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water and sanitation
Department:
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REPUBLIC OF SOUTH AFRICA

Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments

WATER RESOURCE CLASSES REPORT

FINAL
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Department of Water and Sanitation

Chief Directorate: Water Ecosystems Management

PROJECT NUMBER**:** WP 11387

Water Resource Class Report

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES AND DETERMINATION OF RESOURCE QUALITY OBJECTIVES FOR WATER RESOURCES IN THE USUTU TO MHLATHUZE CATCHMENTS

SEPTEMBER 2023

REFERENCE

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REPORT SCHEDULE

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3	WEM/WMA3/4/00/CON/CLA/0322	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Resource Units Delineation and Prioritisation Report**
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	WEM/WMA3/4/00/CON/CLA/0123, volume 2	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecological Consequences Report, Volume 2: Estuaries**
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	WEM/WMA3/4/00/CON/CLA/0623, volume 2	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Resource Quality Objectives Report, Volume 2: Estuaries**
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APPROVAL

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EXECUTIVE SUMMARY

BACKGROUND

Chapter 3 of the National Water Act, 1998 (NWA) (Act 36 of 1998), deals with the protection of water resources. Section 12 of the NWA requires the Minister to develop a system to classify water resources. In response to this, the Water Resource Classification System (WRCS) was gazetted on 17 September 2010 and published in the Government Gazette no. 33541 as Regulation 810. The WRCS is a step-wise process, whereby water resources are categorised according to specific classes that represent a management vision of a particular catchment. This vision takes into account, the current state of the water resource, the ecological, social, and economic aspects that are dependent on the resource. Once significant water resources have been classified through the WRCS, Resource Quality Objectives (RQOs) have to be determined to give effect to the class.

The Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS), initiated a study to determine the Water Resource Classes and RQOs for all significant water resources in the Usutu to Mhlathuze Catchment. The Usutu to Mhlathuze Catchments are amongst many water-stressed catchments in South Africa. These catchment areas are important for conservation, and contain a number of protected areas such as natural heritage sites, cultural and historic sites, as well as other conservation areas that need protection.

STUDY AREA

The study area is the Usutu to Mhlathuze Catchment, which has been divided into six drainage areas, as well as secondary catchment areas:
W1 catchment (main river: Mhlathuze).
W2 catchment (main river: Umfolozi).
W3 catchment (main river: Mkuze).
W4 catchment (main river: Pongola) - part of this catchment area falls within Eswatini.
W5 catchment (main river: Usutu) - much of this catchment falls within Eswatini.
W7 catchment (Kosi Bay and Lake Sibaya).

PURPOSE OF THIS REPORT

The purpose of this report is to document the water Resource Classes and Catchment Configuration. The results forms part of Task 5: Determine Water Resource Classes (based on catchment configuration for the identified scenarios).

RESULTS

Considering that the core purpose of the Classification process is to determine the Class (DWAF, 2007) for a water resource, the scenario evaluation process provides the information needed to assist in arriving at a recommendation that will be considered by the Minister of the DWS or delegated authority to make the final decision.

The overarching aim of the scenario evaluation process is to find the appropriate balance between the level of environmental protection and the use of the water to sustain socio-economic activities. Once the preferred scenario has been selected, the Class is defined by the level of environmental protection embedded in that scenario.

There are three main elements (variables) to consider in this balance, namely the ecology, ecosystem services and the economic benefits obtained from the use of a portion of the water resource. The scenario evaluation process therefore estimates the consequences that a plausible set of scenarios will have on these variables.

A Multi Criteria Assessment (MCA) model was compiled for each IUA in the study area. The objective of the MCA model is to arrive at an overall ranking of metrics from the different components (Ecological, Ecosystem Services, Economics). This information is used to determine the Target Ecological Category (TEC) which then relates to the Integrated Unit of Analysis (IUA) Class and Catchment configuration.

The following criteria parameters presented in the table below (refer to **Section 2.3**) was applied to determine the Classes.

Recommended Water Resource Class criteria table

		% EC representation at units represented by biophysical nodes in an IUA				
		≥ A/B	≥ B	≥ C	≥ D	< D
Class 1		0	60	80	95	5
Class 2			0	70	90	10
Class 3	**Either**			0	80	20
	Or				100	

The above table was applied to both rivers and estuaries to determine the resulting Classes and catchment configuration provided in the following table. Red font in the TEC column indicates where the TEC is a different Class than the Recommended Ecological Category (REC).

