uMnsunduze	C	B	C	3WQ

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

16.1 RQOs FOR RU uMn8 (U20H-04410, U20J-04452, 04461, 04488) (MODERATE PRIORITY - 2 and HIGH WATER QUALITY PRIORITY)

SQ	River	PES	REC	Requirement	TEC
U20J-04452	Mpushini	B/C	B	Water quality from Ashburton must be addressed amongst others.	B
U20J-04488	Mshwati	B/C	B	Lower section in worse state. Reinstate riparian zone, address erosion.	B

16.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20H-04410										
C	5.5	5.5	0.93	16.8	1.39	25.1	0.007	0.014	0.011	0.023
U20J-04452										
B	6.8	5.4	1.43	21.2	2.08	30.7	0.017	0.020	0.013	0.030
U20J-04461										
C/D	4	3.8	0.58	14.5	0.91	22.8	0.003	0.013	0.004	0.016
U20J-04488										
B	7.3	5.9	1.58	21.8	2.27	31.3	0.017	0.026	0.016	0.034

* Flows generated for a B/C rule

16.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW and eThekwini Municipality.
Model: N/A.
Users: Urban (industrial, Camperdown and Lynnfield Park WWTW) impacts; settlements; pultry farming; quarries; Ashburton Horse Training Centre sewage ponds
Water quality issue: Nutrients, toxics, turbidity, faecal coliforms/*E. coli.*
Narrative and numerical: Details for RU uMn8 are provided below.

Table 16.1 RU uMn8: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels are within Tolerable limits.</td><td colspan="3">50^{th} percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).
50^{th} percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that periphyton chl-a levels are within Tolerable limits.</td><td colspan="3">50^{th} percentile of the data must be less than 52.5 mg/m^2 periphyton chl-a (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that turbidity or clarity levels stay within Acceptable limits.</td><td colspan="3">A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that toxics are within Ideal limits or A categories*</td><td colspan="3">95^{th} percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use**.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 – 2 000</td><td>> 2 000</td></tr>
</table>

* It is expected that a number of toxics will already exceed Tolerable levels. It is recommended that a biological monitoring point be instituted at the lower end of the RU and that toxics monitoring be dependent on biotic response.
** Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

16.1.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in the table below.

Table 16.2 RU uMn8: Narrative and numerical habitat and biota RQOs

<table>
<tr><th>Indicators</th><th>Narrative RQO</th><th>Numerical RQO</th></tr>
<tr><td colspan="3">RIPARIAN VEGETATION</td></tr>
<tr><td>Presence of alien plant species in the riparian zone</td><td>The extent of perennial alien plant species within the riparian zone should remain small or decrease.</td><td>Insufficient quantitative data exist to develop numerical RQOs.</td></tr>
<tr><td>Riparian zone continuity</td><td>Modification of riparian zone continuity should remain small, or improve.</td><td>N/A</td></tr>
<tr><td>Riparian zone fragmentation</td><td>Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.</td><td>N/A</td></tr>
<tr><td>Extent of agriculture within the riparian zone</td><td>The extent of agriculture within the riparian zone shall remain small or decrease.</td><td>N/A</td></tr>
<tr><td>Sensitive riparian species</td><td>Viable populations of sensitive riparian plant species should remain within the RU.</td><td>Four (4) listed riparian species should remain viable within the RU (G. natalense; Gladiolus cruentus; H. polymorpha; K. latifolia).</td></tr>
<tr><td colspan="3">FISH</td></tr>
<tr><td>Species richness</td><td rowspan="3">Indigenous fish species richness estimated to be fourteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.</td><td>Maintain indigenous species richness (AAEN, ALAB, AMAR, AMOS, ANAT, BGUR, BNAT, BPAL, BVIV, CGAR, OMOS, PPHI, TREN, and TSPA) of estimated fourteen fish species in this RU. Maintain current habitat diversity.</td></tr>
<tr><td>Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)</td><td>Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).</td></tr>
<tr><td>Secondary indicator species:</td><td>Ensure the habitat requirements of the secondary indicator species are maintained</td></tr>
</table>

Indicators	Narrative RQO	Numerical RQO
Vegetation/SS: PPHI, TSPA Migration: AMOS/ALAB/AMAR Water column/SD: AAEN/TREN/OMOS		and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
There is a significant difference between the sites in RU uMn8, varying between ECs of B and C/D. For setting the RQO for this reach, the higher scoring site (ECs = B) will be used. The PES (11) data (DWS, 2014c) of this reach listed 18 key taxa to be present. However, due to present day influences (dams, turbidity, water quality and flows), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

16.2 RQOs FOR MRU DUZE A (U20H-04449) (MODERATE PRIORITY - 2)

16.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20H-04449										
C	32	32	4.85	15.0	7.51	23.3	0.022	0.056	0.097	0.172

16.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 14.6.

Table 16.3 MRU DUZE A: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*G. natalense; G. cruentus*).
FISH		
Species richness	Indigenous fish species richness estimated to be ten species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BGUR, BNAT, BPAL, BVIV, CGAR, OMOS, PPHI, and TSPA) of estimated ten fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: PPHI, TSPA Migration: AMOS Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity and dams), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).

Indicators	Narrative RQO	Numerical RQO
Pyralidae	Marginal vegetation habitat should be adequate to accommodate this key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

16.3 RQOs FOR MRU DUZE B WITH Mg_R_EWR4 (U20J-0364) (HIGH PRIORITY - 3) (including U20J-04401)

This site is currently in a D/E state with water quality being the overriding driver (water quality is in an E/F Category). The EWR site is downstream of Darvill WWTW. Darvill is already a Low Risk works, with other major impacts in this area being non point-source runoff and the highly polluted Baynespruit which enters the uMnsunduze downstream of Darvill. As part of implementation actions, possibilities for improving the site will be addressed.

The information provided in this document therefore does not reflect RQOs that must be achieved or maintained, but describes the criteria of the current state. Future objectives should therefore be set to move away from these criteria (the current state) to an improved state.

A scenario (Sc 4) which includes the treatment the proposed treatment of domestic sewage from Darvill WWTW to potable standards will not impact on this reach as the discharge point is at Umlass Road, which is downstream of the EWR site and MRU.

Monitoring points should be at or close to the EWR site and in the lower river.

The table below illustrates the PES at the EWR site.

Component	PES
Physico chemical	E/F
Fish	E
Invertebrates	E
Riparian vegetation	D/E
EcoStatus	D/E

16.3.1 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). A GE layer of land use from Umgeni Water was also used to provide information.
Model: PAI model (DWAF, 2008b).
Users: Pietermaritzburg and surrounds urban and industrial impacts, incl. Darvill WWTW and input from Baynespruit; settlements; chicken farms; solid waste dumps; recreation (e.g. canoeing).
Water quality issue: Nutrients, toxics, salts, turbidity, dissolved oxygen, faecal coliforms/*E. coli*. [Note that the median *E. coli* value at RMG019 (2008 - 2013; n = 271) is 3 500 counts/100 ml. See expected impacts in DWAF (1996a).]
Narrative and numerical: Details for MRU Duze B are provided below. Data used for water quality assessments should be collected from U2H041Q01 or UW site RMD019 (specifically to be used for metals).

Table 16.4 Mg_R_E WR4: Narrative and numerical water quality description of an improved state

Narrative RQO	Numerical RQO		
Ensure that nutrient levels (phosphate) are within Tolerable limits.	50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). 50th percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).		
Ensure that periphyton chl-a levels are within Tolerable limits.	50th percentile of the data must be less than 52.5 mg/L periphyton chl-a (Aquatic ecosystems: driver).		
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with increased turbidity levels expected (Aquatic ecosystems: driver).		
Ensure that toxics are within prescribed limits to maintain or improve present state*	Numerical limits can be found in DWAF (1996c) and DWAF (2008b).		
Ensure that ammonia levels are within Tolerable limits.	50th percentile of the data must be less than 0.13 mg/L ammonia (Aquatic ecosystems: driver).		
Ensure that dissolved oxygen levels are within Tolerable limits.	5th percentile of the data must be greater than 5 mg/L dissolved oxygen (Aquatic ecosystems: driver).		
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	**See specified biota requirements.**		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use**.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

*** Note that ammonia (NH_3-N), copper, cadmium and lead already exceed Acceptable or Tolerable levels for aquatic ecosystems, although background levels (natural state) are not known. See biotic requirements for improvements.**
** Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

Table 16.5 Mg_R_EWR4: Water quality EcoSpecs and TPCs (PES and TEC: E/F)

River: uMnsunduze		PES: E/F Category
Monitoring site: RMD019		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts(a)		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 55 mS/m.	The 95th percentile of the data must be 44 – 55 mS/m.
pH	The 5th percentile of the data must be 6.5 – 8.0, and the 95th percentile 8.0 – 8.8	The 5th percentile of the data must be < 6.3 and > 7.8, and the 95th percentile must be < 8.2 and > 8.6
Temperature(b)	Minor to moderate changes in temperature experienced.	Initiate baseline monitoring for this variable.
Dissolved oxygen(b)	The 5th percentile of the data must be ≥ 5.0 mg/L.	The 5th percentile of the data must be 5.2 – 5.0 mg/L. Initiate baseline monitoring for this variable.

River: uMnsunduze		PES: E/F Category
Monitoring site: RMD019		
Water quality metrics	**EcoSpecs**	**TPC**
Turbidity(b)	Increased turbidity levels experienced.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 2.5 mg/L.	The 50th percentile of the data must be 2.0 – 2.5 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.075 mg/L.	The 50th percentile of the data must be 0.06 – 0.075 mg/L.
Response variables		
Chl-*a* phytoplankton(b)	The 50th percentile of the data must be < 20 µg/L.	The 50th percentile of the data must be 16 – 20 µg/L.
Chl-*a* periphyton(b)	The 50th percentile of the data must be ≤ 52.5 mg/m^2.	The 50th percentile of the data must be 42 – 52.5 mg/m^2.
Toxics		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.1 mg/L.	The 95th percentile of the data must be 0.08 – 0.1 mg/L.
Aluminium	The 95th percentile of the data must be ≤ 0.15 mg/L.	The 95th percentile of the data must be 0.012 – 0.15 mg/L.
Copper(c)	The 95th percentile of the data must be ≤ 0.004 6 mg/L.	The 95th percentile of the data must be 0.003 7 – 0.004 6 mg/L.
Cadmium(c)	The 95th percentile of the data must be ≤ 0.000 95 mg/L.	The 95th percentile of the data must be 0.000 76 – 0.000 95 mg/L.
Lead(c)	The 95th percentile of the data must be ≤ 0.005 mg/L.	The 95th percentile of the data must be 0.004 – 0.005 mg/L.
Other toxics(b)	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.
(c) Moderate hardness (i.e. 60 – 119 mg/L $CaCO_3$) (DWAF, 2008).

16.3.2 Habitat and Biota RQOs (EcoSpecs)

RQOs are provided below to be used in future if water quality can be improved.

Table 16.6 Mg_R_EWR4: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in an unacceptable Category E and it should be aimed to improve the fish EC to a D in future if the overall TEC is to be attained. The present indigenous fish species richness of the EWR site is estimated to be ten of an expected thirteen species (only one fish species sampled during EWR study). The primary indicator fish species for this reach (especially in terms of flow-modification) is the large semi-rheophilic Scaly (BNAT) in the absence of the small rheophilic Natal mountain catfish (ANAT). Secondary indicators include the eel (AMOS/ALAB) (longitudinal continuity, undercut banks), Bowstripe barb (BVIV) (overhanging vegetation and SS habitats), Red breasted tilapia (TREN) (instream vegetation, SD habitats) and Mozambique tilapia (OMOS) (water column).
Invertebrates	The macro-invertebrate community should be representative of a medium-sized foot-hill stream assemblage with perennial flows. The habitats in the river are dominated by runs that varies between slower flowing channels and in-stream controls with SIC habitats. A narrow band of marginal vegetation overhangs the stream banks. Poor water quality due to effluent inflows, renders this reach very poor in invertebrate diversity.
Riparian vegetation	The overall PES at Mg_R_EWR 4 (as at August 2013) for riparian vegetation was a Category D/E (41.4%). The TEC for the site is to improve the EC to a Category D. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the TEC of the riparian zone. Perennial invasive alien species shall be removed and kept in check so as not to cause the EC to deteriorate below a Category D. Similarly, species composition within the riparian zone shall reflect specifications in keeping

Component	Narrative RQO
	with the TEC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c).

The EcoSpecs and TPCs are provided in the following tables.

Table 16.7 Fish EcoSpec and TPCs (REC and TEC: D)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
Ecological status	PES	Present ecological status of fish is in a E (37.18%) and it should be aimed to improve it at least into a Category D.	Decrease of PES into a lower EC than PES (<E).	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	Only ten of the expected 13 indigenous fish species estimated to still be present in the reach under PES.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	BNAT (in the absence of ANAT)	BNAT estimated to occurr at a FROC* of 2.5 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	BNAT absent during any survey OR present at FROC of <2.5.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
FD habitats		BNAT estimated to occurr at a FROC* of 2.5 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)
FS habitats		BNAT estimated to occurr at a FROC* of 2.5 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate		BNAT estimated to occurr at a FROC* of 2.5 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.
Water quality intolerance		BNAT estimated to occurr at a FROC* of 2.5 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.		Decreased water quality (especially flow related water quality variables such as oxygen).
Overhanging vegetation	BVIV	BVIV estimated to occurr at a FROC* of 0.5 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BVIV absent during two consecutive surveys OR present at FROC of <0.5.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)
SS habitats		BVIV estimated to occurr at a FROC* of 0.5 under PES have a high requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).
Instream vegetation	TREN	TREN estimated to occurr at a FROC* of 2 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.	TREN absent during two consecutive surveys OR present at FROC of <2.	Significant change in instream vegetation habitats (flow modification, use of herbicides, nutrient enrichment, water quality deterioration)
SD habitats		TREN estimated to occurr at a FROC* of 2 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).
Water column	OMOS	OMOS estimated to occurr at a FROC* of 3 under PES have a high requirement for water column as cover and is	OMOS absent during two consecutive surveys OR present at FROC of <3.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
		the most applicable indicator species for this chabitat feature.		
Undercut banks	AMOS	AMOS estimated to occurr at a FROC* of 0.5 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive surveys OR present at FROC of <0.5.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).
Alien fish species	Presence of any alien/ introduced spp.	CCAR known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A
Migratory success[2]	ALAB AMOS BNAT	It is estimated that the catadromous ALAB, AMOS, may still be present, and various potamodromous species (including BNAT) also occurs.	Loss or decreased FROC[1] of catadromous (such as AMOS) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 16.8 Macro-invertebrate EcoSpec and TPCs (PES and TEC: D)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
2	Coenagrionidae, Atyidae	0.3 – 0.6 m/s	Marginal vegetation	Low
3	Gomphidae	-	Course sediment	-

PES	TPCs	EcoSpecs for a D improvement
SASS5 score: > 40.	SASS5 scores < 40.	To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 50; ASPT value: > 5.5.
MIRAI E: (22.01 – 37.4).	A MIRAI score of 35% or less.	To ensure that the MIRAI score improves to a D Category (42.01 – 57.4), using the same reference data used in this study.
Water quality, shading, temperature and habitat conditions indicators: Libellulidae, Coenagrionidae and Atyidae.	Any one of these taxa missing.	To improve suitable conditions (water quality, shading, temperature and habitat conditions) for the following five key taxa: Heptagenidae, Libellulidae, Coenagrionidae and Atyidae.
Flow velocity (0.3 - 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Libellulidae.	This taxa missing during surveys.	Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae and Libellulidae.
Sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae and Atyidae.	Any one of these taxa missing.	Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae, Atyidae and Nepidae.
Sufficient quantity and quality of coarse sediment to support the following bottom dwelling taxa: Gomphidae.	This taxa missing during surveys.	Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae and Athericidae.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae and Heptageniidae.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.	Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.

Table 16.9 Riparian vegetation EcoSpec and TPCs (PES and TEC: D/E)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 50%.	An absence of indigenous riparian woody species OR an increase in cover above 60%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Reed cover (% aerial)	Maintain an absence of reeds.	A presence of reeds.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 10% or lower.	An increase in perennial alien plant species cover >10%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 10% or lower.	An increase in terrestrial woody species cover above 15%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and	An absence of indigenous riparian woody species OR an increase in cover above 70%.

Assessed Metric	EcoSpec	TPC
	below 60%.	
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Reed cover (% aerial)	Maintain an absence of reeds.	A presence of reeds.
Upper zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species below 25%.	An increase in perennial alien plant species cover >30%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species below 20%.	An increase in terrestrial woody species cover above 25%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 70%.	An decrease in indigenous riparian woody species cover below 5% or an increase above 80%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 30%.	A decrease in non-woody cover (% aerial) below 20%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 45% for the riparian zone.	A decrease in PES score below 42% for the riparian zone.

16.4 RQOs FOR MRU Duze C (U20J-04391) (HIGH WATER QUALITY PRIORITY)

16.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically. Note that the pMAR is higher than natural due to urban runoff, WWTW etc.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20J-04391										
C	85.3	101.4	14.78	17.3	22.52	26.4	0.162	0.306	0.307	0.438

16.4.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Sand-mining; upstream water quality impacts; poultry farming.
Water quality issue: Turbidity, nutrients, faecal coliforms/*E. coli.*
Narrative and numerical: Details for MRU Duze C are provided below.

Table 16.10 MRU Duze C: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
Ensure that nutrient levels (phosphate) are within	50^{th} percentile of the data must be less than 0.075 mg/L PO_4-P

Narrative RQO	Numerical RQO		
Tolerable limits.	(Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

16.5 RQOs FOR MRU Duze D (U20J-04459) (HIGH WATER QUALITY PRIORITY)

SQ	River	PES	REC	Requirement	TEC
U20J-04459	uMnsunduze	C	B	Unlikely that water quality improvement and other improvements required will be sufficient to improve to a B and no resolution to determine whether a B/C is possible. More important to improve the areas closer to the urban area that is below a D EC.	C

16.5.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically. Note that the pMAR is higher than natural due to urban runoff, WWTW etc.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20J-04459										
C	94.7	109.4	16.51	17.4	25.26	26.7	0.167	0.309	0.321	0.483

16.5.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW and eThekwini Municipality.
Model: N/A.
Users: Sand-mining; upstream water quality impacts. High stormwater run-off.
Water quality issue: Turbidity, faecal coliforms/*E. coli.*
Narrative and numerical: Details for MRU Duze D are provided below.

Table 16.11 MRU Duze D: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

16.5.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 16.12 MRU Duze D: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*G. natalense; G. cruentus*).
FISH		
Species richness	Indigenous fish species richness estimated to be thirteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ALAB, AMOS, ANAT, BGUR, BNAT, BPAL, BVIV, CGAR, OMOS, PPHI, TREN, and TSPA) of estimated thirteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: PPHI, TSPA Migration: AMOS/ALAB Water column/SD: AAEN/TREN/OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 18 key taxa to be present. However, due to present day influences (turbidity, water quality), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

17 uMNGENI (U2): IUA U2-5 RESOURCE QUALITY OBJECTIVES

The IUA overview and description are provided below.