Usutu to Mhlathuze Catchment: Recommended Classes and Catchment Configuration

IUA		PES[1]	REC	Proposed Classes associated with the TEC
W11	Matigulu	II	I	I
W12-a	Upper Mhlathuze	I	I	I
W12-b	Mfule, Mhlatuzane, Nseleni Tributary systems	II	II	II
W12-c	Lower Mhlathuze	III	III	III
W12-d	Lake Nhlabane	X	III	III
W12-e	Lake Msingazi	X	III	III
W13	Mlalazi	II	I	I
W21	Upper and Middle White Umfolozi	II	II	II
W22	Upper Black Umfolozi	II	II	II
W23	Umfolozi-Hluhluwe Game Reserve	I	I	I
W31-a	Upper Mkuze	II	I	I
W31-b	Lower Mkuze	II	I	II
W32-a	Upper Hluhluwe	I	I	I
W32-b	Nyalazi and Mzinene Tributaries	II	II	II
W41	Bivane River	II	I	I
W42-a	Upper Pongola	II	II	II
W42-b	Middle Pongola (Ithala)	I	I	I
W44	Middle Pongola (Grootdraai)	III	III	III
W45	Lower Pongola (Floodplain)	III	II	III
W51-a	W5 Upstream major dams (Assegaai)	III	II	II
W51-b	W5 Upstream major dams (Ngwempisi, Usuthu)	III	III	III
W52	W5 Downstream major dams & Hlelo River	II	II	II

IUA		PES[1]	REC	Proposed Classes associated with the TEC
W55	Mpuluzi & Lusushwana River systems	I	I	I
W57	Lower Usutu River	I	I	I
W70-a	Kosi Bay	I	I	I
W70-Muzi Swamps	Muzi Swamps	II	II	II
W70-b	Sibaya	I	I	I
St. Lucia	St Lucia	III	I	III→II→I

1 Present Ecological Category.

The table below summarises the rationale and actions required to achieve the TEC. Information is also provided when the TEC is the same as the PES and where the PES is different from the REC. Note that RUs that require no actions, i.e., the PES, REC and TEC are the same, are excluded from the table.

Usutu to Mhlathuze Catchment: Catchment Configuration showing RUs only where the PES, REC and TEC is not the same EC.

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
IUA & RECOMMENDED CLASS: W11 (MATIGULU) - CLASS I						
W1-Matigulu Estuary	Matigulu	B/C (74%)	B (82.1%)	**B (78%)**	To achieve the REC, a range of non-flow related interventions must be implemented.	Summary of non-flow interventions: 1) Undertake restoration of estuarine floodplain. 2) Control/manage harvesting of *Juncus* and *Phragmites* to reduce some of harvesting pressure (plan in place). 3) Curb/control illegal fishing (gillnetting) activities, increase estuary and coastal recreational and subsistence fishing benefits. 4) Control recreational activities (e.g. boating, driving on beach) to reduce pressure on birds. 5) Improve protection levels through Contracted Conservation on the North Bank. 7) Create interventions within catchment (agricultural best practise and farm plans) and institute a buffer zone along river. 8) Remove invasive aliens to improve baseflows.
IUA & RECOMMENDED CLASS: W12-a (UPPER MHLATHUZE) - CLASS I						
W12-3	Mhlatuze	C	B	**C**	Interventions required would be difficult as flow as well as non-flow and water quality must be addressed. There are no means of operating flow and the non-flow impacts are widespread and diffuse.	None
W12-4	KwaMazula	C	B	**B**	To achieve the B, flow will require improvement by removing forestry species that have encroached or recruited in the riparian vegetation zone. This will improve from a C to a B/C and if non-flow impacts are addressed, it is possible to improve the PES to B.	Remove forestry species that have encroached or recruited the riparian zone and the required corridor adjacent to the river. Manage the riparian zone by removing alien vegetation, preventing access and ensure bank stabilisation.
IUA & RECOMMENDED CLASS: W12-b (MFULE, MHLATUZANE, NSELENI TRIBUTARY SYSTEMS) - CLASS II						
W12-5	Mfule	C	B	**B**	Mitigation will have to focus on non-flow related aspects	Address all non-flow related impacts that impacts on the river. This includes amongst others impacts from Melmoth in terms of water quality, grazing pressure, removal of alien vegetation and impacts associated with vehicle tracks.
IUA & RECOMMENDED CLASS: W12-c (LOWER MHLATHUZE) - CLASS III						
W12-Mhlathuze Estuary	Mhlathuze	D	D	**D**	This system is in a provincial park and on a downwards trajectory.	Non-flow interventions will result in halting downwards trajectory and maintaining TEC.
IUA & RECOMMENDED CLASS: W12-d (LAKE NHLABANE) - CLASS III						
W12-iNhlabane Estuary	Nhlabane	E (30.9%)	D (43.2%)	**D (43.2%)**	To achieve a Class III the REC of a D needs to be achieved. A range of flow and non-flow related	1) Develop an Estuary Management Plan for the iNhlabane Estuarine Lake System (requirement of Integrated Coastal Management Act). 2) Develop an Estuary Mouth/Maintenance

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
					interventions must be implemented to ensure estuary connectivity is re-established.	Management Plan to facilitate skimming of the berm at the mouth (>3.0 m MSL) and/or artificial breaching of estuary. Note: Removal of 5 m^3 of sediment at estuary trigger need for EIA approval. 3) Remove accumulated organic sludge with earth-moving equipment (may need repeating every 10 to 20 years). Note: Removal of 5 m^3 of sediment at estuary trigger need for EIA approval. 4) Prevent disturbance of riparian vegetation. including trampling, cattle, fire, and removal of alien vegetation. 5) Ensure connectivity between the estuary and the various parts of the lakes through installation/reworking of functional fish ladders. Historical EWR: Fish way continuous discharges 0.1 m3/s. To improve marine connectivity the estuary requires 175 000 m^3 to fill up a breach, historical EWR specify 33m^3/s for 9 hours every 2 years. 6) Address deteriorating water quality, e.g. 7) Increase freshwater runoff to estuary and lakes through controlling/removing of unauthorised woodlots/commercial plantations and removal of alien vegetation.
IUA & RECOMMENDED CLASS: W12-e (LAKE MSINGAZI) - CLASS III						
W12-Lake Msingazi	Msingazi	D/E	D	**D**	Notwithstanding that the Lake was historically saline and connected to the estuary and is now segregated and is a freshwater system, it is possible to make improvements by addressing connectivity, over utilisation, water quality and importance to biodiversity which would improve the lake to a D REC.	The following actions would result in improvement: 1) re-establish connectivity by way of a fish ladder to enable fish movement between upstream freshwater habitats and downstream estuarine habitats. 2) Regulate and reduce gill netting pressure and possibly regulate catch sizes. 3) Reduce water bird deaths from gill nets and promote birding as ecotourism. 4) Eutrophication of the lake from surrounding runoff needs to be monitored and rectified where necessary.
IUA & RECOMMENDED CLASS: W13 (MLALAZI) - CLASS I						
W13-1	Mlalazi	C	B	**B**	Difficult but can be achieved through non-flow mitigation and improvement of Waste Water Treatment Works (WWTW).	Improve WWTW. Address grazing, trampling, sand mining and alien vegetation amongst others.
W13-2	Manzamnyama	B/C	B	**B/C**	Decision to maintain PES as achieving the REC will require removal of commercial forestry.	None
W13-Mlalazi Estuary	Mlalazi	B/C (74.1%)	B (78%)	**B (78%)**	This system is in a provincial park and forms part of the uThukela Marine Protected Area (MPA) and on a downwards trajectory.	Non-flow interventions will result in halting downwards trajectory and achieving TEC.
W13-Siyaya Estuary	Siyaya	D/E (43%)	C (63%)	**D (50%)**	This system is in a provincial park and forms part of the uThukela MPA and on a downwards trajectory.	Ecosystem-based adaptation restoration project in an Estuary Management Plan is needed to restore the iSiyaya Estuary's functionality and address downwards trajectory. Short-term (1-5 years): Remove accumulated organic sludge through dredging of bottom substrate to improve water quality (once-off intervention, but may need repeating in 10 - 20 years if marine connectivity