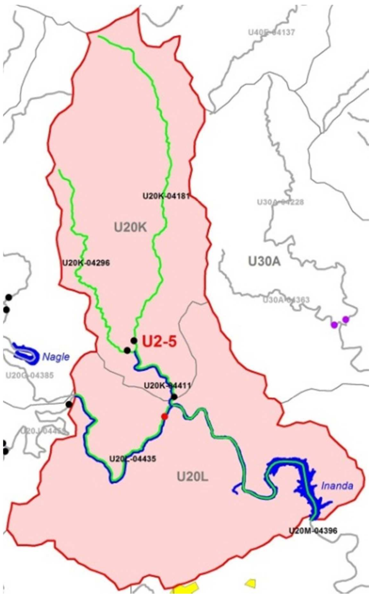
The SQ reaches in the IUA are in a C and B/C PES. Impacts are flow related (no releases from Nagle Dam) and water quality from the uMnsunduze River. Tributaries are influenced by forestry, dams and agriculture.

The IUA is regulated by the upstream Midmar Dam and Albert Falls Dams, Nagle Dam as well as Inanda Dam located at the lower end of the IUA and is regarded as highly regulated. Abstractions are made from Inanda Dam for supplying water to the eThekwini area and the dam is supported by the upstream dams. The water quality of the uMngeni River reduces after the confluence with the uMnsunduze River. There are no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact on the water resources as well as the potential implementation of the Darvill re-use project.

A large portion of the IUA is rural, with scattered rural villages and subsistence farming activities. There are a large number of rural settlements located around the Inanda Dam area. Areas in the upper reaches of the IUA are covered by extensive cultivation (dryland sugar cane) and forestry.

IUA U2-5 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U2-5: uMNGENI DOWNSTREAM OF THE uMNSUNDUZE CONFLUENCE TO INANDA DAM



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
MRU uMn D	U20L-04435 Mg_I_EWR 5	uMngeni	D	D	D	3
	U20M-04396	uMngeni (upstream of Inanda dam)				
RU uMn9	U20K-04181	Mqeku	C	C	C	2
	U20K-04296	Tholeni	C	B/C	B/C	
	U20K-04411	Mqeku	B/C	B	B	

The RQOs are provided below for the TEC and the catchment configuration as illustrated above.

17.1 RQOs FOR MRU uMn D WITH Mg_I_EWR5 (U20L-04435) (HIGH PRIORITY - 3) (INCLUDING U20M-04396)

The TECs are provided for this EWR site below. Note that this reach could be impacted by scenarios. None of the scenarios however impact on the PES and REC and some may even improve the situation.

Component	PES and REC Short term TEC
Physico chemical	C/D
Fish	D
Invertebrates	C/D
Riparian vegetation	D
EcoStatus	D

17.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a,b).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
Mg_I_EWR5	REC: D	583.7	245.3	123.47	21.20	141.81	24.3	0.856	2.017	1.655	2.477

17.1.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). GE layers of land use from UW and eThekwini Municipality were also used to provide information.
Model: PAI model (DWAF, 2008B).
Users: Settlements and associated sewage systems; urban impacts; extensive sand-mining; quarries; Northern WWTW and others at a distance from the main stem (i.e. Mkiswana WWWTW). Note Maphephetwa WWTW is located alongside Inanda Dam and does not discharge into the river.
Water quality issue: Nutrients, turbidity, faecal coliforms/*E. coli*.
Narrative and numerical: Details for MRU uMngeni D are provided below. Data used for water quality assessments should be collected from U2H055Q01. Microbial data can be collected from UW site RMG017.

Table 17.1 MRU uMn D: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels (phosphate) are within Tolerable limits.	50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). 50th percentile of the data must be less than 4.0 mg/L TIN-N (Aquatic ecosystems: driver).
Ensure that periphyton chl-a levels are within Tolerable limits.	50th percentile of the data must be less than 21 mg/L periphyton chl-a (Aquatic ecosystems: driver).
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).

Narrative RQO	Numerical RQO		
Ensure that toxics are within Ideal limits or A categories*.	95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008b).		
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use**.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

*** Note that ammonia (NH_3-N) already exceeds Tolerable levels for aquatic ecosystems, although background levels (natural state) are not available.**

** Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

Table 17.2 Mg_I_EWR5: Water quality EcoSpecs and TPCs (PES and TEC: C/D)

River: uMngeni		**PES: C/D Category**
Monitoring site: U2H055Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 55 mS/m.	The 95th percentile of the data must be 44 – 55 mS/m.
pH	The 5th percentile of the data must be 6.5 – 8.0, and the 95th percentile 8.0 – 8.8	The 5th percentile of the data must be < 6.3 and > 7.8, and the 95th percentile must be < 8.2 and > 8.6
Temperature[(b)]	A natural ttemperature range expected.	Initiate baseline monitoring for this variable.
Dissolved oxygen[(b)]	The 5th percentile of the data must be ≥ 7.0 mg/L.	The 5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.
Turbidity[(b)]	A small change from present with minor silting of habitats and turbidity loads.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 4.0 mg/L.	The 50th percentile of the data must be 3.2 – 4.0 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.075 mg/L.	The 50th percentile of the data must be 0.06 – 0.075 mg/L.
Response variables		
Chl-*a* phytoplankton[(b)]	The 50th percentile of the data must be < 15 µg/L.	The 50th percentile of the data must be 12 – 15 µg/L.
Chl-*a* periphyton[(b)]	The 50th percentile of the data must be ≤ 21 mg/m².	The 50th percentile of the data must be 16.8 – 21 mg/m².
Toxics		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.1 mg/L.	The 95th percentile of the data must be 0.08 – 0.1 mg/L.

River: uMngeni		PES: C/D Category
Monitoring site: U2H055Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Other toxics(b)	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the Target Water Quality Range (TWQR) as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.

(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

17.1.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 17.3 MRU uMn D: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category D and it should be aimed to at least maintain this fish EC to achieve the overall TEC. The present indigenous fish species richness of the EWR site is estimated to be fifteen (five fish species sampled during EWR study). The primary indicator fish species for this reach (especially in terms of flow-modification) is the large semi-rheophilic Scaly (BNAT) since the small rheophilic Natal mountain catfish (ANAT) is estimated to be very scarce. Secondary indicators include the eels (AMOS/ALAB) (longitudinal continuity, undercut banks), Bowstripe barb (BVIV) (overhanging vegetation and SS habitats), Red breasted tilapia (TREN) (instream vegetation, SD habitats) and Mozambique tilapia (OMOS) (water column).
Invertebrates	The macro-invertebrate community should be representative of a large lowland river assemblage with perennial flows. The wide variety of habitats in the river is represented by good SIC, adequate marginal vegetation overhanging the stream banks, and clean substrate in the runs. There are some deeper water with slower flows and rocky or bottoms. Although the area contains rural settlements that have local impacts on riparian zone, alien and invasive plants, and the flows are mainly from the Duzi River due to operation of Nagle Dam, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category C/D, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The overall PES at Mg_I_EWR 5 (as at August 2013) for riparian vegetation was a Category D (42.7%). This is also the TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the TEC of the riparian zone. Perennial invasive alien species shall be removed and kept in check so as not to cause the EC to deteriorate below a Category D. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the TEC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c).

The EcoSpecs and TPCs are provided in the following tables.

Table 17.4 Fish EcoSpec and TPCs (PES and TEC: D)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
Ecological status	PES	Present ecological status of fish is in a D (54.78%).	Decrease of PES into a lower EC than PES (<D).	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	All of the expected 15 indigenous fish species estimated to still be present in the reach under PES although some may have become very scarce.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	BNAT (ANAT estimated to be very scarce)	BNAT estimated to occurr at a FROC* of 3 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	BNAT absent during any survey OR present at FROC of <3.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
FD habitats		BNAT estimated to occurr at a FROC* of 3 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)
FS habitats		BNAT estimated to occurr at a FROC* of 3 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate		BNAT estimated to occurr at a FROC* of 3 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.
Water quality intolerance		BNAT estimated to occurr at a FROC* of 3 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.		Decreased water quality (especially flow related water quality variables such as oxygen).

Table 17.5 Macro-invertebrate EcoSpec and TPCs (PES and TEC: C/D)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp.	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
6	Paleomonidae	0.3 - 0.6 m/s	SIC biotope	Low
7	Coenagrionidae, Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
8	Gomphidae, Tabanidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: >170; ASPT value: > 6.0.	SASS5 scores < 185 and ASPT < 6.0.
To ensure that the MIRAI score remains within the range of a C/D Category (>57.4 and <62.01), using the same reference data used in this study.	A MIRAI score of 60% or less.
Presence of at least three of the following four high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae and Heptagenidae.	Two or more of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Tricorythidae and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following five key taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae, Heptagenidae and Leptophlebidae.	Less than four of the five key taxa listed.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp. and Tricorythidae.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae and Libellulidae.	Any one of these taxa missing for two consecutive surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae and Atyidae.	Any one of these taxa missing during surveys.
Maintain suitable conditions in the SIC habitat and no migration barriers for this migrational species Paleomonidae.	This taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.

Table 17.6 Riparian vegetation EcoSpec and TPCs (PESC and TEC: D)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 50%.	An absence of indigenous riparian woody species OR an increase in cover above 60%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (%	Maintain non-woody cover (% aerial) above 20%.	A decrease in non-woody cover (% aerial) below 15%.

Assessed Metric	EcoSpec	TPC
aerial)		
Reed cover (% aerial)	Maintain reed cover below 10%.	An increase in reed cover above 15%.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species at 10% or lower.	An increase in perennial alien plant species cover >10%.
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species at 10% or lower.	An increase in terrestrial woody species cover above 15%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 60%.	An absence of indigenous riparian woody species OR an increase in cover above 70%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 30%.	A decrease in non-woody cover (% aerial) below 20%.
Reed cover (% aerial)	Maintain reed cover below 10%.	An increase in reed cover above 15%.
Upper zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species below 20%.	An increase in perennial alien plant species cover >30%
Terrestrial woody species aerial cover	Maintain cover (% aerial) of terrestrial woody species below 25%.	An increase in terrestrial woody species cover above 30%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 70%.	An decrease in indigenous riparian woody species cover below 5% or an increase above 80%
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 30%.	A decrease in non-woody cover (% aerial) below 20%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 42% for the riparian zone.	A decrease in PES score below 40% for the riparian zone.

17.2 RQOs FOR RU uMn9 (U20K-04181, 04296, 04411) (MODERATE PRIORITY - 2)

SQ	River	PES	REC	Requirement	TEC
U20K-04296	Tholeni	C	B/C	Riparian zone buffer to be improved.	B/C
U20K-04411	Mqeku	B/C	B	Riparian zone buffer to be improved.	B

17.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)

Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20K-04181										
C	19.5	17.7	4.03	20.7	5.76	29.5	0.022	0.069	0.016	0.083
U20K-04296										
B/C*	4.2	3.8	0.59	14.1	0.93	22.4	0.003	0.007	0.001	0.009
U20K-04411										
B*	26.2	23.8	5.29	20.1	7.78	29.6	0.034	0.11	0.029	0.133

* Flows generated for a C and B/C rules.

17.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 17.7 RU uMn9: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall be reduced to moderate and remain moderate or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; K. latifolia; P. serratum*)
FISH		
Species richness	Indigenous fish species richness estimated to be thirteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, AMOS, ANAT, BGUR, BNAT, BPAL, BVIV, CGAR, GCAL, OMOS, PPHI, TREN, and TSPA) of estimated thirteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: PPHI, TSPA Migration: AMOS Water column/SD: AAEN/TREN/OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
There is a significant difference between the sites in RU uMn9, varying between ECs of B and B/C. For setting the RQO for this reach, the higher scoring site (ECs = B) will be used		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be	Maintain suitable conditions in the SIC habitat

Indicators	Narrative RQO	Numerical RQO
	adequate to ensure suitable habitats for this sensitive species.	regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

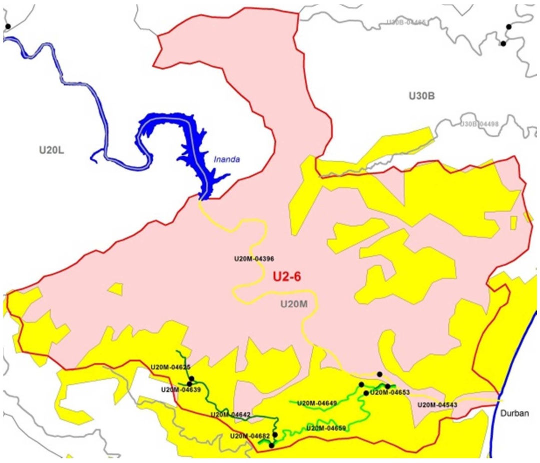
18 uMNGENI (U2): IUA U2-6 RESOURCE QUALITY OBJECTIVES

The IUA overview and description are provided below.

This IUA includes the uMngeni River downstream of Inanda Dam, as well as the Palmiet River (U20M). RQOs will only be set for the Palmiet River and the estuary. The Palmiet River reaches a range between a PES of C and D and the alterations are primarily non-flow and water quality related due to the extensively developed catchment (urban/residential and industrial areas).

IUA U2-6 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U2-6: DOWNSTREAM OF INANDA DAM TO ESTUARY



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU uMn10	U20M-04625		D	D	D	3 WQ
	U20M-04639	Palmiet	D	D	D	
	U20M-04642	Palmiet	D	D	D	
	U20M-04649	Mbongokazi	C	C	C	
	U20M-04653	Palmiet	C/D	C/D	C/D	
	U20M-04659	Palmiet	C	C	C	
	U20M-04682		C/D	C/D	C/D	

The RQOs are provided below for the TEC and the catchment configuration as illustrated above.

18.1 RQOs FOR RU uMn 10 (HIGH WATER QUALITY PRIORITY - 3WQ)

18.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: DRM (Hughes and Hannart, 2003), RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U20M-04642										
D	1.6	1.6	0.24	15.1	0.39	24.2	0.005	0.005	0.001	0.006
U20M-04649										
C	0.5	0.8	0.08	10.5	0.15	19.5	0.000	0.001	0.001	0.002
U20M-04653										
C/D	3.9	3.9	0.49	12.8	0.87	22.4	0.003	0.012	0.004	0.012
U20M-04659										
C	2.9	2.9	0.57	19.6	0.88	30.1	0.003	0.009	0.004	0.015

18.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW and eThekwini Municipality.
Model: N/A.
Users: Urban (residential and limited industrial) impacts; septic tanks, pit latrines and unsewered areas; hiking (Palmiet); New Gemany WWTW (Palmiet).
Water quality issues: Nutrients, toxics, salts, faecal coliforms/*E. coli.*
Narrative and numerical: Details for RU uMm 10 are provided below

Table 18.1 RU uMn 10: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels (phosphate) are within Tolerable limits.</td><td colspan="3">50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).
50th percentile of the data must be less than 4.0 mg/L TIN-N (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that periphyton chl-a levels are within Tolerable limits.</td><td colspan="3">50th percentile of the data must be less than 21 mg/L periphyton chl-a (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that toxics and salt levels are within appropriate limits for intended use, e.g. industrial use</td><td colspan="3">Numerical limits can be found in DWAF (1996e) (Industrial use: driver).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

18.1.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 18.2 RU uMn10: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain small or decrease.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of urban or residential development into the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. cruentus; K. latifolia; P. serratum*)

19 uMDLOTI (U3) and NORTHERN COAST (U3 and U5) RESOURCE QUALITY OBJECTIVES

19.1 IUA 3-1 (RU U3.1): uMDLOTI RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The SQs in the IUA 3.1 are in a B/C and D PES. The impacts are non-flow related activities (informal settlements with related subsistence agriculture and grazing).

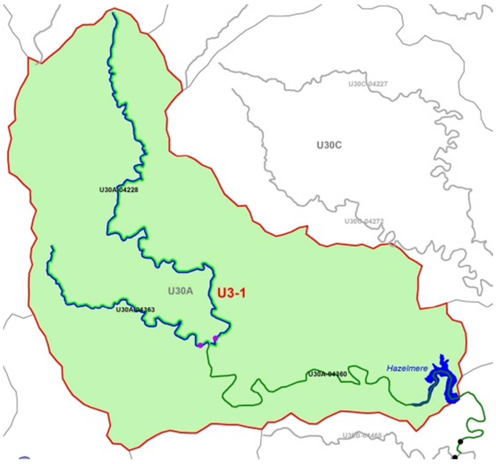
This zone includes all the rivers falling within quaternary catchments U30A (upper uMdloti), U30B (lower uMdloti), U30C (upper uThongati and Mona Rivers) and U30D (lower uThongati).

The IUA is regulated by the Hazelmere Dam located at the lower end of the IUA. The raising of Hazelmere Dam has been approved, which will take place in the near future and will have a further impact on river flows downstream of the dam.

There is some dryland sugar cane located in the upper reaches of the IUA and sand mining upstream of the dam. There are a large amount of low density settlements and rural settlements spread throughout the IUA.

IUA U3-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U3-1 - uMDLOTI UPSTREAM OF HAZELMERE DAM



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU U3.1	U30A-04228	uMdloti	B/C	B	B	3WQ
	U30A-04363	Mwangala	B/C	B	B	
	U30A-04360	uMdloti	D	D	D	

The RQOs are provided below for the TEC and the catchment configuration as illustrated above.

SQs that require improvement are listed below:

SQ	River	PES	REC	Requirement	TEC
U30A-04228	uMdloti	B/C	B	Improve riparian buffer zone, erosion control.	B
U30A-04363	Mwangala	B/C	B	Improve riparian buffer zone, erosion control.	B

19.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U30A-04228										
B*	29.8	29	4.97	16.7	8.42	28.3	0.03	0.075	0.067	0.133
U30A-04363										
B*	10.6	10.3	1.87	17.6	3.10	29.2	0.024	0.027	0.025	0.049
U30A-04360										
D	73.9	61.4	6.4	8.7	12.66	17.1	0.031	0.126	0.064	0.2

* Flows generated for a B/C rule.

19.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from eThekwini Municipality.
Model: N/A.
Users: Dispersed settlements; sand-mining; Ogungini WWTW some distance from the river; Hazelmere WWTW; Bayer Chemicals downstream dam.
Water quality issue: Turbidity, nutrients, toxics, faecal coliforms/*E. coli.*

Table 19.1 RU U3.1: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that toxics are within Ideal limits or A categories	95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008b).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

19.1.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 19.2 RU U3.1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The absence of perennial alien plant species within the riparian zone should be maintained.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should be	N/A

Indicators	Narrative RQO	Numerical RQO
	reduced to small and remain small, or improve.	
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; K. latifolia; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be seventeen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ALAB, AMAR, AMOS, ANAT, BGUR, BNAT, BPAL, BPAU, BVIV, CGAR, GAES, MFLU, OMOS, PPHI, TREN, and TSPA) of estimated seventeen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BPAU, PPHI, TSPA Migration: AMOS, ALAB, AMAR Water column/SD: AAEN,TREN,OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
There is a significant difference between the sites in RU U3.1, varying between ECs of B and D. For setting the RQO for this reach, the higher scoring site (ECs = B) will be used. The PES (11) data (DWS, 2014c) of this reach listed 18 key taxa to be present. However, due to present day influences (turbidity, water quality, dams), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Paleomonidae	Flows, without migration barriers, should be	Maintain suitable conditions in the SIC

Indicators	Narrative RQO	Numerical RQO
	adequate to ensure suitable habitats for this flow dependant species.	habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

19.2 IUA 3-2 (RU U3.2): BLACK MHLASHINI RESOURCE QUALITY OBJECTIVES

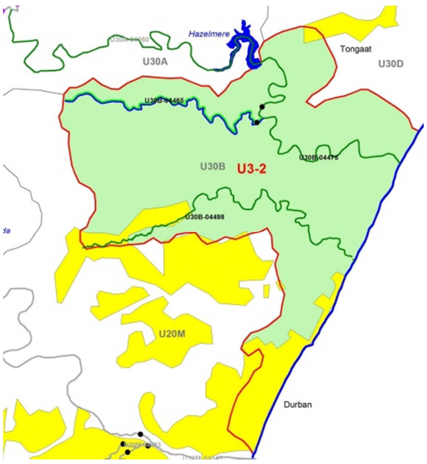
The IUA overview and description is provided below.