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
						and water quality not improves); mechanical removal of reeds in lower reaches to increase open water area (once-off); and develop an Estuary Mouth/ Maintenance Management Plan (EIA requirement), that considers/guide mechanical removal of sediment that build-up at the mouth to allow for overwash recruitment when closed for long periods (more than 2- 3 years) and sub-marine communication cable. Revegetate the dune at the mouth; Long-term (5-10 years): Restore the upstream riparian zone (buffer) and remove alien vegetation. Institute 1 km mining and plantation buffer. Develop a groundwater-surface water model to protection of groundwater resources and estuary protection and guide management of the plantations and woodlots. Note that a reduction of community woodlots may require establishment of alternative livelihoods,
IUA & RECOMMENDED CLASS: W21 (UPPER AND MIDDLE WHITE MFOLOZI) - CLASS II						
W21-1	White Mfolozi	C	B	**B**	REC achieved by combination of flow and non-flow mitigation.	Address impacts that can be managed such as: Water quality impacts such as spills from mine to be addressed. Remove agriculture within delineated wetlands, as per the NWM5, 2018. Improve flows by managing instream dams.
W21-3	White Mfolozi	C	B	**C**	Impacts linked to forestry, grazing and erosion. Restoration where possible will be insufficient to achieve the REC.	None
IUA & RECOMMENDED CLASS: W31-a (UPPER MKUZE) - CLASS I						
W31-1	Mkuze	C	B	**B**	REC achieved by combination of flow and non-flow mitigation.	Flow abstractions must be managed to achieve a B/C. Non-flow measures must be focused on the riparian zone.
IUA & RECOMMENDED CLASS: W31-b (LOWER MKUZE) - CLASS II						
W31-5	Mkuze	C (74.8%)	B	**B/C**	Improvements must be achieved by non-flow measures.	The detailed actions will be identified during the RQO phase of this study. A B could not be achieved, and the TEC was set as a B/C.
IUA & RECOMMENDED CLASS: W41 (BIVANE RIVER) - CLASS I						
W41-1	Bivane	C	B	**B/C**	Improvement will require both improvement in flow and non-flow related aspects. It is not possible to improve flows, therefore a half a category improvement can be achieved by non-flow required means.	Amongst others impacts in the riparian zone must be addressed. Some of the mitigation measures are removing aliens and forestry species that have encroached or recruited within the riparian zone, and to control and manage access to the riparian zone.
IUA & RECOMMENDED CLASS: W42-a (UPPER PONGOLA) - CLASS II						
W42-1	Phongolo	C	B	**C**	The downstream EWR site requires no improvement and therefore the TEC is set to maintain the PES at a C which is the same as at the EWR site.	None

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
IUA & RECOMMENDED CLASS: W45 (LOWER PONGOLA (FLOODPLAIN)) - CLASS III						
W45-Pongola Floodplain	Phongola	D	C	**D**	The high EIS warrants improvement. However, improvement will be based on EWR releases from Pongolapoort Dam amongst other. There will however be a serious impact on the dependency of rural communities living on the floodplain and utilising the floodplain for subsistence agriculture.	None
IUA & RECOMMENDED CLASS: W51-a (W5 UPSTREAM MAJOR DAMS (ASSEGAAI)) - CLASS II						
W51-1	Assegaai	C/D	B/C	**B/C**	REC achieved by combination of flow and non-flow mitigation.	Actions may include the following but are not limited to these mentioned: Improve flows to achieve a C by managing abstractions and controlling the numerous instream dams. Other actions required are addressing alien vegetation and dealing with mine spills.
IUA & RECOMMENDED CLASS: W57 (LOWER USUTU RIVER) - CLASS I						
W57-1	uSuthu	B/C	B	**B/C**	The river is downstream of Eswatini. Flow is the most important impact to address to achieve the REC. As we have no control over the management of the river within Eswatini, the TEC is set to maintain the PES.	None
IUA & RECOMMENDED CLASS: W70-a (KOSI BAY) - CLASS I						
W70-Kosi Lakes & Estuary		A/B	A	**A (93%)**	The system is in iSimangaliso Wetland Park and of very biodiversity and conservation importance. Largely groundwater and threatened by forestry.	In addition to capping the groundwater utilisation, especially during drought conditions, non-flow interventions will result in halting downwards trajectory and achieving TEC (DWS 2016b).
IUA & RECOMMENDED CLASS: W70-b (SIBAYA) - CLASS I						
W70-uMgobezeleni Estuary		B	A (93%)	**A/B (88%)**	The system is in iSimangaliso Wetland Park.	Non-flow interventions) will result in halting downwards trajectory and achieving TEC.
IUA & RECOMMENDED CLASS: ST LUCIA – CLASS III (SHORT TERM), CLASS II (MEDIUM TERM), CLASS I (LONG TERM)						
St. Lucia, W2 & W3 feeder streams	St. Lucia	D ↑↓	B	D➔C➔ B	The system is in iSimangaliso Wetland Park and of very biodiversity and conservation importance. The DWS (2016) overarching REC recommendation is 'Best Attainable State' of a B/C (~72) with a B Category is achievable in the long-term. The Department of Forestry and Fisheries and Environment (DFFE) Ministerial Panel of Independent Experts also advocate for a REC of a B Category (DFFE, 2022).	DWS (2016a) provides minimum recommend flows for a B/C Category, include: 1) Cap minimum discharge in the Mfolozi at 3 m^3/s to maintain an open mouth. 2) Ensure a combined Mfolozi/Mkuze drought discharge of 5 m^3/s (that include 1.6 m^3/s in Mkuze); and 3) Improve the water quality coming from the Mkuze catchment. Non-Flow interventions include: a) St Lucia/uMfolozi should have a single mouth and manipulation of the mouth (artificial breaching or closing) kept to a minimum as it increase drought/climate change vulnerability. b) Restore low-lying areas of the uMfolozi floodplain to natural vegetation to allow for natural processes