The Black Mhlashini is in a B/C PES due to non-flow related activities (informal settlements with related subsistence agriculture and grazing). The main uMdloti River downstream of Hazelmere Dam will be addressed as part of the estuary.

A large portion of the IUA is occupied by urban areas (Verulam) and numerous WWTW discharges.

IUA U3-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U3-2 - BLACK MHLASHINI



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU U3.2	U30B-04465	Black Mhlashini	**B/C**	**B/C**	**B/C**	**3WQ**

The RQOs are provided below for the TEC above.

SQs that require improvement are listed below:

SQ	River	PES	REC	Requirement	TEC
U30B-04465	Black Mhlashini	**B/C**	**B/C**	Extensive agriculture and urban area. Not possible to improve.	**B/C**

19.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U30B-04465										
B/C	5.5	5.4	1.01	18.5	1.63	29.7	0.005	0.014	0.012	0.031

19.2.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2012a-j; DWA, 2013a, c; DWAF, 1996a-d) were used, including a GE layer of land use from eThekwini Municipality.
Model: N/A.
Users: Settlements; quarry.
Water quality issue: Turbidity, faecal coliforms/*E. coli.*

Narrative and numerical details are provided in below.

Table 19.3 RU U3.1: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

19.3 IUA 3-3 (RU U3.3): uTHONGATI RESOURCE QUALITY OBJECTIVES

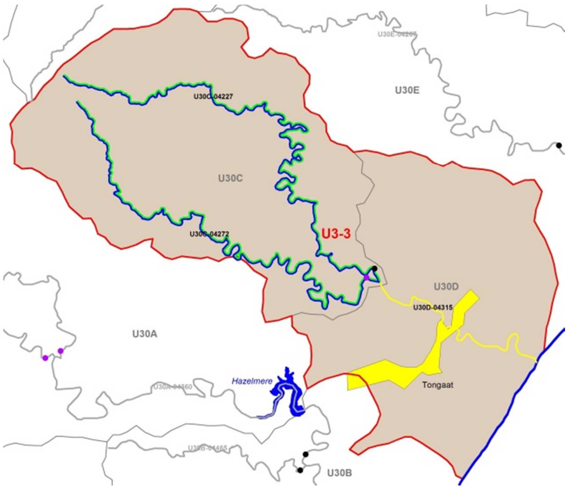
The IUA overview and description is provided below.

The SQ in the IUA is in a B/C PES. Only the two upper SQs were evaluated as the lower uThongati is represented by the estuary (E PES). The impacts in the two SQs related to non-flow related activities (informal settlements with related subsistence agriculture and grazing).

The IUA is regulated by the Dudley Pringle Dam. There is also Siphon Dam in the area. There are a large amount of low density settlements and rural settlements spread throughout the IUA. The uThongati town and industries are located in the IUA area discharges from the uThongati WWTW enter the uThongati River affecting both flow and water quality of the river. The area is predominantly a sugar cane farming area with most of the IUA covered with dry land sugar cane plantations.

IUA U3-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U3-3 - UTHONGATI



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU U3.3	U30C-04227	uThongathi	B/C	B/C	B/C	2
	U30C-04272	Mona	B/C	B	B/C	

The RQOs are provided below for the TECs as illustrated above.

SQs that require improvement are listed below:

SQ	River	PES	REC	Requirement	TEC
U30C-04272	Mona	B/C	B	Riparian buffer zone improvement.	B

19.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U30C-04227										
B/C	23.8	23.3	2.72	11.4	5.36	22.6	0.008	0.027	0.013	0.05
U30C-04272										
B*	17.1	16.8	1.95	11.4	3.88	22.6	0.009	0.017	0.012	0.041

* Flows generated for a B/C rule.

19.3.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 19.4 RU U3.3: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall	N/A

Indicators	Narrative RQO	Numerical RQO
	not expand or intensify towards or within the riparian zone.	
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; K. latifolia; P. serratum*).
	FISH	
Species richness	Indigenous fish species richness estimated to be sixteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABER, AMAR, AMOS, BGUR, BNAT, BPAL, BPAU, BVIV, CGAR, MCAP, MCEP, OMOS, PPHI, TREN, and TSPA) of estimated sixteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BPAU, PPHI, TSPA Migration: AMOS, AMAR Water column/SD: AAEN,TREN,OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
	MACRO-INVERTEBRATES	
The PES (11) data (DWS, 2014c) of this reach listed 16 key taxa to be present. However, due to present day influences (turbidity and water quality), fewer key taxa are expected (13). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae	Flows should be adequate to ensure suitable habitats for this moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

19.4 IUA NCC RESOURCE QUALITY OBJECTIVES

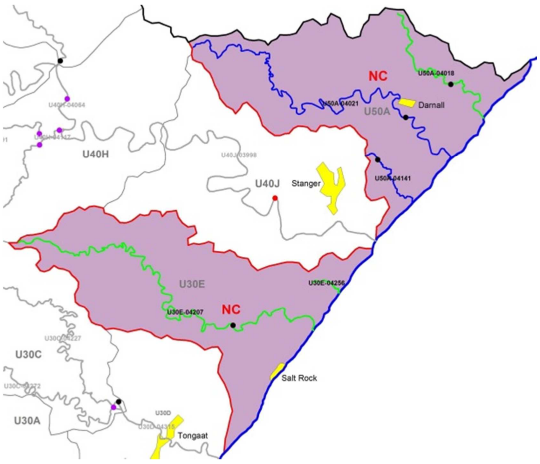
The IUA overview and description is provided below.

This ecological zone includes all the coastal rivers falling in secondary catchment U5 (U50A, B/C PES) as well as sub-quaternary reach U30E-4207 (C PES). The three U5 rivers (Zinkwazi, Nonoti and Mdlotane) and the U3E (Mhlali) are all subjected to similar land use activities of which the dominant activity is dry land formal agriculture (sugar cane). The impacts are therefore flow related, non-flow related (agriculture and settlements) as well as water quality related (agricultural and township runoff, WWTW effluents).

The storage regulation in this IUA is low and the only dams in the area include one or two small Instream dams. The area is predominantly a sugar cane farming area with most of the IUA covered with dry land sugar cane plantations. There are a few small coastal towns, some slightly inland and a few rural villages. Return flows from WWTW enter river systems in one or two cases.

IUA NCC is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA NCC - NORTHERN COASTAL CLUSTER



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU NC.1	U30E-04207	Mhlali	C	C	C	3WQ
RU NC.2	U50A-04018	Zinkwazi	B/C	B/C	B/C	2
	U50A-04021	Nonoti	B/C	B/C	B/C	
	U50A-04141	Mdlotane	B/C	B/C	B/C	

The RQOs are provided below for the TEC as illustrated above.

19.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U30E-04207										
C	33.2	32.0	4.58	13.8	8.52	25.6	0.01	0.028	0.027	0.152
U50A-04018										
B/C	11	10.7	2.62	23.8	3.95	35.9	0.015	0.035	0.022	0.063
U50A-04021										

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
B/C	30.5	26.0	3.66	12	7.31	23.9	0.018	0.033	0.028	0.083

19.4.2 Water quality RQOs (U30E-0427 only)

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used.
Model: N/A.
Users: Dispersed settlements; sand-mining; wastewater discharges.
Water quality issue: Turbidity, nutrients, faecal coliforms/*E. coli.*

Narrative and numerical details are provided below.

Table 19.5 RU NCC: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that turbidity or clarity levels stay within Acceptable limits.</td><td colspan="3">A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that nutrient levels are within Acceptable limits.</td><td colspan="3">50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

19.4.3 Habitat and Biota RQOs (EcoSpecs) for RU NC.1

Habitat and biota RQOs are provided below

Table 19.6 RU NC.1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain large or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; K. latifolia; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be twenty-four species under PES in the unit. Flows should be adequate to ensure suitable	Maintain indigenous species richness (AAEN, ABER, ABIC, ALAB, AMAR, AMOS, BGUR, BNAT, BPAL, BPAU, BVIV, CGAR, GAES,

Indicators	Narrative RQO	Numerical RQO
	habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	GCAL, GGIU, LMCR, LRIC, MCAP, MCEP, OMOS, PPHI, RDEW, TREN, and TSPA) of estimated twenty-four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BPAU, PPHI, TSPA Migration: Eels Water column/SD: AAEN,TREN,OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 15 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (11). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for both this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Gomphidae Tabanidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

19.4.4 Habitat and Biota RQOs (EcoSpecs) for RU NC.2

Habitat and biota RQOs are provided below.

Table 19.7 RU NC.2: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A

Indicators	Narrative RQO	Numerical RQO
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall be reduced to large, and remain large or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*Kniphofia latifolia; Prionium serratum*)
FISH		
Species richness	Indigenous fish species richness estimated to be twenty-six species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABER, ABIC, ALAB, AMAR, AMOS, ANAT, BGUR, BNAT, BPAL, BPAU, BTRI, BVIV, CGAR, GAES, GCAL, GGIU, LMCR, LRIC, MCAP, MCEP, OMOS, PPHI, RDEW, SSIB, TSPA) of estimated twenty-six fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BPAU, PPHI, TSPA Migration: Eels Water column/SD: AAEN,OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 15 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (14). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

Indicators	Narrative RQO	Numerical RQO
Gomphidae Tabanidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

20 MVOTI (U4): IUA U4-1 AND U4-2 (MVOTI RIVER SECTION) RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

Most SQs are in a C and B/C PES, with only the Mvozana a C/D PES. Impacts are predominantly non-flow related such as forestry, agriculture (vegetation and wetland removal), overgrazing, erosion, aquatic alien macrophytes and dams. The Heinespruit passes close to Greytown which influences the water quality. Some irrigation and centre pivots are also prevalent.

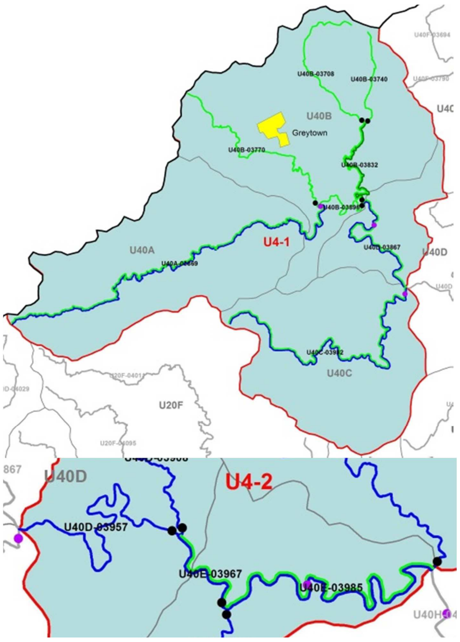
The main river is the Mvoti and the Heinespruit, Intinda, Mvozana and Khamanzi Rivers form its tributaries. In IUA U4-2, most of the Mvoti flows through a gorge and is highly confined. Predominant impacts are non-flow related: Mostly overgrazing, informal agriculture and some erosion.

The storage regulation in this IUA is low and the only dams in the area include a number of small farm and instream dams. The dams are of such nature that no releases are made for downstream users. The Greytown town is located in the upper reaches of the IUA and the discharges from the towns WWTW enter the river system, affecting both the flow and water quality of the river system.

The main land use activities in the IUA include extensive forestry and a significant amount sugar cane plantations and irrigation (sugar cane, maize etc.) also occur. There are also a few low density settlements and rural settlements located in the lower reaches.

IUA U4-1 and U4-2 (Mvoti only) are depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U4-1 and U4-2 (MVOTI ONLY)



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
MRU Heyns A	U40B-03770 Mv_I_EWR1	Heinespruit	C	C	C	3
MRU Mvoti A	U40A-03869	Mvoti	B/C	B	B	2
RU Mv 1	U40B-03708	Intinda	C	C	C	2, 3WQ
	U40B-03740	Mvozana	C	C	C	
	U40B-03832	Mvozana	C/D	C/D	C/D	
RU MV 2	U40C-03982	Khamanzi	B/C	B	B	2
MRU Mvoti B	U40B-03896	Mvoti	Mv_I_EWR2			3b
	U40D-03867	Mvoti				
	U40D-03957	Mvoti				
	U40E-03967	Mvoti				
	U40E-03985	Mvoti				

The RQOs are provided below for a ***Water Resource Class II*** and the catchment configuration as illustrated above.

20.1 RQOs FOR MRU HEYNS A WITH MV_I_EWR1 (U40B-03770) (HIGH PRIORITY - 3)

The TECs are provided below. Note that this site will not be impacted on by any of the proposed scenarios.

Component	PES, REC and TEC
Physico chemical	C
Fish	C
Invertebrates	C
Instream	C
Riparian vegetation	B/C
EcoStatus	C

20.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a,b).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC (REC)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
U40B-03770 Mv_I_EWR1	C	17.36	7.08	3.164	18.2	4.847	27.9	0.030	0.037	0.067	0.093

20.1.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWSA, 2014b). A GE layer of land use from UW was also used to provide information.
Model: PAI model (DWAF, 2008b).
Users: Agriculture; urban impacts from upstream Greytown (incl. Greytown WWTW).
Water quality issues: Nutrients, salts, toxics, faecal coliforms/*E. coli*. Note that the median *E. coli* values at RMV005 (2008-2013; n = 59) are 480 counts/100 ml. See expected impacts in DWAF (1996c).

Narrative and numerical: Details for MRU Heyns A are provided below. Data used for water quality assessments should be collected from UW site RMV005.

Table 20.1 MRU HEYNS A: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that nutrient levels (phosphate) are within Tolerable limits.</td><td colspan="3">50th percentile of the data must be less than 0.125 mg/L PO_4-P (Aquatic ecosystems: driver).
50th percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that electrical conductivity (salt) levels are within Ideal limits.</td><td colspan="3">95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that toxics are within prescribed limits to maintain or improve present state*</td><td colspan="3">Numerical limits for 95th percentiles can be found in DWAF (1996c) and DWAF (2008b).</td></tr>
<tr><td>Ensure water quality state maintains biotic requirements as specified by RQOs for biota.</td><td colspan="3">See specified biota requirements</td></tr>
<tr><td rowspan="2">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use**.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
</table>

Narrative RQO	Numerical RQO		
	< 600	600 - 2 000	> 2 000

*** Note that ammonia (NH_3-N) already exceeds Tolerable levels for aquatic ecosystems, although background levels (natural state) are not available.**

** Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

Table 20.2 MV_I_EWR1: Water quality EcoSpecs and TPCs (PES and TEC: C)

River: Heinespruit		PES: C Category
Monitoring site: RMV005		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th and 95th percentiles of the data must range from 6.5 to 8.0.	The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.
Temperature[(b)]	Natural temperature range expected.	Initiate baseline monitoring for this variable.
Dissolved oxygen[(b)]	The 5th percentile of the data must be ≥ 7.5 mg/L.	The 5th percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.
Turbidity[(b)]	Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 2.5 mg/L.	The 50th percentile of the data must be 2.0 – 2.5 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.125 mg/L.	The 50th percentile of the data must be 0.01 – 0.125 mg/L.
Response variables		
Chl-*a* phytoplankton[(b)]	The 50th percentile of the data must be < 15 µg/L.	The 50th percentile of the data must be 12 – 15 µg/L.
Chl-*a* periphyton[(b)]	The 50th percentile of the data must be ≤ 21 mg/m^2.	The 50th percentile of the data must be 17 – 21 mg/m^2.
Toxics[(b)]		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.1 mg/L.	The 95th percentile of the data must be 0.08 – 0.1 mg/L.
Other toxics	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.

(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

20.1.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 20.3 MRU HEYNS A: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category C and it should be aimed to maintain this fish EC to achieve the overall TEC. The present indigenous fish species richness of the EWR site is estimated to be six (two fish species sampled during EWR study). The primary indicator fish species for this reach (especially in terms of flow-modification) is the large semi-rheophilic Scaly (BNAT). Secondary indicators include the eel (AMOS) (longitudinal continuity, undercut banks), Bowstripe barb (BVIV) (overhanging vegetation and SS habitats), Banded tilapia (TSPA) (instream vegetation) and Mozambique tilapia (OMOS) (water column, SD habitats).
Invertebrates	The macro-invertebrate community should be representative of a small mountain stream assemblage with perennial flows. The habitats in the river are dominated by good SIC with moderate marginal vegetation overhanging the stream banks. The runs are narrow with rocky bottoms. Although the area contains exotic forestry, agricultural lands (dryland), WWTW at Greytown and river bed modification, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The overall PES at MV_I_EWR 1 (as at August 2013) for riparian vegetation was a Category B/C (81.5%). This is also the TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the TEC of the riparian zone. Perennial invasive alien species shall be removed and kept in check so as not to cause the EC to deteriorate below a Category B/C. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the TEC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). The integrity of seep wetlands associated with the riparian zone shall not deteriorate.

The EcoSpecs and TPCs are provided in the following tables.

Table 20.4 Fish EcoSpec and TPCs (PES and TEC: C)

Metric	Indicator	EcoSpecs[#]	TPC (Biotic)	TPC (Habitat)
Ecological status	PES	PES of fish is in a C (64.97%).	Decrease of PES into a lower EC than PES (<C)	Any deterioration in habitat that results in decrease in FROC* of species.
Species richness	All indigenous species	All of the expected 6 indigenous fish species estimated to still be present in the reach under PES (in reduced FROC*).	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	BNAT	BNAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	BNAT absent during two consecutive surveys OR present at FROC of <0.5.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
FD habitats		BNAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).
FS habitats		BNAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate		BNAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.

Metric	Indicator	EcoSpecs#	TPC (Biotic)	TPC (Habitat)
Water quality intolerance		BNAT estimated to occur at a FROC* of 0.5 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.		Decreased water quality (especially flow related water quality variables such as oxygen).
Overhanging vegetation	BVIV	BVIV estimated to occur at a FROC* of 1 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BVIV absent two consecutive surveys OR present at FROC of <1.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).
SS habitats		BVIV estimated to occur at a FROC* of 1 under PES have a high requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).
Instream vegetation	TSPA	TSPA estimated to occur at a FROC* of 2 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.	TSPA absent during any survey OR present at FROC of <2.	Significant change in instream vegetation habitats (flow modification, use of herbicides, nutrient enichment, water quality deterioration, invasive alien macrophytes).
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 2.5 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive surveys OR present at FROC of <2.5.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).
Water column	OMOS	OMOS estimated to occur at a FROC* of 0.5 under PES have a high requirement for water column as cover and is the most applicable indicator species for this chabitat feature.	OMOS absent during two consecutive surveys OR present at FROC of <0.5.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).
SD habitats		OMOS estimated to occur at a FROC* of 0.5 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).
Alien fish species	Presence of any alien/ introduced spp.	LMAC, MPUN, MSAL known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A
Migratory success##	AMOS BNAT	It is estimated that the catadromous AMOS may still be present, and various potamodromous species (including BNAT) also occurs.	Loss or decreased FROC[1] of catadromous (such as AMOS) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 20.5 Macro-invertebrate EcoSpec and TPCs (PES and TEC: C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Tricorythidae	> 0.6 m/s	SIC biotope	Moderate
2	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
3	Coenagrionidae, Ephemeroptera	0.3 - 0.6 m/s	Marginal vegetation	Low
4	Gomphidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 100.	SASS5 scores < 100.
To ensure that the MIRAI score remains within the range of a C Category (62.01 – 77.4), using the same reference data used in this study.	A MIRAI score of 70% or less.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following two key taxa: Tricorythidae and Heptagenidae.	Any of the two taxa absent altogether (for two consecutive samples): Tricorythidae and Heptagenidae.
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Tricorythidae.	This taxa missing during a survey.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae	This taxa missing during a survey.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae and Ephemeroptera	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae.	This taxa missing during a survey.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

Table 20.6 Riparian vegetation EcoSpec and TPCs (PES and TEC: B/C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 20%.	An absence of indigenous riparian woody species OR an increase in cover above 30%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 60%.	A decrease in non-woody cover (% aerial) below 50%.
Reed cover (% aerial)	Maintain an absence of reeds	The presence of reeds
Lower zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.

Assessed Metric	EcoSpec	TPC
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 40%.	An absence of indigenous riparian woody species OR an increase in cover above 50%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 40%.	A decrease in non-woody cover (% aerial) below 30%.
Reed cover (% aerial)	Maintain an absence of reeds.	The presence of reeds.
Upper zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species below 10%.	An increase in perennial alien plant species cover >10%.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species.	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 60%.	An decrease in indigenous riparian woody species cover below 5% or an increase above 70%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 30%.	A decrease in non-woody cover (% aerial) below 20%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 80% for the riparian zone.	A decrease in PES score below 77% for the riparian zone.
Dominant vegetation type	The dominant vegetation type within the riparian zone shall remain grass.	Aerial cover (%) of grass below 50%.

20.2 RQOs FOR MRU MVOTI A (U40A-03869) (MODERATE PRIORITY - 2)

SQ	River	PES	REC	Requirement	TEC
U40A-03869	Mvoti	B/C	B	Improve riparian buffer in forestry and agriculture areas.	B

20.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF 2008b)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40A-03869										
B*	52.1	26.6	10.06	19.3	13.75	26.4	0.054	0.083	0.179	0.727

* Flows generated for a B/C rule.

20.2.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Extensive agriculture.
Water quality issue: Nutrients, salts.

Table 20.7 MRU MVOTI A: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels (phosphate) are within Acceptable limits.	50^{th} percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95^{th} percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).

20.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in the table below.

Table 20.8 MRU MVOTI A: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall be reduced from serious to moderate within the riparian zone, and be maintained as moderate.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, BNAT, BVIV, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, BVIV, TSPA Migration: AMOS Water column/SD:OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).

Indicators	Narrative RQO	Numerical RQO
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

20.3 RQOs FOR RU Mv1 (U40B-03708, 03740, 03832) (HIGH WATER QUALITY - 3WQ AND MODERATE PRIORITY - 2)

20.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40B-03708										
C	8.2	2.3	0.54	6.6	1.24	15.2	0.003	0.003	0.014	0.018
U40B-03740										
C	4.7	1.2	0.27	5.8	0.68	14.5	0.003	0.003	0.005	0.007
U40B-03832										
C/D	22.4	6.1	1.74	7.8	2.62	11.7	0.004	0.008	0.037	0.095

20.3.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Extensive agriculture.
Water quality issue: Nutrients, salts.

Table 20.9 RU Mv1: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels (phosphate) are within Acceptable limits.	50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95^{th} percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).

20.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 20.10 RU Mv1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain large or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BANO, BNAT, BVIV, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, BVIV, TSPA Migration: AMOS Water column/SD:OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.

Indicators	Narrative RQO	Numerical RQO
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this these species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

20.4 RQOs FOR RU Mv2 (U40C-03982) (MODERATE PRIORITY - 2)

20.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40C-03982										
B*	32.0	15.7	5.02	15.7	7.59	23.7	0.029	0.068	0.079	0.147

* Flows generated for a B/C rule.

20.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 20.11 RU Mv2: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain large or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*)
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable	Maintain indigenous species richness (AMOS, ANAT, BANO, BNAT, BVIV, CGAR, OMOS, and TSPA) of estimated eight fish species in

Indicators	Narrative RQO	Numerical RQO
	habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BANO, BVIV, TSPA Migration: AMOS Water column/SD:OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

20.5 RQOs FOR MRU Mvoti B (U40B-03896, U40D-03867, 03957, U40E-03967, 03985) (MODERATE PRIORITY - 2)

20.5.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40B-039896										
C	70.93	34.75	n/a	n/a	17.86	25	0.081	0.031	0.013	0.007
U40D-03867										

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
B	96.60	41.79	n/a	n/a	24.36	25	0.110	0.042	0.019	0.010
U40D-03957										
B	146.04	72.67	n/a	n/a	36.53	25	0.169	0.061	0.029	0.015
U40E-03967										
B/C	161.62	87.66	n/a	n/a	40.25	24.9	0.189	0.064	0.034	0.017
U40E-03985										
B	199.90	119.39	n/a	n/a	49.53	24.8	0.230	0.072	0.043	0.020

All nodes extrapolated from Mv_I_EWR2 (C EcoStatus). Note that rather than incorporating these nodes with Mv_I_EWR2, they have been kept separate as they are situated upstream of the proposed dam and under Sc 42 they cannot be linked.

21 MVOTI (U4): IUA U4-2 (MVOTI RIVER TRIBUTARIES) RESOURCE QUALITY OBJECTIVES

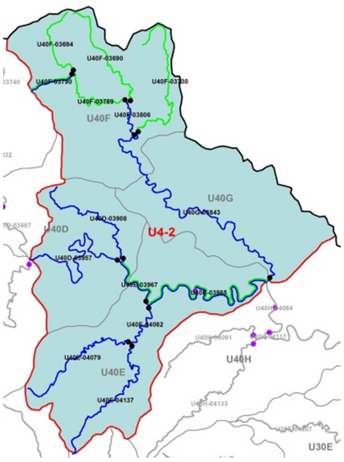
The IUA overview and description is provided below.

The Hlimbitwa and tributaries upstream of U40G-03843 are mostly C PES with the main impacts being forestry, overgrazing and instream dams.

The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The dams are of such nature that no releases are made for downstream users. The main land use in the IUA is extensive forestry and sugar cane (dryland and irrigated).

IUA U4-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U4-2 (TRIBUTARIES ONLY): MVOTI MIDDLE REACHES



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU MV3	U40D-03908	Mtize	B	B	B	2
RU MV 4	U40E-04079	Faye	B	B	B	2
	U40E-04082	Sikoto	B	B	B	
	U40E-04137	Sikoto	B	B	B	
RU Mv 5	U40F-03690	Potspruit	C	C	C	2
	U40F-03694	Hlimbitwa	C	C	C	
	U40F-03730	Cubhu	C	C	C	
	U40F-03769	Hlimbitwa	C	C	C	
	U40F-03790	Nseleni	B/C	B/C	B/C	
	U40F-03806	Hlimbitwa	B	B	B	
RU Mv 6	U40G-03843	Hlimbitwa	B	B	B	2

The RQOs are provided below for a ***Water Resource Class I*** and the catchment configuration as illustrated above.

21.1 RQOs FOR RU Mv3 (U40D-03908) (MODERATE PRIORITY - 2)

21.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40D-03908										
B	7.6	7.3	1.57	20.5	2.46	32.2	0.012	0.021	0.017	0.040

21.1.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 21.1 RU Mv3: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone.	N/A
Extent of agriculture within the riparian zone	Maintain the absence of agriculture within the riparian zone.	N/A
Extent of forestry within the riparian zone	Maintain the absence of forestry within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BNAT, BTRI, BVIV, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BTRI, BVIV, TSPA Migration: AMOS Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).

Indicators	Narrative RQO	Numerical RQO
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

21.2 RQOs FOR RU Mv4 (U40E-04079, 04082, 04137) (MODERATE PRIORITY - 2)

21.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40E-04079										
B	13.4	10.7	2.25	16.9	3.81	28.5	0.014	0.020	0.039	0.077
U40E-04082										
B	32.2	25.9	5.84	18.2	9.57	29.8	0.019	0.041	0.093	0.218
U40E-04137										
B	15.4	12.4	2.89	18.8	4.66	30.3	0.008	0.017	0.042	0.098

21.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 21.2 RU Mv4: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain small or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be eleven species under PES in the unit.	Maintain indigenous species richness (AAEN, AMOS, ANAT, BGUR, BNAT, BPAL, BTRI,

Indicators	Narrative RQO	Numerical RQO
	Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	BVIV, CGAR, OMOS, and TSPA) of estimated eleven fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA Migration: AMOS Water column/SD: AAEN, OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (dams), fewer key taxa are expected (16). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

21.3 RQOs FOR RU Mv5 (U40F-03690, 03694, 03730, 03769, 03790, 03806) (MODERATE PRIORITY - 2)

21.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40F-03690										
C	4.7	1.5	0.85	18.3	1.04	22.3	0.004	0.008	0.008	0.020
U40F-03694										
C	5.1	1.7	0.75	14.5	0.99	19.2	0.006	0.008	0.012	0.021
U40F-03730										
C	4.9	1.6	0.70	14.3	0.95	19.5	0.004	0.008	0.007	0.018
U40F-03769										
C	11.0	3.9	1.82	16.6	2.41	21.9	0.015	0.023	0.02	0.057
U40F-03790										
B/C	1.3	0.7	0.21	16.8	0.33	25.7	0.001	0.001	0.002	0.004
U40F-03806										
B	17.9	6.6	3.71	20.7	4.44	24.8	0.023	0.039	0.052	0.135

21.3.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 21.3 RU Mv5: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced to large and remain large or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, BGUR, BNAT, BTRI, BVIV, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV,		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of

Indicators	Narrative RQO	Numerical RQO
BTRI, TSPA Migration: AMOS Water column/SD: OMOS, GAR		these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
There is a significant difference between the sites in RU Mv5, varying between ECs of B and C. For setting the RQO for this reach, the higher scoring site (ECs = B) will be used. The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (16). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

21.4 RQOs FOR RU Mv6 (U40G-03843) (MODERATE PRIORITY - 2)

21.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40G-03843										
B	64.6	51.3	13.3	20.6	20.34	31.5	0.118	0.196	0.214	0.414

21.4.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Dispersed settlements and sedimentation.
Water quality issue: Turbidity.

Table 21.4 RU Mv6: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).

21.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 21.5 RU Mv6: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; K. latifolia; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMAR, AMOS, ANAT, BGUR, BNAT, BPAL, BTRI, BVIV, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BTRI, BVIV, TSPA Migration: AMOS Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (16). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s)

Indicators	Narrative RQO	Numerical RQO
	species.	and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

22 MVOTI (U4): IUA U4-3 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

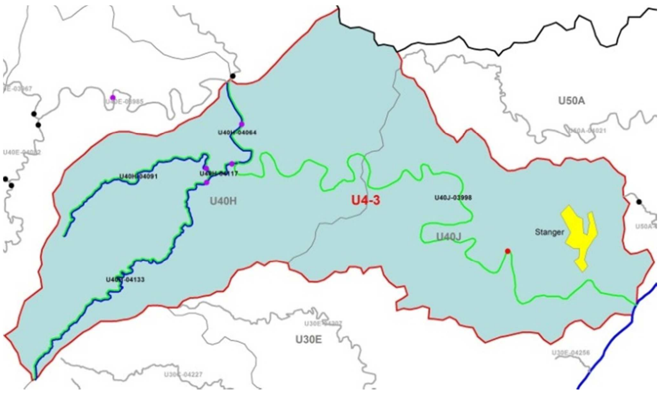
The SQs are in a B/C and C PES. Main impacts are non-flow related, especially sedimentation, overgrazing, trampling and vegetation removal. The last section of the Mvoti (U40J-03998) consists mainly of subsistence farming, dryland sugar cane, road crossings, sand mining and residential in the lower reach until the estuary.

This zone includes the Mvoti from U40H-04064 to the coast and includes the Nsuze and Pambela tributaries.

The storage regulation in this IUA is low but could however be impacted by future surface water resource developments planned upstream in the catchment i.e. the development of IsiThunda Dam. The town Kwadukuza (Stanger) is located in the lower end of the IUA and water is abstracted directly from the Mvoti River (run of river abstraction) for supplying the town, which affects the downstream river flow.

IUA U4-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U4-3 - MVOTI LOWER REACHES



RIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
MRU Mvoti C	U40H-04064 Mv_I_EWR2	Mvoti	C	C	C	3
MRU Mvoti C MRU Mvoti D	U40J-03998	Mvoti	Mvoti_I_EWR2			3WQ
RU MV 7	U40H-04091	Pambela	B/C	B	B	2
	U40H-04117	Nsuze	B/C	B	B	
	U40H-04133	Nsuze	B/C	B	B	

The RQOs are provided below for a ***Water Resource Class II*** and the catchment configuration as illustrated above.

22.1 RQOs FOR MRU MVOTI C WITH MV_I_EWR2 (U40H-04064) (HIGH PRIORITY - 3)

The TECs are provided below. Note that this site can be impacted on by the proposed scenarios. As can be seen below, fish is the only component negatively impacted on by the scenario. It must also be noted that improvement for the instream components are required through better catchment management (eg removal of alien vegetation). If these actions take place in the future, the RQOs may need revision.

Component	PES and REC	Sc 42
	Immediately applicable RQOs	RQOs if Sc 42 is implemented
Physico chemical	C	B/C
Fish	B/C	C
Invertebrates	B/C	B/C
Riparian vegetation	C/D	C/D
EcoStatus	C	C

22.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a,b).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
U40H-04064 Mv_I_EWR2	C	273.96	168.84	39.525	14.4	58.056	21.2	0.174	0.402	0.622	1.336
U40H-04064 Mv_I_EWR2	C (Sc 42)	273.96	156.1	63.3	24.1	156.1	57	0.724	0.869	1.169	1.189

22.1.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). A GE layer of land use from UW was also used to provide information.
Model: PAI model (DWAF, 2008b).
Users: Sedimentation (overgrazing and trampling).
Water quality issues: Turbidity, nutrients.
Narrative and numerical: Details for MRU Mvoti C are provided below. Data used for water quality assessments should be collected from UW site RHB001.

Table 22.1 MRU MVOTI C: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	50^{th} percentile of the data must be less than 0.125 mg/L PO_4-P (Aquatic ecosystems: driver).
Ensure that turbidity or clarity levels stay within Acceptable limits.	A small change from present with minor silting of habitats and turbidity loads (Aquatic ecosystems: driver).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements

Table 22.2 MV_I_EWR2: Water quality EcoSpecs and TPCs (PES and TEC: C)

River: Mvoti		**PES and TEC*: C Category**
Monitoring site: RHB001 on the Hlimbitwa River upstream of the EWR site		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts(a)		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th and 95th percentiles of the data must range from 6.5 to 8.0.	The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.
Temperature(b)	Natural temperature range expected.	Initiate baseline monitoring for this variable.
Dissolved oxygen(b)	The 5th percentile of the data must be ≥ 7.5 mg/L.	The 5th percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.
Turbidity(b)	Changes in turbidity are related to minor man-made modifications. Some silting of habitats are expected.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 0.475 mg/L.	The 50th percentile of the data must be 0.38 – 0.475 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.125 mg/L.	The 50th percentile of the data must be 0.1 – 0.125 mg/L.
Response variables		
Chl-*a* phytoplankton(b)	The 50th percentile of the data must be < 15 µg/L.	The 50th percentile of the data must be 12 – 15 µg/L.
Chl-*a* periphyton(b)	The 50th percentile of the data must be ≤ 21 mg/m^2.	The 50th percentile of the data must be 17 – 21 mg/m^2.
Toxics(b)		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.1 mg/L.	The 95th percentile of the data must be 0.08 – 0.1 mg/L.
Aluminium	The 95th percentile of the data must be ≤ 0.15 mg/L.	The 95th percentile of the data must be 0.012 – 0.15 mg/L.
Other toxics	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.

(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

* Note that although water quality improves with Sc 41, this is not the target as the target is usually not set higher than the REC.

22.1.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 22.3 MRU MVOTI C: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category B/C and it should be aimed to maintain this fish EC to achieve the overall TEC. It is estimated that the fish EC may decrease to a Category C over the medium to long term under Sc 42. The present indigenous fish species richness of the EWR site is estimated to be sixteen (eight fish species sampled during EWR study) and no change in species richness is expected under Sc 42. The primary indicator fish species for this reach (especially in terms of flow-modification) is the large semi-rheophilic Scaly (BNAT). Secondary indicators include the eels (longitudinal continuity, undercut banks), River goby (AAEN) (substrate), Redtail barb (BGUR) (water quality), Bowstripe barb (BVIV) (overhanging vegetation and SS habitats), Straightfin barb (BPAU) (instream vegetation) and Mozambique tilapia (OMOS) (water column, SD habitats).
Invertebrates	The macro-invertebrate community should be representative of a large low-land river assemblage with perennial flows. The wide variety of habitats in the river is represented by good SIC, adequate marginal vegetation overhanging the stream banks, and clean substrate in the runs. There are some deeper water with slower flows and rocky or bottoms. Although the area contains Low density rural settlement, overgrazing and moderate bed modification, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category B/C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The overall PES at MV_I_EWR 2 (as at August 2013) for riparian vegetation was a Category C/D (62%). This is also the target VEGRAI score for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the TEC of the riparian zone. Perennial invasive alien species shall be removed and kept in check so as not to cause the EC to deteriorate below a Category C/D. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the TEC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c).

The EcoSpecs and TPCs are provided in the following tables.

Table 22.4 Fish EcoSpec and TPCs (TEC (PES and TEC: B/C; Sc 42: C)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)	Sc 41 expected changes in EcoSpecs
Ecological status	PES	PES of fish is in a B/C (77.7%).	Decrease of PES into a lower EC than PES.	Any deterioration in habitat that results in decrease in FROC* of species.	A slight deterioration is expected under this scenario with the fish EC decreasing to a C.
Species richness	All indigenous species	16 of the expected 16 indigenous fish species estimated to be present in the reach under PES.	>10% decrease in species richness.	Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.	No change in fish species richness expected (only decreased abundance and FROC*)
Requirement for flowing water	BNAT	BNAT estimated to occur at a FROC* of 2 have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	BNAT absent during any survey OR present at FROC of <2.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).	A slight decrease in abundance and FROC expected (flow modification, decreased habitat suitability)
FD habitats		BNAT estimated to occur at a FROC* of 2 have a high requirement for FD habitats and are the most applicable FD indicator species.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)	
FS habitats		BNAT estimated to occur at a FROC* of 2 under PES have a high requirement for FS habitats and is the most applicable FS indicator species.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).	
Substrate	AAEN	AAEN estimated to occur at a FROC* of 1 have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.	AAEN absent during any survey OR present at FROC of <1.	Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.	A slight decrease in abundance and FROC expected (flow modification, decreased habitat suitability).
Water quality intolerance	BGUR	BGUR estimated to occur at a FROC* of 1.5 have a high requirement for unmodified water quality and is the most applicable water quality indicator species	BGUR absent during two consecutive surveys OR present at FROC of <1.5.	Decreased water quality (especially flow related water quality variables such as oxygen).	A slight decrease in abundance and FROC expected (flow modification, decreased habitat suitability).
Overhanging vegetation	BVIV	BVIV estimated to occur at a FROC* of 5 have a high requirement for overhanging vegetation and is the most	BVIV absent during any survey OR present at FROC of <5.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).	A slight decrease in abundance and FROC expected (flow modification, decreased habitat suitability).