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
						(e.g. carbon sequestration, mouth closure). Detailed remote sensing study needed to identify these low-lying areas that is inundated during wetter cycle. c) Remove alien vegetation around the Lake, estuaries and rivers. d) Limit further natural deforestation such as in the Dukuduku Forest. e) Eradicate illegal gillnetting from the system. f) Eradicate and monitor occurrence of alien invasive species (plants, inverts and fish). g) Strategic planning needed to prevent urbanization in the catchments feeding directly into the Lake and the Narrows. h) Reduce commercial forestation in the lake catchments to increase low flows as much as possible. i) In the uMfolozi River catchment, land care practices should focus on the most critical sub-catchment areas to limit future erosion and land degradation which could further reduce low flows. j) Unauthorised river abstractions on especially the Mkuze and uMfolozi Rivers must be eliminated. DWS will need to undertake further investigations into limiting further forestry applications in St Lucia and Mfolozi catchments and review license conditions in relation to buffer zones. Validation and verification of water use is required (compulsory licensing)

THE WAY FORWARD

The proposed Classes and Catchment Configuration have been documented and concludes the National Water Resource Classification phase of this study.

The information leads to the final phase, i.e., the determination of Resource Quality Objectives. All TEC at high priority RUs will be defined in terms of flow, water quality and habitat and riparian biota and habitat. Additional to this quantitative information, a suggested monitoring programme with ecological specification to achieve and maintain the RQOs (and TEC) will also be provided. This will also form part of information that will/can input into an implementation plan.

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CC	Climate Change
CD: WEM	Chief Directorate: Water Ecosystems Management
DFFE	Department of Fisheries, Forestry and Environment
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Ecological Category
EFZ	Estuary Functional Zone
EGSA	Ecological Goods and Services Attributes
EHI	Estuary Health Index
ESS	Ecosystems Services
EWR	Ecological Water Requirements
GDP	Gross Domestic Product
Geom	Geomorphology
GOS	Gross Operating Surplus
HFY	Historic Firm Yield
I IHI	Instream Index of Habitat Integrity
Inverts	Macro-invertebrates
IUA	Integrated Unit of Analysis
MCA	Multi Criteria Analysis
MCM	Million Cubic Meters
MPA	Marine Protected Area
nMAR	Natural Mean Annual Runoff
NWA	National Water Act
PC (WQ)	Physico-Chemical (Water Quality)
PD	Present Day
PES	Present Ecological State
REC	Recommended Ecological Category
REC	Recommended Ecological Category
Rip Veg	Riparian Vegetation
RQO	Resource Quality Objectives
RU	Resource Unit
Sc	Scenario
SQ	Sub-quaternary
TEC	Target Ecological Category
WRC-DSS	Water Resource Class-Decision Support System
WRCS	Water Resource Classification System
WTW	Water Treatment Works
WWTW	Waste Water Treatment Works

SPELLING

There are multiple references to the spelling of various Rivers, Lakes, Dams and Estuaries, depending on the source of information. For the purposes of this report, the following Table presents the selected spelling of indicated water resources and places.