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)	Sc 41 expected changes in EcoSpecs
		applicable indicator species for this habitat feature.			
SS habitats		BVIV estimated to occur at a FROC* of 5 under PES have a high requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).	
Instream vegetation	BPAU	BPAU estimated to occur at a FROC* of 1 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.	BPAU absent during two consecutive surveys OR present at FROC of <1.	Significant change in instream vegetation habitats (flow modification, use of herbicides, nutrient enrichment, water quality deterioration, invasive alien macrophytes).	A slight decrease in abundance and FROC expected (flow modification, decreased habitat suitability).
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 2 under PES have a high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	AMOS absent during three consecutive surveys OR present at FROC of <2.	Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).	A slight decrease in abundance and FROC expected (flow modification, decreased habitat suitability).
Water column	OMOS	OMOS estimated to occur at a FROC* of 3.5 under PES have a high requirement for water column as cover and is the most applicable indicator species for this chabitat feature.	OMOS absent during any survey OR present at FROC of <3.5.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).	A slight decrease in abundance and FROC expected (flow modification, decreased habitat suitability).
SD habitats		OMOS estimated to occur at a FROC* of 3.5 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).	
Alien fish species	presence of any alien/introduced spp.	LMAC, MSAL known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A	No change expected.
Migratory success#	ABIC AMAR AMOS BNAT	It is estimated that the catadromous ABIC, AMAR, AMOS may still be present, and various potamodromous species (including BNAT) also occurs.	Loss or decreased FROC[1] of catadromous (such as AMOS) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).	No significant change expected (dam in upstream catchment)

Table 22.5 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B/C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp.	> 0.6 m/s	SIC biotope	Good
2	Tricorythidae, Philopotamidae	> 0.6 m/s	SIC biotope	Moderate
3	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
4	Leptophlebidae, Elmidae	0.3 - 0.6 m/s	SIC biotope	Moderate
5	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
6	Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
7	Gomphidae, Tabanidae, Athericidae	-	Course sediment	Low
EcoSpecs		**TPCs**		
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 200; ASPT value: > 6.0.		SASS5 scores < 200 and ASPT < 6.3.		
To ensure that the MIRAI score remains within the range of a B/C Category (>77.4 and <82.01), using the same reference data used in this study.		A MIRAI score of 80% or less.		
Presence of at least four of the following five high-scoring taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae, Heptagenidae and Philopotamidae.		2 or > of these taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., Tricorythidae, Heptagenidae and Philopotamidae.		
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following six key taxa: Perlidae, Hydropsychidae 2 spp., Tricorythidae, Philopotamidae, Heptagenidae and Leptophlebidae.		Less than five of the six key taxa listed.		
Maintain suitable flow velocity (maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae, Hydropsychidae 2 spp., Tricorythidae and Philopotamidae.		Any one of these taxa missing for two consecutive surveys.		
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae, Elmidae and Libellulidae.		Any one of these taxa missing for two consecutive surveys.		
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Atyidae		This taxa missing during surveys.		
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae and Athericidae.		Any one of these taxa missing during surveys.		
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.		The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.		

Table 22.6 Riparian vegetation EcoSpec and TPCs (PES and TEC B/C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain the presence of indigenous riparian woody species.	An absence of indigenous riparian woody species OR an increase in cover above 40%

Assessed Metric	EcoSpec	TPC
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 60%.	A decrease in non-woody cover (% aerial) below 50%.
Reed cover (% aerial)	Maintain reeds cover below 10%.	Reeds cover exceeds 10%.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species below 15%.	An increase in perennial alien plant species cover >20%.
Terrestrial woody species aerial cover	Maintain cover of terrestrial woody species below 10%.	An incresae in terrestrial woody species cover above 20%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 40%.	An absence of indigenous riparian woody species OR an increase in cover above 50%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 50%.	A decrease in non-woody cover (% aerial) below 40%.
Reed cover (% aerial)	Maintain reeds cover below 10%.	Reeds cover exceeds 10%.
Upper zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species below 30%.	An increase in perennial alien plant species cover >40%.
Terrestrial woody species aerial cover	Maintain cover of terrestrial woody species below 30%.	An incresae in terrestrial woody species cover above 40%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 60%.	An decrease in indigenous riparian woody species cover below 5% or an increase above 70%.
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 50%.	A decrease in non-woody cover (% aerial) below 40%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 60% for the riparian zone.	A decrease in PES score below 57% for the riparian zone.

22.2 RQOs FOR MRU MVOTI C AND D (U40J-03998) (HIGH WATER QUALITY PRIORITY - 3WQ)

22.2.1 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Dispersed settlements and sedimentation; **extensive sand-mining**; Mvoti and Stanger WWTW; Ushukela sugar mill and Sappi Stanger mill, Stanger mill effluent and ponds; some urban impacts in lower reaches. Poor quality water, particularly below the confluence of the Nchaweni and Mbozambo rivers and the Mvoti River (Malherbe, 2006).
Water quality issue: Nutrients, salts, toxics, turbidity, faecal coliforms/*E. coli.*

Narrative and numerical details are provided in Table 22.7.

Table 22.7 U40J-03998: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that turbidity or clarity levels stay within Acceptable limits.</td><td colspan="3">A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that nutrient levels are within Acceptable limits.</td><td colspan="3">50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that electrical conductivity (salt) levels are within Ideal limits.</td><td colspan="3">95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that toxics are within Ideal limits or A categories</td><td colspan="3">95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008b).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

22.3 RQOs FOR RU Mv7 (U40H-04091, 04117, 04133) (MODERATE PRIORITY - 2)

SQ	River	PES	REC	Requirement	TEC
U40H-04091	Pambela	B/C	B	Reinstate riparian zone.	B
U40H-04117	Nsuze	B/C	B	Reinstate riparian zone.	B
U40H-04133	Nsuze	B/C	B	Reinstate riparian zone, erosion control.	B

22.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a)
Model: RDRM (Hughes *et al*., 2013), WRYM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U40H-04091										
B*	13.2	13.2	2.05	15.6	3.43	26	0.012	0.021	0.017	0.04
U40H-04117										
B*	29.8	29.8	5.0	16.9	8.22	27.6	0.014	0.020	0.039	0.077
U40H-04133										
B*	15.7	15.7	2.66	17	4.34	27.6	0.019	0.041	0.093	0.218

* Flows generated for a B/C rule.

22.3.2 Water quality RQOs

Source: Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used, including a GE layer of land use from UW.
Model: N/A.
Users: Sedimentation.
Water quality issue: Turbidity.

Table 22.8 RU Mv7: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).

22.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 22.9 RU Mv7: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian zone.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; K. latifolia; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be thirteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABIC, AMOS, BGUR, BNAT, BPAL, BPAU, BTRI, BVIV, CGAR, OMOS, PPHI, and TSPA) of estimated thirteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BPAU, PPHI, TSPA Migration: Eels Water column/SD: AAEN,OMOS		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity, water quality, dams), fewer key taxa are expected (11). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for these flow dependant	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s)

.Indicators	Narrative RQO	Numerical RQO
	species.	and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

23 uMLAZI (U6) RESOURCE QUALITY OBJECTIVES

23.1 IUA U6-1 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

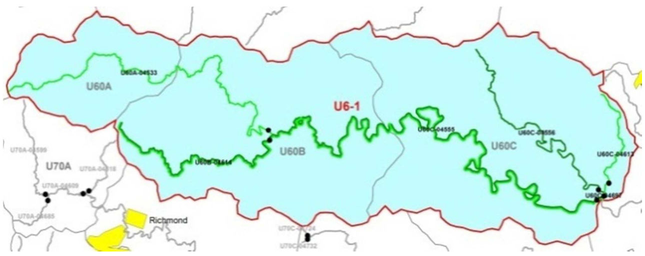
The IUA is dominated by C/D and D PES rivers. Upstream of the Shongweni Dam predominant impacts are both flow (instream dams and irrigation) and non-flow related (forestry, agricultural activities, alien invasive vegetation, and water quality especially in U60C-04556).

The IUA is regulated by the Shongweni Dam located at the lower end of the IUA and there are also a number of small farm and instream dams. There is no future surface water developments planned in the IUA.

The main landuse activities include cultivation (dryland sugar cane, maize), irrigation and forestry located in the upper half of the IUA. There are some low density settlements as well as semi-urban and urban areas with industries located in the lower half of the IUA. Discharges from the Hopewell and Hammersdale (industrial area) WWTW into the rivers affect both the flow and especially the water quality of the river.

IUA U6-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U6-1 UPPER uMLAZI



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU U6.1	U60A-04533	uMlazi	C	C	C	3WQ
	U60B-04614	Mkuzane	C/D	C/D	C/D	
	U60C-04555	uMlazi	C/D	C/D	C/D	
RU U6.2	U60C-04556	Sterkspruit	D	D	D	3WQ
RU U6.3	U60C-04613	Wekeweke	C	C	C	3WQ

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

23.1.1 RQOs for RU U6.1 (U60A-04533, 04614, 04555) (High water quality priority - 3 WQ and moderate priority - 2 for habitat and biota)

23.1.2 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U60A-04533										
C	33.2	19.4	5.44	16.4	7.95	23.9	0.015	0.023	0.033	0.191
U60B-04614										
C/D	8.5	3.1	1.54	18.1	1.86	21.9	0.012	0.019	0.02	0.039
U60C-04555										
C/D	76.1	38.8	12.29	16.2	17.32	22.8	0.019	0.019	0.02	0.303

23.1.3 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used. A GE layer of land use from UW was also used to provide information.
Model: N/A.
Users: Irrigation; Mpumalanga WWTW; urban discharges (Hopewell, Mpumalanga); Baynesfield Piggery and associated ponds; intensive agriculture and veg production; extensive poultry farming; sand-mining
Water quality issue: Nutrients, turbidity, salts, toxics, faecal coliforms/*E. coli.*

Table 23.1 RU U6.1: Narrative and numerical water quality RQOs

<table>
<tr><th>Narrative RQO</th><th colspan="3">Numerical RQO</th></tr>
<tr><td>Ensure that turbidity or clarity levels stay within Acceptable limits.</td><td colspan="3">A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that electrical conductivity (salt) levels are within Tolerable limits.</td><td colspan="3">95th percentile of the data must be less than or equal to 85 mS/m (Aquatic ecosystems: driver).</td></tr>
<tr><td>Ensure that toxics are within Ideal limits or A categories</td><td colspan="3">95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).</td></tr>
<tr><td>Ensure that nutrient levels are within Tolerable limits.</td><td colspan="3">50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).</td></tr>
<tr><td rowspan="3">Meet faecal coliform and E. coli targets for recreational / other (full or partial contact) use*.</td><td colspan="3">Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>< 600</td><td>600 - 2 000</td><td>> 2 000</td></tr>
</table>

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

23.1.4 Habitat and Biota RQOs (EcoSpecs)

Habitat and Biota RQOs (EcoSpecs) for U60A-04533 (uMlazi) are provided below.

Table 23.2 RU U6.1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian zone.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*H. polymorpha; K. latifolia; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be eleven species under PES in the unit.	Maintain indigenous species richness (AAEN, AMOS, ANAT, BGUR, BNAT, BPAL, BVIV,

Indicators	Narrative RQO	Numerical RQO
	Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	CGAR, OMOS, TREN, and TSPA) of estimated eleven fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA Migration: AMOS Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (11). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

23.1.5 RQOs for RU U6.2 (U60C-04556) (High water quality priority - 3 WQ)

23.1.6 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U60C-04556										
D	9.3	8.7	1.50	16.1	2.25	24.2	0.005	0.015	0.007	0.023

23.1.7 Water quality RQOs

Source: Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used. A GE layer of land use from UW was also used to provide information.
Model: N/A.
Users: Cato Ridge WWTW; Old Hammarsdale sludge disposal (incl Hg and Sn waste); urban and industrial discharges from Hammarsdale; extensive poultry farming in upper part of RU; sand-mining; Sterkspruit quarry; recreational users of Shongweni Dam Nature Reserve; textile industries;.
Water quality issue: Nutrients, salts, turbidity, toxics, faecal coliforms/*E. coli.*

Narrative and numerical details are provided below.

Table 23.3 RU U6.2: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	95^{th} percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).		
Ensure that toxics are within Ideal limits or A categories, particularly Hg and Sn	95^{th} percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).		
Ensure that nutrient levels are within Tolerable limits.	50^{th} percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

23.1.8 RQOs for RU U6.3 (U60C-04613) (High water quality priority - 3 WQ)

23.1.9 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U60C-04613										
C	1.8	1.1	0.2	11.1	0.38	21.1	0.002	0.002	0.002	0.003

23.1.10 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used. A GE layer of land use from Umgeni Water was also used to provide information.
Model: N/A.
Users: Intensive agriculture; Shongweni hazardous waste site.
Water quality issue: Nutrients, toxics.

Table 23.4 RU U6.3: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that toxics are within Ideal limits or A categories	95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008b).
Ensure that nutrient levels are within Tolerable limits.	50th percentile of the data must be less than or equal to 0.075 mg/L PO_4-P (Aquatic ecosystems: driver).

23.2 IUA U6-2 RESOURCE QUALITY OBJECTIVES

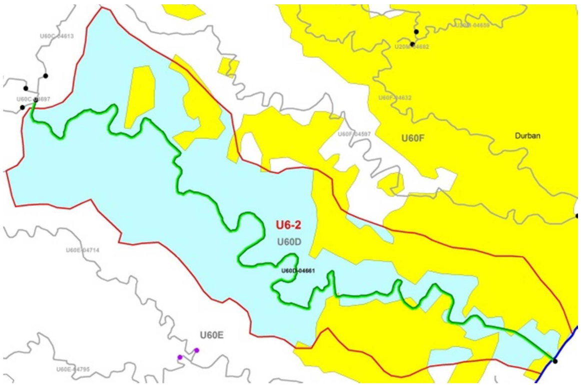
The IUA overview and description is provided below.

The river is in a D PES and impacts are degraded water quality and riparian vegetation removal (wood harvesting and grazing).

The IUA is regulated by the upstream Shongweni Dam and there is no future surface water developments planned in the IUA. The middle to upper reach of the IUA is occupied by scattered rural villages and the middle to lower reach by semi-urban and urban areas. Discharges from numerous WWTW enter the river system affecting both flow and especially the water quality of the river. There is also a hazardous landfill site in the upper reaches of the tributaries which also affect the water quality of the uMlazi River, which is regarded as very poor. The lower end of the Mlazi River has been canalised and hence there is no estuary

IUA U6-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U6-2 LOWER uMLAZI



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU U6.4	U60D-04661	uMlazi	C/D	C/D	C/D	3WQ

The RQOs are provided below for the TEC as illustrated above.

23.2.1 RQOs for RU U6.4 (U60D-04661) (High water quality priority - 3 WQ)

23.2.2 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U60D-04661										
C/D	101.6	65.2	17.19	16.9	25.13	24.7	0.097	0.293	0.137	0.461

23.2.3 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used. A GE layer of land use from UW was also used to provide information.
Model: N/A.
Users: Old KwaNdengezi and Dassenhoek WWTW; hazardous landfill; dense settlements incl. informal settlements and Umlazi; sand mining
Water quality issue: Nutrients, salts, toxics, turbidity, faecal coliforms/*E. coli*.

Table 23.4 RU U6.4: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).		
Ensure that toxics and salt levels are within appropriate limits for intended use, e.g. industrial use	Numerical limits can be found in DWAF (1996e) (Industrial use: driver).		
Ensure that nutrient levels are within Tolerable limits.	50^{th} percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). 50^{th} percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

23.3 IUA U6-3 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The upper Mbokodweni (U60E-04714) is a B PES and the remainder of the IUA a C PES. Impacts are non-flow related including water quality, vegetation removal (wood harvesting) and sugar cane plantations (in the upper reach). Similarly, the main impacts on the Bivane River is also non-flow related (trampling, sedimentation, vegetation removal).

The storage regulation in this IUA is low and there are no major dams present. There is some sugar cane (dryland) located in the upper reaches of the IUA. The middle to upper reach of the IUA is occupied by scattered rural villages and the middle to lower reach by semi-urban areas, urban areas (uMlazi, Isipingo) as well as industrial areas close to the coast (Prospecton Industrial area). Discharges from numerous WWTW enter the river system affecting both flow and especially the water quality of the river.

IUA U6-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U6-3 MBOKODWENI

PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU U6.5	U60E-04714	Mbokodweni	B	B	B	2
	U60E-04795	Bivane	B/C	B	B	
RU U6.6	U60E-04792	Mbokodweni	C	C	C	3WQ

The RQOs are provided below for TEC as illustrated above.

23.3.1 RQOs for RU U6.5 (U60E-04714, 04795) (Moderate priority - 2)

SQ	River	PES	REC	Requirement	TEC
U60E-04795	Bivane	B/C	B	Erosion control, riparian buffer instatement, agricultural practices.	B

23.3.2 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U60E-04714										
B	16.8	15.7	2.97	17.6	4.81	28.6	0.02	0.046	0.041	0.082
U60E-04795										
B	6.6	6.1	1.17	17.8	1.89	28.8	0.009	0.017	0.014	0.038

23.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and Biota RQOs (EcoSpecs) are provided below.

Table 23.5 RU U6.5: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	Maintain the absence of perennial alien plant species within the riparian zone.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Extent of forestry within the riparian zone	Forestry shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*I. flanaganiae; P. serratum*).

.Indicators	Narrative RQO	Numerical RQO
FISH		
Species richness	Indigenous fish species richness estimated to be fourteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABER, AMOS, ANAT, BGUR, BNAT, BPAL, BVIV, CGAR, OMOS, PPHI, RDEW, TREN, and TSPA) of estimated fourteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for this key species.

23.3.4 RQOs for RU U6.6 (U60E-04792) (High water quality priority - 3WQ)

23.3.5 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U60E-04792										
C	26.1	24.3	4.4	16.8	7.04	26.9	0.015	0.059	0.028	0.102

23.3.6 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used. GE layers of land use from UW and eThekwini Municipality were also used to provide information.
Model: N/A.
Users: aManzimtoti WWTW; Izimbokodweni wastewater pump station; dense settlements so urban impacts
Water quality issue: Nutrients, salts, toxics, faecal coliforms/*E. coli*.

Table 23.6 RU U6.6: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that toxics and salt levels are within appropriate limits for intended use, e.g. industrial use	Numerical limits can be found in DWAF (1996e) (Industrial use: driver).		
Ensure that nutrient levels are within Tolerable limits.	50^{th} percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). 50^{th} percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 – 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

24 LOVU (U7): IUA U7-1 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The upper Lovu catchment (U70A) is situated in areas mainly covered with plantation forestry (C and B/C PES). Further downstream there are large areas of forestry. Sugar cane, rural development (towns/townships), and dams, have increased impacts on these rivers, especially the water quality (C/D PES). The deeper valleys of the Lovu and Nungwane prevent the people from impacting too much on the rivers but water quality impacts prevail.

The storage regulation in this IUA is low and the only dams include a number of small farm and instream dams.

There are extensive forestry and sugar cane plantations located in the middle to upper reach of the IUA with Richmond town and adjacent township also located in the upper reach. The middle to lower reach of the IUA is occupied by scattered rural villages. Discharges from the Richmond and township area enter the river systems affecting both the flow and especially the water quality of the river.

IUA U7-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA U7-1 LOVU RIVER

PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
MRU Lovu A	U70A-04609	Lovu	B/C	B/C	B/C	2
	U70A-04685	Lovu	C	C	C	
RU L1	U70A-04599	Serpentine	C	C	C	2
	U70A-04618		C	C	C	
MRU Lovu B	U70B-04655	Lovu	C/D	C/D	C/D	3WQ
RU L2	U70C-04710	Mgwahumbe	C	C	C	2
	U70C-04724		C	C	C	
	U70C-04732		C	C	C	
MRU Lovu D	U70C-04859 Lo_R_EWR1	Lovu	B/C	B/C	B/C	3
RU L3	U70D-04800	Nungwane	B/C	B/C	B/C	2

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

24.1 RQOs FOR MRU LOVU A (U70A-04609, 04685) (MODERATE PRIORITY - 2)

24.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U70A-04609										
B/C*	17.81	10.51	n/a	n/a	6.36	36	0.027	0.009	0.005	0.002
U70A-04685										
C*	1.66	1.01	n/a	n/a	0.59	36	0.003	0.001	0.000	0.000

* Extraplated from Lo_R_EWR1 (B/C EcoStatus).

24.1.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 24.1 MRU LOVU A: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry activities into the riparian zone and existing forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate or decrease.	N/A
Extent of agriculture within the riparian zone	Agriculture shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*).
FISH		
Species richness	Indigenous fish species richness estimated to be six species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BNAT, CGAR, OMOS, and TSPA) of estimated six fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: TSPA Migration: AMOS Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (flows), fewer key taxa are expected (15) . The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15

Indicators	Narrative RQO	Numerical RQO
		cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

24.2 RQOs FOR RU L1 (U70A-04599, 04618) (MODERATE PRIORITY - 2)

24.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U70A-04599										
C	10.4	6.0	1.68	16.1	2.57	24.6	0.012	0.023	0.024	0.048
U70A-04618										
C	3.5	2.2	0.59	17.1	0.89	25.8	0.002	0.009	0.009	0.014

24.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 24.2 RU L1: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry activities into the riparian zone and existing forestry shall not	N/A

.Indicators	Narrative RQO	Numerical RQO
	expand or intensify towards or within the riparian zone.	
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate or decrease.	N/A
Extent of agriculture within the riparian zone	Agriculture shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia*)
FISH		
Species richness	Indigenous fish species richness estimated to be six species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BNAT, CGAR, OMOS, and TSPA) of estimated six fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: TSPA Migration: AMOS Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (flows), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

24.3 RQOs FOR MRU LOVU B (U70B-04655) (HIGH WATER QUALITY PRIORITY AND MODERATE PRIORITY - 2 (HABITAT AND BIOTA))

24.3.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U70B-04655										
C/D*	61.24	37.21	n/a	n/a	21.11	34.5	0.094	0.028	0.021	0.009

*Extraplated from Lo_R_EWR1 (B/C EcoStatus).

24.3.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used. A GE layer of land use from UW was also used to provide information.
Model: N/A.
Users: Urban and industrial (Richmond and Ndaleni), incl. Richmond WWTW - at upper end of MRU; intensive agriculture
Water quality issue: Nutrients, toxics, salts, faecal coliforms/*E. coli*.

Table 24.3 MRU Lovu B: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that salt levels are within Ideal limits.	95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Ensure that toxics are within Ideal limits or A categories	95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996c) and DWAF (2008b).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	Medium	High
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

24.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 24.4 MRU Lovu B: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A

.Indicators	Narrative RQO	Numerical RQO
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry activities into the riparian zone and existing forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate or decrease.	N/A
Extent of agriculture within the riparian zone	Agriculture shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Five (5) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; I. flanaganiae; K. latifolia; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be eight species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, BGUR, BNAT, BPAL, CGAR, OMOS, and TSPA) of estimated eight fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BPAL, TSPA Migration: AMOS Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (flows, dams and water quality), fewer key taxa are expected (10). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for both this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

24.4 RQOs FOR RU L2 (U70C-04710, 04724, 04732) (MODERATE PRIORITY - 2)

24.4.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U70C-04710										
C	22.2	20.2	5.28	23.8	7.35	33.1	0.04	0.106	0.06	0.115
U70C-04724										
C	0.1	0.1	Catchment too small for Desktop modelling.							
U70C-04732										
C	0.0	0.0	Catchment too small for Desktop modelling.							

24.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 24.5 RU L2: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry activities into the riparian zone and existing forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate or decrease.	N/A
Extent of agriculture within the riparian zone	Agriculture shall remain absent within the riparian zone.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*I. flanaganiae; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be ten species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, AMOS, ANAT, BGUR, BNAT, BPAL, BVIV, CGAR, OMOS, and TSPA) of estimated ten fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).

.Indicators	Narrative RQO	Numerical RQO
Secondary indicator species: Vegetation/SS: BPAL, BVIV, TSPA Migration: AMOS Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (flows), fewer key taxa are expected (154). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

24.5 RQOs FOR MRU LOVU D WITH LO_R_EWR1 (U70C-04859) (HIGH PRIORITY - 3)

Component	PES, REC and TEC
Physico chemical	**B/C**
Fish	**B/C**
Invertebrates	**B/C**
Riparian vegetation	**B/C**
EcoStatus	**B/C**

24.5.1 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

EWR	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
								90%	60%	90%	60%
U70C-04859 Lo_R_EWR2	**B/C**	87.76	73.42	20.044	22.8	33.231	37.9	0.142	0.189	0.359	0.533

24.5.2 Water quality RQOs

Source: Water quality assessment was conducted as part of the 2012 - 2015 Mvoti to Umzimkulu WMA Comprehensive Reserve study (DWS, 2014b). GE layers of land use from UW and eThekwini Municiaplity were also used to provide information.
Model: PAI model (DWAF, 2008b).
Users: Settlements; subsistence agriculture; sedimentation (overgrazing and trampling).
Water quality issues: Turbidity
Narrative and numerical: Details for MRU Lovu D are provided below. Data used for water quality assessments should be collected from UW site RNW001, although not ideal as this site is on the Nungwane River in U70D-04800. However, both the EWR and UW site are in the same Level II EcoRegion.

Table 24.6 MRU Lovu D: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity or clarity levels stay within Acceptable limits.	A small change from present with minor silting of habitats and turbidity loads (Aquatic ecosystems: driver).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 24.7 LO_R_EWR1: Water quality EcoSpecs and TPCs (PES and TEC: B/C)

River: Lovu		**PES: B/C Category**
Monitoring site: RNW001		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95th percentile of the data must be ≤ 16 mg/L.	The 95th percentile of the data must be 13 – 16 mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L.	The 95th percentile of the data must be 16 – 20 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L.	The 95th percentile of the data must be 12 – 15 mg/L.
$CaCl_2$	The 95th percentile of the data must be ≤ 21 mg/L.	The 95th percentile of the data must be 17 – 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L.	The 95th percentile of the data must be 36 – 45 mg/L.
$CaSO_4$	The 95th percentile of the data must be ≤ 351 mg/L.	The 95th percentile of the data must be 280 – 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 30 mS/m.	The 95th percentile of the data must be 24 – 30 mS/m.
pH	The 5th percentile of the data must be 6.5 – 8.0, and the 95th percentile 8.0 – 8.8	The 5th percentile of the data must be < 6.3 and > 7.8, and the 95th percentile must be < 8.2 and > 8.6
Temperature[(b)]	Natural temperature range.	Initiate baseline monitoring for this variable.
Dissolved oxygen[(b)]	The 5th percentile of the data must be ≥ 7.5 mg/L.	The 5th percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.
Turbidity[(b)]	Changes in turbidity are related to minor man-made modifications. Some silting of habitats are expected.	Initiate baseline monitoring for this variable.
Nutrients		
Total Inorganic Nitrogen (TIN-N)	The 50th percentile of the data must be ≤ 2.5 mg/L.	The 50th percentile of the data must be 2.0 – 2.5 mg/L.
PO_4-P	The 50th percentile of the data must be ≤ 0.015	The 50th percentile of the data must be 0.012 –

River: Lovu		**PES: B/C Category**
Monitoring site: RNW001		
Water quality metrics	**EcoSpecs**	**TPC**
	mg/L.	0.015 mg/L.
Response variables		
Chl-*a* phytoplankton(b)	The 50th percentile of the data must be < 15 µg/L.	The 50th percentile of the data must be 12 – 15 µg/L.
Chl-*a* periphyton(b)	The 50th percentile of the data must be ≤ 12 mg/m^2.	The 50th percentile of the data must be 10 – 12 mg/m^2.
Toxics		
Ammonia (NH_3-N)	The 95th percentile of the data must be ≤ 0.1 mg/L.	The 50th percentile of the data must be 0.08 – 0.1 mg/L.
Aluminium	The 95th percentile of the data must be ≤ 0.15 mg/L.	The 95th percentile of the data must be 0.012 – 0.15 mg/L.
Other toxics	The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).	An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

24.5.3 Habitat and Biota RQOs (EcoSpecs)

The narrative RQOs are provided as follows.

Table 24.8 MRU LOVU D: Narrative habitat and biota RQOs

Component	Narrative RQO
Fish	The PES based on fish of the EWR site in this unit was estimated to fall in a Category B/C and it should be aimed to maintain this fish EC to achieve the overall TEC. The present indigenous fish species richness of the EWR site is estimated to be twelve (eight fish species sampled during EWR study). The primary indicator fish species for this reach (especially in terms of flow-modification) is the large semi-rheophilic Scaly (BNAT). Secondary indicators include the eels (longitudinal continuity, undercut banks), Redtail barb (BGUR) (water quality), Bowstripe barb (BVIV) (overhanging and instream vegetation and SS habitats) and Mozambique tilapia (OMOS) (water column, SD habitats).
Invertebrates	The macro-invertebrate community should be representative of a medium foothill stream assemblage with perennial flows. The habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks. Although cultivation, subsistence farming, roads, a large instream dam with water abstraction, rural villages and instream weirs, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category B/C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.
Riparian vegetation	The overall PES at LO_R_EWR 1 (as at August 2013) for riparian vegetation was a Category B/C (77.7%). This is also the TEC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the TEC of the riparian zone. Perennial invasive alien species shall be removed and kept in check so as not to cause the EC to deteriorate below a Category B/C. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the TEC and maintain current levels of endemism. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (DWS, 2014c). The integrity of seep wetlands associated with the riparian zone shall not deteriorate.

The EcoSpecs and TPCs are provided in the following tables.

Table 24.9 Fish EcoSpec and TPCs (PES and TEC: B/C)

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
Ecological status	PES	Present ecological status of fish is in a B/C (78.9%).	Decrease of PES into a lower EC than PES (<B/C).	Any deterioration in habitat that results in decrease in FROC* of species.
Species	All	12 of the expected 12	>10% decrease in	Loss in diversity, abundance

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
richness	indigenous species	indigenous fish species estimated to be present in the reach under PES.	species richness.	and condition of velocity-depth categories and cover features that lead to a loss of species.
Requirement for flowing water	BNAT	BNAT estimated to occur at a FROC* of 3 under PES have a high requirement for flow during all life stages and is the most applicable indicator species for flow modification.	BNAT absent during any survey OR present at FROC of <3.	Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, altered seasonality).
FD habitats		BNAT estimated to occur at a FROC* of 3 under PES have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows)
FS habitats		BNAT estimated to occur at a FROC* of 3 under PES have a high requirement for FS habitats and is the most applicable indicator species for this velocity-depth category.		Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).
Substrate		AAEN estimated to occur at a FROC* of 1 under PES have a high requirement for substrate of good quality and is the most applicable indicator species for this habitat feature.		Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.
Water quality intolerance	BGUR	BGUR estimated to occur at a FROC* of 1 under PES have a high requirement for unmodified water quality and is the most applicable indicator species for water quality deterioration.	BGUR absent during two consecutive surveys OR present at FROC of <1.	Decreased water quality (especially flow related water quality variables such as oxygen).
Overhanging vegetation	BVIV	BVIV estimated to occur at a FROC* of 3 under PES have a high requirement for overhanging vegetation and is the most applicable indicator species for this habitat feature.	BVIV absent during any survey OR present at FROC of <3.	Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)
SS habitats		BVIV estimated to occur at a FROC* of 3 under PES have a high requirement for SS habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).
Instream vegetation		MARG estimated to occur at a FROC* of 1 under PES have a high requirement for instream vegetation and is the most applicable indicator species for this velocity-depth category.		Significant change in instream vegetation habitats (flow modification, use of herbicides, water quality deterioration, alin invasive macrophytes)
Water column	OMOS	MARG estimated to occur at a FROC* of 1 under PES have a high requirement for water column as cover and is the most applicable indicator species for this chabitat feature.	OMOS absent during any survey OR present at FROC of <4.	Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).
SD habitats		ALAB estimated to occur at a FROC* of 1 under PES have a high requirement for SD habitats and is the most applicable indicator species for this velocity-depth category.		Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).
Undercut banks	AMOS	AMOS estimated to occur at a FROC* of 1 under PES have a	AMOS absent during three consecutive	Significant change in undercut bank and rootwads habitats

Metric	Indicator spp.[1]	REC EcoSpecs	REC TPC (Biotic)	REC TPC (Habitat)
		high requirement for undercut banks and is the most applicable indicator species for this habitat feature.	surveys OR present at FROC of <1.	(e.g. bank erosion, reduced flows).
Alien fish species	presence of any alien/ introduced spp.	No known or expected to be present in the SQ reach.	Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.	N/A
Migratory success[##]	ABIC ALAB AMOS BNAT	It is estimated that the catadromous ABIC, ALAB, AMOS may still be present, and various potamodromous species (including BNAT) also occurs.	Loss or decreased FROC[1] of catadromous (such as AMOS) or potamodromous species (such as BNAT).	Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).

Table 24.10 Macro-invertebrate EcoSpec and TPCs (PES and TEC: B/C)

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	Perlidae, Hydropsychidae 2 spp.	> 0.6 m/s	SIC biotope	Good
2	Heptagenidae	0.3 - 0.6 m/s	SIC biotope	Good
3	Leptophlebidae	0.3 - 0.6 m/s	SIC biotope	Moderate
4	Libellulidae	0.3 - 0.6 m/s	SIC biotope	Low
5	Coenagrionidae, Atyidae	0.3 - 0.6 m/s	Marginal vegetation	Low
6	Gomphidae, Tabanidae, Athericidae	-	Course sediment	Low

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 160; ASPT value: > 6.0.	SASS5 scores < 170 and ASPT < 6.3.
To ensure that the MIRAI score remains within the range of a B/C Category (>77.4 and <82.01), using the same reference data used in this study.	A MIRAI score of 80% or less.
Presence of at least two of the following three high-scoring taxa: Perlidae, Hydropsychidae 2 spp., and Heptagenidae.	Any of the following taxa present only as individuals, or two taxa absent altogether (for two consecutive samples): Perlidae, Hydropsychidae 2 spp., and Heptagenidae.
Maintain suitable conditions (water quality, shading, temperature and habitat conditions) for the following eight key taxa: Perlidae, Hydropsychidae 2 spp., Heptagenidae and Leptophlebidae.	Less than 3 of the 4 key taxa listed.
Maintain suitable flow velocity(maximum > 0.6 m/s) and clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: Perlidae and Hydropsychidae 2 spp.	Any one of these taxa missing for two consecutive surveys.
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent (moderate flows) taxa in the FFCS biotope: Heptageniidae, Leptophlebidae and Libellulidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: Coenagrionidae and Atyidae.	Any one of these taxa missing during surveys.
Maintain sufficient quantity and quality of course sediment to support the following bottom dwelling taxa: Gomphidae, Tabanidae and Athericidae.	Any one of these taxa missing during surveys.
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae, Hydropsychidae, Heptageniidae). No group to consistently dominate the fauna i.e. be present in D abundance (>1000) over more than two consecutive surveys.	The presence of one or more taxon occurring in D abundance, i.e. >1000 individuals for two consecutive surveys.

Table 24.11 Riparian vegetation EcoSpec and TPCs (PES and TEC B/C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien plant species.	An occurrence of perennial alien plant species.
Terrestrial woody species aerial cover	Maintain an absence of terrestrial woody species	An occurrence of terrestrial woody species in the sub-zone.
Indigenous riparian woody species cover (% aerial)	Maintain the presence of indigenous riparian woody species.	An absence of indigenous riparian woody species OR an increase in cover above 40%
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 70%.	A decrease in non-woody cover (% aerial) below 60%.
Reed cover (% aerial)	Maintain reeds cover below 10%.	Reeds cover exceeds 10%.
Lower zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species below 10%.	An increase in perennial alien plant species cover >15%
Terrestrial woody species aerial cover	Maintain cover of terrestrial woody species below 10%.	An incresae in terrestrial woody species cover above 20%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 5% and below 40%.	An absence of indigenous riparian woody species OR an increase in cover above 50%
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 70%.	A decrease in non-woody cover (% aerial) below 60%.
Reed cover (% aerial)	Maintain reeds cover below 10%.	Reeds cover exceeds 10%.
Upper zone		
Alien invasion (perennial alien species)	Maintain cover (% aerial) of perennial alien plant species below 20%.	An increase in perennial alien plant species cover >30%
Terrestrial woody species aerial cover	Maintain cover of terrestrial woody species below 10%	An incresae in terrestrial woody species cover above 20%.
Indigenous riparian woody species cover (% aerial)	Maintain cover (% aerial) of indigenous riparian woody species above 10% and below 80%.	An decrease in indigenous riparian woody species cover below 5% or an increase above 90%
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs) (% aerial)	Maintain non-woody cover (% aerial) above 50%.	A decrease in non-woody cover (% aerial) below 40%.
Riparian zone		
PES	Maintain PES score (using VEGRAI level 4 for assessment) of at least 77% for the riparian zone.	A decrease in PES score below 75% for the riparian zone.

24.6 RQOs FOR RU L3 (U70D-04800) (MODERATE PRIORITY - 2)

24.6.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U70D-04800										
B/C	15.2	9.3	3.28	21.6	4.34	28.6	0.021	0.048	0.027	0.07

24.6.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 24.12 RU L3: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain moderate or decrease.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Two (2) listed riparian species should remain viable within the RU (*I. flanaganiae; P. serratum*).
FISH		
Species richness	Indigenous fish species richness estimated to be fourteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABER, AMAR, AMOS, ANAT, BGUR, BNAT, BPAL, BVIV, CGAR, OMOS, PPHI, TREN, and TSPA) of estimated fourteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BPAL, BVIV, TSPA Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope

.Indicators	Narrative RQO	Numerical RQO
		(15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

25 CENTRAL CLUSTER (CC) IUA (U6 AND U7) RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

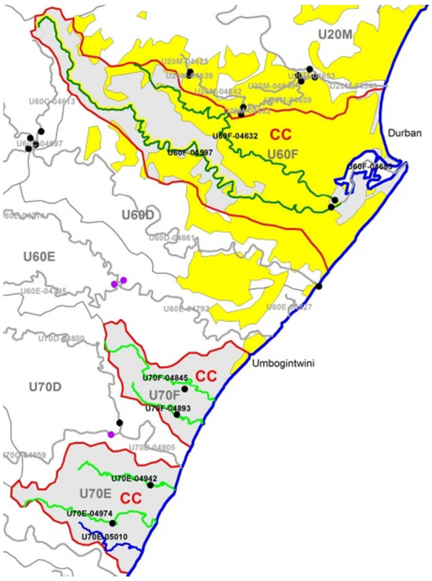
Four coastal rivers in the U7 (Lovu) were evaluated and are in a C PES. The impacts are rural settlement with extensive high density townships, with associated activities (informal agriculture and some sugar cane).

The Mhlatuzana and Umbilo Rivers in U60F upstream of Durban harbour are highly developed with many residential, rural and industrial areas. Main impacts are non-flow related with poor water quality, trampling, sedimentation, alien vegetation and vegetation removal resulting in a PES of D and D/E for the Umbilo and Mhlatuzana respectively.

The storage regulation in this IUA is low and the only dams in the area include one or two small Instream dams. The area is predominantly urban with some semi-urban and rural settlements. Return flows from a number of WWTW enter river systems affecting both the flow and quality of the river system.

IUA CC is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA CC (COASTAL CLUSTER)



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU CC	U60F-04597	Mhlatuzana	D/E	D	D/E	3WQ
	U60F-04632	Umbilo	D	D	D	
RU CC 1	U70E-04942	Umsimbazi	C	C	C	2
	U70E-04974	uMgababa	C	C	C	
RU CC 2	U70F-04845	aManzimtoti	C	C	C	3WQ
	U70F-04893	Little aManzimtoti River	C	C	C	

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

25.1 RQOs FOR RU U6 CC (U60F-04597, 04632) (HIGH WATER QUALITY PRIORITY - 3WQ)

25.1.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U60F-04597										
D/E	Water quality issues only									
U70F-04632										
D	12.7	19.4	1.82	14.4	2.9	22.9	0.006	0.014	0.007	0.03

25.1.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used. GE layers of land use from Umgeni Water and eThekwini Municipality were also used to provide information.
Model: N/A.
Users: Umbilo and Umhlatuzana WWTW; dense settlements and urban areas; large quarry; hikers use Paradise Valley Nature Reserve.
Water quality issue: Nutrients, toxics, salts, turbidity, faecal coliforms/*E. coli*.

Table 25.1 RU CC: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that toxics and salt levels are within appropriate limits for intended use, e.g. industrial use	Numerical limits can be found in DWAF (1996e) (Industrial use: driver).		
Ensure that nutrient levels are within Tolerable limits.	50th percentile of the data must be less than 0.075 mg/L PO_4-P (Aquatic ecosystems: driver). 50th percentile of the data must be less than 2.5 mg/L TIN-N (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	**Medium**	**High**
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

25.2 RQOs FOR RU U7 CC.1 (U70E-04942, 04974) (MODERATE PRIORITY - 2)

25.2.1 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U70E-04942										
C	7.9	7.7	1.38	17.5	2.10	26.7	0.009	0.018	0.016	0.033
U70E-04974										
C	5.0	4.9	1.03	20.7	1.49	29.9	0.004	0.015	0.011	0.025

25.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 25.2 RU U7 CC.1: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should remain small.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry activities into the riparian zone and existing forestry shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced to, and remain moderate.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain absent.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*G. natalense; H. polymorpha; K. latifolia).*
FISH		
Species richness	Indigenous fish species richness estimated to be twenty-four species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (ANAT and BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABER, AMAR, AMOS, ANAT, BGUR, BNAT, BPAL, BVIV, CGAR, GAES, GCAL, GGIU, LMCR, LRIC, MARG, MCAP, MCEP, MFAL, OMOS, PPHI, RDEW, TREN, and TSPA) of estimated twenty-four fish species in this RU. Maintain current habitat diversity.
Primary indicator species: ANAT and BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows during all seasons for small rheophilic species (ANAT) and large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (wet season).
Secondary indicator species: Vegetation/SS: BPAL, BVIV, TSPA Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 18 key taxa to be present. However, due to present day influences (turbidity and dams), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.

.Indicators	Narrative RQO	Numerical RQO
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment.

25.3 RQOs FOR RU U7 CC.2 (U70F-04845, 04893) ((HIGH WATER QUALITY PRIORITY - 3WQ)

25.3.1 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U70F-04845										
C	4.7	4.6	0.69	14.5	1.2	25.3	0.003	0.01	0.006	0.018
U70F-04893										
C	1.4	2.4	0.16	11.3	0.29	20.5	0.001	0.001	0.001	0.003

25.3.2 Water quality RQOs

Source: No detailed water quality assessment conducted. PES (11) data and literature sources (e.g. DWA, 2012b-k; DWA, 2013a; DWS, 2014c; DWAF, 1996a-d) were used. GE layers of land use from Umgeni Water and eThekweni Municipality were also used to provide information.
Model: N/A.
Users: Extensive settlements and urban impacts, including Kingsburgh WWTW.
Water quality issue: Nutrients, faecal coliforms/*E. coli*

Table 25.3 RU U7 CC.2: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO		
Ensure that nutrient levels are within Acceptable limits.	50th percentile of the data must be less than 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).		
Meet faecal coliform and *E. coli* targets for recreational / other (full or partial contact) use*.	Potential health risks in terms of counts / 100 ml (SA NMMP guidelines).		
	Low	Medium	High
	< 600	600 - 2 000	> 2 000

* Guidelines are provided in the absence of data or knowledge of recreational activities in the area.

26 U8 RESOURCE QUALITY OBJECTIVES

26.1 IUA U8-1 RESOURCE QUALITY OBJECTIVES

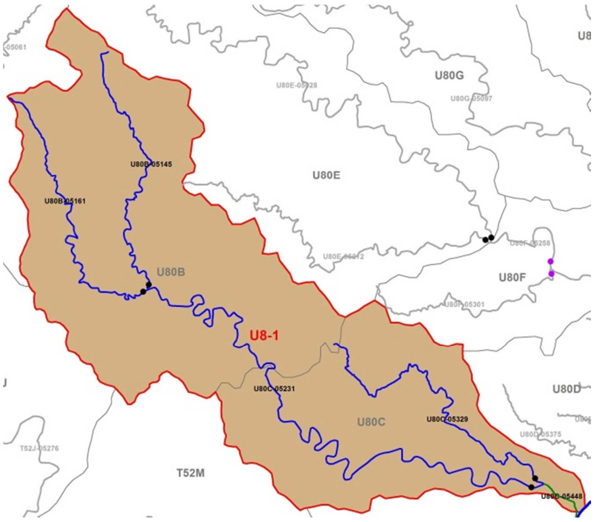
The IUA overview and description is provided below.

All the SQs that comprise the Mzumbe system have B PES. Impacts in the Mzumbe comprise mainly forestry (U80B-05145), rural settlements and subsistence farming, small dams in the tributaries, and associated non-flow related impacts such as grazing, but all with low severity or extent.

The storage regulation in this IUA is low with no significant dams present. The Mhlabatshane Dam has been commissioned during the last few years.

IUA is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 8-1 MZUMBE



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU U8 1	U80B-05145	Mzumbe	B	B	B	2
	U80B-05161	Mhlabatshane	B	B	B	
	U80C-05231	Mzumbe	B	B	B	
	U80C-05329	Kwa-Malukaka	B	B	B	

The RQOs are provided below for the TEC and catchment configuration as illustrated above.

26.1.1 RQOs for RU 8.1 (U80B-05145, 05161, U80C-05231, 05329) (Moderate priority - 2)

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep 90%	Sep 60%	Feb 90%	Feb 60%
U80B-05145										
B	7.9	6.4	1.86	23.6	2.74	34.9	0.013	0.022	0.024	0.059
U80B-05161										
B	8.8	8.1	2.12	24.1	3.11	35.4	0.02	0.031	0.021	0.054
U80C-05231										
B	47.9	44.7	10.70	22.4	16.59	34.7	0.071	0.21	0.159	0.329

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U80C-05329										
B	9.4	9.1	2.19	23.3	3.33	35.4	0.014	0.02	0.021	0.051

26.1.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 26.1.

Table 26.1 RU 8.1: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The absence of perennial alien plant species within the riparian zone should be maintained.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain absent.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*I. flanaganiae; M. whitei; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be seventeen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABER, AMAR, AMOS, BGUR, BNAT, BPAL, BVIV, CGAR, GCAL, GGIU, LMCR, LRIC, OMOS, PPHI, TREN, and TSPA) of estimated seventeen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BPAL, BVIV, TSPA Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).

.Indicators	Narrative RQO	Numerical RQO
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

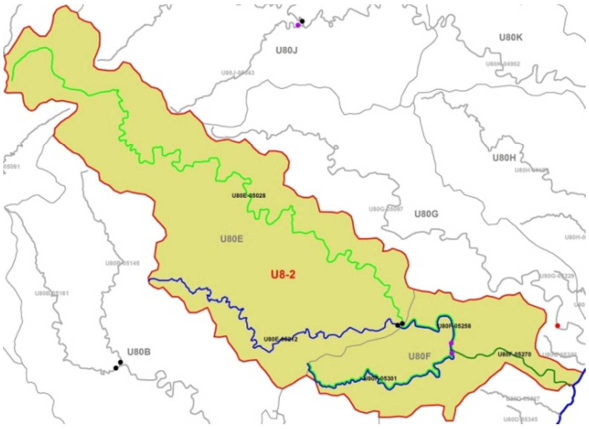
26.2 IUA U8-2 RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.
Rivers are mostly in a B, C, B/C and D PES. Both flow and non-flow related impacts dominate the Mtwalume and its tributaries. Notable are instream dams, forestry, subsistence agriculture and encroaching sugar cane fields. Rural villages are also scattered throughout the IUA with semi-urban and urban areas located along the coast

The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few instream dams. There is no future surface water developments planned in the IUA.

IUA is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 8-2 MTWALUME



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU U8 2	U80E-05028	Mtwalume	C	B	C	2
RU U8 3	U80E-05212	Quha	B	B	B	2
	U80F-05258	Mtwalume	B/C	B	B	
	U80F-05301	uMngeni	B/C	B	B	

The RQOs are provided below for the TECs as illustrated above.

26.2.1 RQOs for RU 8.2 (U80E-05028) (moderate priority - 2)

SQ	River	PES	REC	Requirement	TEC
U80E-05028	Mtwalume	C	B	14 dams in first 12 km. Without removal of dams, not possible to improve. Therefore maintain the PES.	C

26.2.2 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U80E-05028										
C	27.8	18.1	3.91	14.1	6.08	21.9	0.024	0.058	0.058	0.108

26.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 26.2.

Table 26.2 RU 8.2: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The absence of perennial alien plant species within the riparian zone should be maintained.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain moderate, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain absent.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain moderate or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*I. flanaganiae; M. whitei; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be seven species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, AMOS, BGUR, BNAT, CGAR, OMOS, and TSPA) of estimated seven fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS:, TSPA Migration: AMOS Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (dams and turbidity), fewer key taxa are expected (14). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s)

.Indicators	Narrative RQO	Numerical RQO
	species.	and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

26.2.4 RQOs for RU U8.3 (U80E-05212, U80F-05258, 05301) (Moderate priority - 2)

SQ	River	PES	REC	Requirement	TEC
U80F-05258	Mtwalume	B/C	B	Improve water quality of return flows.	B
U80F-05301	uMngeni	B/C	B	Improve water quality of return flows. Reinstate buffer zone.	B

26.2.5 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U80E-05212										
B	11.2	10.6	3.01	26.8	4.3	38.4	0.014	0.034	0.022	0.054
U80F-05258										
B*	42.6	32.2	5.88	13.8	10.27	24.1	0.082	0..165	0.132	0.182
U80F-05301										
B*	7.2	7.1	1.30	18	2.11	29.1	0.011	0.017	0.012	0.029

* Flows generated for a B/C rule.

26.2.6 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in below.

Table 26.3 RU U8.3: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The absence of perennial alien plant species within the riparian zone should be maintained.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be	N/A

.Indicators	Narrative RQO	Numerical RQO
	no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain absent.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain small or decrease.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*I. flanaganiae; M. whitei; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be seventeen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AAEN, ABER, AMAR, AMOS, BGUR, BNAT, BVIV, CGAR, GAES, GCAL, GGIU, MCAP, MCEP, MCYP, OMOS, PPHI, and TSPA) of estimated seventeen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA Migration: Eels Water column/SD: OMOS, CGAR		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Paleomonidae	Flows, without migration barriers, should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s), low water quality and no migration barriers for this species.
Coenagrionidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

26.3 IUA U8 SC RESOURCE QUALITY OBJECTIVES

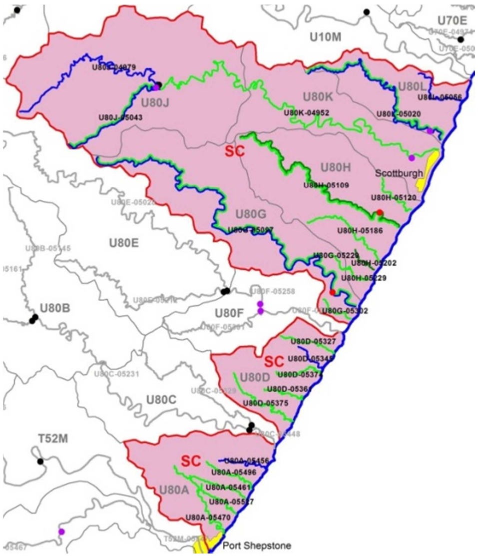
The IUA overview and description is provided below.

The Mzinto River is in a D PES. Extensive sugar cane farming, in addition to other developments in the catchment is present. The Mpambanyoni system (U80J and U80K) is in a B, B/C and C PES. Impacts are forestry on the upper catchments, with rural developments and associated cultivation, as well as in-stream weirs downstream. The Fafa River system (U80G) is in a C PES mainly due to rural developments, plantations and an in-stream weir. Low priority wetlands have been noted on the Fafa (U80G-05097), Mzinto (U80H-05109) and Mpambanyoni (U80K-04952) Rivers. These consist of small to narrow patches of both channelled and unchannelled valley bottom wetlands.

The lower density in human settlement in the Mbizana (T4) River has resulted in a B PES. The higher density of rural settlements, sugar cane farming, an in-stream dam, WWTW and quarries close to the river, places the Vungu (T4) River in a B/C PES.

IUA U8 SC is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA SC SOUTHERN COASTAL



PRIORITY RATING

RU	SQ	River	PES	REC	TEC	PR
RU SC 3	U80G-05097	Fafa	**B/C**	**B**	**B**	**2**
RU SC 4	U80H-05109	Mzinto	**C/D**	**C**	**C**	**2**
RU SC 5	U80J-04979	Mpambanyoni	**B**	**B**	**B**	**2**
	U80J-05043	Ndonyane	**B/C**	**B**	**B/C**	
RU SC 6	U80K-04952	Mpambanyoni	**C**	**B**	**C**	**2**
RU SC 7	U80L-05020	aMahlongwa	**B/C**	**B**	**B/C**	**2**

The RQOs are provided below for the TECs as illustrated above.

26.3.1 RQOs for RU SC 3 (U80G-05097) (Moderate priority - 2)

SQ	River	PES	REC	Requirement	TEC
U80G-05097	Fafa	**B/C**	**B**	Reinstate riparian zone. Improve flow (optimise irrigation methods) , and agricultural return flows – watr quality.	**B**

26.3.2 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U80G-05097										
B*	46.4	38.6	8.76	18.9	14.02	30.2	0.038	0.113	0.134	0.216

* Flows generated for a B/C rule.

26.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided below.

Table 26.4 RU SC 3: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should be reduced to zero.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced from moderate to small and be maintained as small.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall be reduced from moderate to small and be maintained as small.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*I. flanaganiae; M. whitei; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be nineteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (ABER, AMAR, AMOS, BNAT, BVIV, CGAR, GAES, GCAL, GGIU, LMCR, LRIC, MCAP, MCEP, MCYP, MFAL, OMOS, PPHI, TREN, and TSPA) of estimated nineteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA, PPHI Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (dams andturbidity), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15

Indicators	Narrative RQO	Numerical RQO
		cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

26.3.4 RQOs for RU SC 4 (U80H-05109) (Moderate priority (2) for biota and habitat)

SQ	River	PES	REC	Requirement	TEC
U80H-05109	Mzinto	C/D	C	Reinstate riparian zone. Improve flow (optimise irrigation methods), and agricultural return flows – watr quality.	C

26.3.5 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U80H-05109										
C/D*	22.9	19.9	3.17	13.9	5.75	25.1	0.01	0.031	0.019	0.05

* Flows generated for a C/D rule.

26.3.6 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in below.

Table 26.5 RU SC 4: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should be maintained as zero.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone	Riparian zone fragmentation shall not	N/A

.Indicators	Narrative RQO	Numerical RQO
fragmentation	increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain absent.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall be maintained as small.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*I. flanaganiae; M. whitei; P.m serratum).*
	FISH	
Species richness	Indigenous fish species richness estimated to be nineteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (*BNAT*). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (ABER, AMAR, AMOS, BNAT, BVIV, CGAR, GAES, GCAL, GGIU, LMCR, LRIC, MCAP, MCEP, MCYP, MFAL, OMOS, PPHI, TREN, and TSPA) of estimated nineteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA, PPHI Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
	MACRO-INVERTEBRATES	
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (Dams and water quality), fewer key taxa are expected (11). The RQOs therefore consider these adjustments to the PES (11) results.		
Hydropsychidae 2 spp.	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae	Flows should be adequate to ensure suitable habitats for this flow dependant species.	Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

26.3.7 RQOs for RU SC 5 (U80J-0497, 05043) (Moderate priority - 2)

SQ	River	PES	REC	Requirement	TEC
U80J-05043	Ndonyane	B/C	B	Reinstate riparian zone. Erosion control difficult. Therefore maintain the PES.	B/C

26.3.8 Flow RQOs

Source: DWA (2014a,b), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U80J-0497										
B	12.6	10.2	3.09	24.5	4.55	36.1	0.015	0.034	0.023	0.057
U80J-05043										
B/C	6.5	5.7	1.29	19.7	2.04	31.3	0.012	0.017	0.011	0.022

26.3.9 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in below.

Table 26.6 RU SC5: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should be reduced to zero.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall be reduced from moderate to small and be maintained as small.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall be maintained as small.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*I. flanaganiae; M. whitei; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be nine species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers	Maintain indigenous species richness (AMAR, AMOS, BGUR, BNAT, BVIV, CGAR, OMOS, TREN, and TSPA) of estimated nine fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet

.Indicators	Narrative RQO	Numerical RQO
	to fish.	season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA, Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

26.3.10 RQOs for RU SC 6 (U80K-04952) (Moderate priority - 2)

SQ	River	PES	REC	Requirement	TEC
U80K-04952	Mpambanyoni	C	B	Water quality from irrigation return flows addressed, Reinstate riparian zone as buffer. Erosion control. Difficult. Therefore maintain the PES.	C

26.3.11 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes *et al*., 2013), WRPM (DWAF, 2008c)

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U80K-04952										
C	58.0	53.1	5.79	10	11.72	20.2	0.084	0.164	0.148	0.178

26.3.12 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in below.

Table 26.7 RU SC 6: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The presence of perennial alien plant species within the riparian zone should be reduced to zero.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should remain small, or improve.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall be reduced from moderate to small and be maintained as small.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*I. flanaganiae; M. whitei; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be nineteen species under PES in the unit. Flows should be adequate to ensure suitable habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (ABER, AMAR, AMOS, BNAT, BVIV, CGAR, GAES, GCAL, GGIU, LMCR, LRIC, MCAP, MCEP, MCYP, MFAL, OMOS, PPHI, TREN, and TSPA) of estimated nineteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA, PPHI Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae Hydropsychidae 2 spp. Psephenidae Prosopistomatidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).

.Indicators	Narrative RQO	Numerical RQO
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

26.3.13 RQOs for RU SC 7 (U80L-05020) (Moderate priority - 2)

SQ	River	PES	REC	Requirement	TEC
U80L-05020	aMahlongwa	B/C	B	Reinstate riparian zone as buffer. Erosion control Difficult. Therefore maintain the PES.	B/C

26.3.14 Flow RQOs

Source: DWA (2014a), DWS (2014a).
Model: RDRM (Hughes et al., 2013), WRPM (DWAF, 2008c).

A summary of the flow RQOs are provided below and the full EWR rule is available electronically.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
U80L-05020										
B/C	10.5	10.1	2.55	24.3	3.73	35.6	0.014	0.04	0.019	0.058

26.3.15 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in below.

Table 26.8 RU SC 7: Narrative and numerical habitat and biota RQOs

.Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Presence of alien plant species in the riparian zone	The absence of perennial alien plant species within the riparian zone should be reduced to zero.	Insufficient quantitative data exist to develop numerical RQOs.
Riparian zone continuity	Modification of riparian zone continuity should be improved from oderate to small and maintained as small.	N/A
Riparian zone fragmentation	Riparian zone fragmentation shall not increase (from its 2014 state). There shall be no expansion of forestry or agricultural activities into the riparian.	N/A
Extent of forestry within the riparian zone	The extent of forestry within the riparian zone shall remain zero.	N/A
Extent of agriculture within the riparian zone	The extent of agriculture within the riparian zone shall remain zero.	N/A
Sensitive riparian species	Viable populations of sensitive riparian plant species should remain within the RU.	Three (3) listed riparian species should remain viable within the RU (*I. flanaganiae; M. whitei; P. serratum).*
FISH		
Species richness	Indigenous fish species richness estimated to be eighteen species under PES in the unit. Flows should be adequate to ensure suitable	Maintain indigenous species richness (ABER, AMAR, AMOS, BNAT, BVIV, CGAR, GAES, GCAL, GGIU, LMCR, LRIC, MCAP, MCEP,

.Indicators	Narrative RQO	Numerical RQO
	habitats for primary (flow dependent) indicator species (BNAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation and water column (depth) as cover for some fish species and do not allow an increase in migration barriers to fish.	MFAL, OMOS, PPHI, TREN, and TSPA) of estimated eighteen fish species in this RU. Maintain current habitat diversity.
Primary indicator species: BNAT (flow, flow related water quality, substrate condition)		Maintain suitable flows for large semi-rheophilic species (BNAT). Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be available to facilitate migration (especially wet season).
Secondary indicator species: Vegetation/SS: BVIV, TSPA, PPHI Migration: Eels Water column/SD: OMOS, TREN		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
The PES (11) data (DWS, 2014c) of this reach listed 17 key taxa to be present. However, due to present day influences (turbidity), fewer key taxa are expected (15). The RQOs therefore consider these adjustments to the PES (11) results.		
Perlidae Hydropsychidae 2 spp. Psephenidae	Flows and water quality should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm deep).
Tricorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant species.	Maintain suitable conditions for both these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Libellulidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and low water quality for this species.
Heptagenidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive species.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.
Leptophlebidae Elmidae	Flows should be adequate to ensure suitable habitats for these moderate flow dependant species.	Maintain suitable conditions in moderate velocity (0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).
Pyralidae	Marginal vegetation habitat should be adequate to accommodate these key species.	Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for this key species.
Coenagrionidae Atyidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.
Gomphidae Tabanidae Athericidae	The quantity and quality of clean course sediment should be sufficient to support these bottom-dwelling taxa.	Maintain suitable conditions associated with the course sediment for these key species.

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28 APPENDIX A: REPORT COMMENTS

Page / Section	Report statement	Comments	Changes made?	Author comment
Renelle Pillay, DWS – 20 April 2015				
General comment: coliforms		The South African Water Quality Guidelines (SAWQG) have set limits for Faecal Coliforms and not E. coli according to my understanding. E. coli is a highly specific indicator of faecal pollution relating to humans and warm blooded animals. However, the SAWQG only makes reference to Faecal coliforms. Please could this be clarified? Both E. coli and Faecal coliforms can still be monitored at the EWR sites.	No	The South African Water Quality Guidelines include guidelines for both *E. coli* and facial coliforms. Both are retained in the RQO report.
Table 4-1		Numerical RQO – e.g turbidity - report uses the words ‘vary by a small amount from nature’ – should the order of variation not be defined. There are other tables that refer to moderate variation. My concern is how we define small / moderate variation from background concentration. Is this defined by DWS in a guideline document?	No	The water quality manual for rivers (DWAF, 2008) provides descriptive cues where quantitative data are not available, e.g. for turbidity. Unfortunately the orders of variation can only be more specifically defined once a database of turbidity data exists, and categories have been defined.
General comment		In areas were the background and current concentrations exceeds the SAWQG already, a phased approach to meet the target should be set, perhaps at 5 year intervals to reduce the background/current concentration (can be based on percentage reduction in relation to historic/current concentrations.	No	The Implementation Report for the study will look at providing more information regarding the phased implementation of water quality RQOs.
General comment: phosphates		At some points lower down in the catchment where there higher agricultural areas and diffuse sources of phosphates – it may not be always be possible to achieve target values (50^{th} percentile below 0.015mg/l for orthophosphate)	No	Monitoring and implementation of water quality RQOs will show where modification of RQOs may be required, or enforcement should take place to meet instream objectives.
Table 23.1	Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95^{th} percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).	On the Sterkspruit River (Hammarsdale / Shongweni area), the EC cannot be achieved in the resource due to the Textile Industry. Source control measures are in place but even with this, the WWTW will still only be able to treat EC to between 200 -250 mS/m. Flow in the resource may not achieve dilution needed to meet the 95th percentile of the data must be less than or equal to 55 mS/m. Has background data of EC on this river been provided by eThekwini.	Yes	The RQO has been modified as follows: Ensure that electrical conductivity (salt) levels are within Tolerable limits: 95^{th} percentile of the data must be less than or equal to 85 mS/m (Aquatic ecosystems: driver). Note that even under this change the water quality RQO for Electrical Conductivity will not be met, and this will be noted as a non-compliant area.
General comment: faecal coliforms		The faecal coliform counts in rivers in the urban areas are > 2000 counts/100ml in general, so this target cannot be achieved 100% of the time.	No	The high levels of faecal coliforms / *E. coli* in the urban areas therefore indicate high risk to persons exposed to these levels as either intermediate or full-contact users.

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Laura Taylor, Little aManzimtoti Conservancy – 13 May 2015				
Table 2-14	IUA 7CC, row RU CC 2	Please note that these are two distinct rivers (Little aManzimtoti and aManzimtoti rivers) flow into the sea separately, not one mouth and estuary, but two.	No	The rivers are placed into the same Resource Unit, but not dealt with as one estuarine system. The estuaries are therefore acknowledged to be two different estuaries.
Mmaphefo Thwala, DWS – 22 May 2015				
		Flow RQOs: you say throughout the report that the full EWR rule is available electronically, please send me a copy or refer me to the file if I already have it.	No	A CD of electronic data will be submitted as a final deliverable which will accompany the reports. The full EWR rule will form part of this information.
		Water Resource Classes are provided throughout the report, even for systems where WRCs have not been determined/provided yet, please verify.	Yes	Where the information is obvious regarding what the Class must be (i.e. all ECs are a C, therefore it must be a WRC II it has been provided. For others, it has been stated just that it is for the appropriate WRC. It does not affect the RQOs. Adjustments have however been made according to the above statement for systems other than the Mvoti and uMkhomazi to be consisten and avoid confusion
Table 12.4 as example		Where RQOs are affected by the preferred Scenario, do the same WQ, Habitat and Biota EcoSpecs apply for both the REC and the Scenario?	Yes	No. But in the example provided here, the water quality does not change in category so the EcoSpecs are the same. If they do change, then specific mention in the tables are made.
		The Amanzimtoti and little Amanzimtoti river names: please verify? Is it **M**anzimtoti as currently appearing in the report or **Ama**nzimtoti?	Yes	These are the same rivers. The outdated names, i.e. Manzimtoti occurs in the DWS database and cannot be changed due to linkages in maps and spreadsheets.. I will however make a search and replace for text regarding this in this report.
Editorial changes			Yes	Addressed and corrected
Dr Sabine Stuart-Hill, University of KwaZulu-Natal – 26 May 2015				
Volume 2: Wetland RQOs				
General comment: Industrial discharges		The term 'industrial discharge' is too general. This is one of the most dangerous issues we have in our catchments. The heavy metals and toxins that 'hide' behind this term are not only health threatening, they also accumulate in soils and plant matter. The exposure of people relying on the river water for domestic use and irrigation is highly problematic. The approach here taken is thus by far too general and dangerously blurs the crisis at hand.	No	Agreed. Unfortunately we are not always aware, or do not have the data to define what these industrial discharges are composed of. All we can do is then alert everyone to the existence of the industrial discharge, with the hope that data may become available, thereby enabling us to prepare a useful water quality RQO.
		Furthermore, the assumption that any discharge from WWT works or industry are within the limits is not acceptable what	No	The assumption originally made is that discharge standards will be met. However, it was then decided to include coliform

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		so ever. They have not been in the past and they will not in the near future – sadly. This needs to be discussed in the PSC.		and nutrient RQOs below WWTW as an additional protection measure.
Percy Sithole, Umgeni Water – 26 May 2015				
Chapter 19		What of sand-mining upstream Hazelmere Dam in IUA3-1?	Not required	Sand-mining has been captured in Table 2.15, RU U3.1
1.6.1		uMkhomazi system – added scenario criteria	Yes	
1.6.3	uMngeni scenario descriptions	Is eThekwini's Western Aqueduct demands included?	No	The detailed scenarios are described in the Water Resources Report. The aqueduct has been included in various scenarios.
1.6.4	Mvoti scenario descriptions	Phase 2 of Imvutshane Dam includes support from Hlimbitwa River	No	Al details are supplied in the appropriate report.
Fig 2.1	Maps	Labelling of Rivers requested	No	The main rivers are described in the figure heading. Although your point is taken, these maps become to busy and the key rivers are the SQ rivers. We did try and it has to be either or. And as everything is linked to the SQ numbers it is the best way to go. More importantly, the GIS data coverage on rivers include all the wrong spellings (DWS/CSIR data base) and it would be impossible to change all this as all links made to names will then fall apart.
9		Adjustment regarding status of feasibility study	Yes	
9.1.1		Why is pMAR more than nMAR	Yes	A mistake, has been adjusted.
13		Information added re IUA description	Yes	
14		Information added re IUA description	Yes	
15		Information added re IUA description	Yes	
16		Information added re IUA description	Yes	
16.4.1		Note why pMAR is larger than nMAR	Yes	
16.5.1		Note why pMAR is larger than nMAR	Yes	
19		Information added re IUA description	Yes	
19.3		Mention is made of Siphon Dam in the area	Yes	
21		What about Imvutshane River/Dam	No	The Dam has been included in the scenario MV3 and MV4. The river is not included as it did not form part of the 1:500 river coverage. Reserves are only required for these as being a surrogate for a significant resource.
26		What about Mhlabatshane Dam that has been commissioned?	Yes	

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26.2		Mtwalume is very silt-laden as well, what are the impacts.	No	At this desktop level this impact has not been picked up apart from the action that the riparian buffer zone must be reinstated. This will address erosion if this is the cause of the silt.
26.3		The Mzinto River is over allocated.	No	It is not the place in this report to make statements such as this as one cannot provide the data and it does not affect the RQOs.
Bill Pfaff, Ethikwini – 10 June 2015				
		One factor which has not received attention during this project, and in particular in the discussion around RQOs , is the influence of the Ingonyama Trust lands. I copy below the following explanation of this : The Ingonyama Trust is a corporate entity established to administer the land traditionally owned by the king for the benefit, material welfare and social well-being of the Zulu nation. The board of the trust consists of the Zulu king (the chairman), currently Goodwill Zwelithini kaBhekuzulu, and eight members appointed by the Minister of Rural Development and Land Reform in the national government, after consultation with the King, the Premier of KwaZulu-Natal and the chairperson of the KwaZulu-Natal House of Traditional Leaders. As of 2012, the Trust owns 32% of the land in KwaZulu-Natal, about three million hectares, occupied by over 4 million people.[3] It also manages the mineral rights to the land.[4] The trust does not pay taxes to the eThekwini municipality Although a significant portion of the Trust lands are situated in eThekwini , and eThekwini supplies a range of services to these so-called ‘rural areas’ (incl basic water and sanitation) , eThekwini is unable to administer any of the conventional controls over development in these areas. There are no realistic controls over the size and nature of buildings (mainly large houses) which are erected without conventional building plans approval processes and thus no controls as to whether the level of service (particularly sewage disposal) matches the size and nature of these buildings.	No	This is a good point, and one that DWS will have to take cognisance of. During our drafting of the RQOs we were aware of the issue he refers to, namely the potential impact that inadequate sanitation structures will have on instream water quality. In fact, the eThekwini GIS data that we had access to showed areas of different levels of sanitation very clearly. Although this is a very valid point, the possible impacts of inadequate sanitation is the business of a risk assessment study, or impact assessment studies at least. It is not appropriate for river RQOs to be set more leniently because of inadequate sanitation structures in some areas. This is also the case for industrial discharges and high faecal coliform/*E. coli* levels in rivers of the WMA. Although we need to try and take cognisance of reality, we have to set RQOs that balance protection and use. The Implementation Report for the study will flesh out issues such as the phasing in of RQOs and monitoring activities which may result in the modification of RQOs if needed. These are not issues that can be dealt with in the setting of RQOs; particularly in areas of little data, but rather when RQOs are implemented and management actions need to be taken in areas of non-compliance.

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		The other affected Municipalities are presumably in a similar position. Unless and until the situation of the Ingonyama Trust lands is regularised such that building control standards and norms apply it is clear that the water resources in these areas will be impacted by the disposal of sewage , and other uncontrolled pollution events , in one form or another. It is therefore suggested that the area of the Ingonyama Trust Lands be identified in respect of its effect on each 'unit of analysis', and the narrative both record this for each river and resource unit (RU) and how this will impact on the realistic achievement of any RQO set for any particular RU.		
Ethikwini Water and Sanitation Unit – 28 October 2015				
		Both suitable plans and tables need to be provided to enable the ready referencing of IUAs and SCs without having to search back through previous reports.	Yes	Maps will be added as appendices. List of tables re: scenarios will be included where relevant.
		The impact of Ingonyama Trust Lands on achieving RQOs has still not been appropriately dealt with. The area of the Ingonyama Trust Lands must be identified in respect of its effect on each 'unit of analysis', and the narrative both record this for each river and resource unit (RU) and how this will impact on the realistic achievement of any RQO set for any particular RU.	Yes	The impact of tribal lands and inadequate sanitation structures can only be considered by evaluating water quality monitoring data and trying to set immediately applicable RQOs with care. It has to be the responsibility of all relevant government departments and other institutions to manage the matter of inadequate infrastructure and impacts on water resources. The issue of tribal lands and their potential impact on non-compliance to RQOs has been highlighted in the report.
		RQOs need to take congisance of "on the ground" realities. Promulgations can only be supported, and required feasibility and other studies required conducted, if premised by the identification of a set of viable and practical RQOs.	Yes	The practicality of implementing RQOs has been considered in the setting of immediately applicable RQOs, vs. those that can not be applicable until data are collected and other factors have been considered (i.e. provisional RQOs). It is recommended that discussion around the feasibility and ability to "phase in" certain RQOs will have to be undertaken between DWS and other parties responsible for water resource management.
S Jooste, DWS: RQIS – 11 November 2015				
		The water quality RQOs are under-specified. Although the use of percentiles is acceptable, one needs to recognize the data implications. When you test compliance to a percentile (in fact to any number) one needs to know something about the expected statistical confidence that was intended, because that determines whether the data you have is	Yes.	Addressed in both the RQO Methods section and Implementation Report.

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		sufficient. And that in turn speaks to the frequency. The time window of observation should also be specified (1 year, 5 years, 10 years etc). Data quality should therefore have been discussed in the RQO study.		
		Monitoring implementability: The report recognized that there are often insufficient data to generate a realistic RQO at a point and that monitoring is necessary. But where that is the case, it would be senseless setting any form of RQO. It should rather be specified what sort and quality of data should be produced in order to generate RQOs. Generally, compliance monitoring programs are much more data intensive than national programs and the implications of this has significant impact on the spatial and temporal requirements of RQO compliance monitoring and its cost and practicality.	Yes	The text in the report has been enhanced and clarified to explain the difference between RQOs that have been based on suitable monitoring data and are immediately applicable (and will be gazetted), vs. those that are only provisional indications of RQOs. The latter can only be evaluated and confirmed once adequate monitoring data are available. The type of data to be collected depends on the driving varaibles identified per RU and are documented in this report. These factors are also mentioned in the RQO Methods section and Implementation Report. The removal of provisional RQOs from this report was considered, but finally left in the document so as to provide the DWS with some indications as to the expected range a RQO for a particular variable in a particular area, may fall into. All provisional RQOs must however be verified by appropriate monitoring data before they become applicable.
R Pillay, DWS Durban – 13 November 2015				
		Targets for faecal coliforms and E. coli cannot be achieved in some of the more urbanised areas without adopting a phased approach toward achieving reduction. It would have been better if the guideline relates to an incremental reduction in coliform counts over a specified period (e.g. achieve a 25% reduction from present state within a 5 year period). This will allow for progressive movement towards achieving the target.	No	This comment was made in response to reviewing the gazette. It is no longer relevant as RQOs not immediately applicable will not be gazetted. The RQO Report does state that a phased approach to reaching objectives would be required in some instances. The exact detail of how reaching objectives would be phased, and over what time period, has to be assessed on a site-by-site basis as part of planning and water use licensing, for example. Note that RQOs for faecal coliforms and *E. coli* have been rewritten in terms of assessing health risk rather than achieving absolute values.
Comments from S Naidoo and provided by M Thwala				
		Ensure detailed documentation of the Methods and Approach is provided in the RQOs report or water quality.	Yes	Relevant sections of the report checked and expanded to aid understanding.
		Provide clear rationale for *E.coli* RQOs.	Yes	Relevant sections of the report checked and expanded to aid understanding.
		Simply referring to WQ guidelines as RQOs is insufficient.	No	The water quality guidelines are referred to as a source of where additional information or toxic-specific information can be found.
		What RQOs have been set to manage the Waste Water (for both Rivers and Estuaries).	No (rivers)	Relevant variables for management have been identified where possible (e.g. metal ions, salts and nutrients). There

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				will also be concomitant biological monitoring, with toxicity testing recommended if indicated by biotic responses.