Selected Spelling for this Study	Alternate spellings
Usutu River	Usuthu River
Mhlathuze River	Mhlatuze, uMhlatuze River
Pongola (river, Town & Pongolapoort Dam)	Phongola, Phongolo
Lake Sibaya	Lake Sibiya, Lake Sibhayi, Lake Sibhaya
Eswatini	eSwatini
Umfolozi River	Mfolozi River
Amatigulu River	Amatikulu, Matigulu River
Goedertrouw Dam	Lake Phobane
Mfuli River	Mefule River
aMatigulu/iNyoni Estuary	
Sibiya Estuary	
Mlalazi Estuary	
uMhlathuze /Richards Bay Estuary	
iNhlabane Estuary	
uMfolozi/uMsunduze Estuary	
St Lucia Estuary	
uMgobezeleni Estuary	
Kosi Estuary	
Hluhluwe Game Reserve	
iMfolozi Game Reserve	
Ithala Game Reserve	
Ndumo Game Reserve	
Tembe Elephant Reserve	
iSimangaliso Wetland Park	
Kosi Bay and Coastal Forest Area	
uMkhuze Game Reserve	

The names adopted in the estuaries report are the official names assigned to the systems in the ‘South African National Ecosystem Classification System’ (and the KwaZulu-Natal Department of Economic Development and Environmental Affairs) (Dayaram *et al.,* 2021).

GLOSSARY

Basic Human Needs	Water needs to be set aside for basic human needs such as drinking, food preparation, and health and hygiene purposes. This is referred to as the Basic Human Needs Reserve (BHNR).
Ecological Water Requirements (EWR)	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.
Ecosystem services	The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth.
EcoClassification	The term used for the Ecological Classification process - refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river.
Integrated Unit of Analysis (IUAs)	An IUA is a homogeneous area that can be managed as an entity. It is the basic unit of assessment for the Classification of water resources, and is defined by areas that can be managed together in terms of water resource operations, quality, socio-economics and ecosystem services.
Resource Quality Objectives (RQOs)	RQOs are numeric or descriptive goals or objectives that can be monitored for compliance to the Water Resource Classification, for each part of each water resource. “The purpose of setting RQOs is to establish clear goals relating to the quality of the relevant water resources” (NWA, 1998).
Sub-quaternary reaches (SQR)	A finer subdivision of the quaternary catchments (the catchment areas of tributaries of main stem rivers in quaternary catchments), to a sub-quaternary reach or quinary level.
Target Ecological Category (TEC)	This is the ecological category toward which a water resource will be managed once the Classification process has been completed and the Reserve has been finalised. The draft TECs are therefore related to the draft Classes and selected scenario.
Water Resource Class	The Water Resource Class (hereafter referred to as Class) defines three management classes, Class I, II, and III, based on extent of use and alteration of ecological condition from the predevelopment condition.

1 INTRODUCTION

1.1 BACKGROUND

Chapter 3 of the National Water Act, 1998 (NWA) (Act 36 of 1998), deals with the protection of water resources. Section 12 of the NWA requires the Minister to develop a system to classify water resources. In response to this, the Water Resource Classification System (WRCS) was gazetted on 17 September 2010 and published in Government Gazette 33541 as Regulation 810. The WRCS is a stepwise process whereby water resources are categorised according to specific classes that represent a management vision of a particular catchment. This vision takes into account the current state of the water resource, the ecological, social and economic aspects that are dependent on the resource. Once significant water resources have been classified following the WRCS, Resource Quality Objectives (RQOs) must be determined to give effect to the class. The implementation of the WRCS therefore assesses the costs and benefits associated with utilisation versus protection of a water resource. Section 13 of the NWA requires that Water Resource Classes and RQOs be determined for all significant water resources.

Thus, the Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS) initiated a study for determining the Water Resource Classes and RQOs for all significant water resources in the Usutu to Mhlathuze Catchment. The Usutu to Mhlathuze Catchments are amongst many water-stressed catchments in South Africa. These catchment areas are important for conservation and contain a number of protected areas, natural heritage sites, cultural and historic sites as well as other conservation areas that need protection. There are five RAMSAR[1] sites within the catchment, which includes the world heritage site and St Lucia. The others are Sibaya, Kosi Bay, Ndumo Game Reserve and Turtle Beaches.

1.2 STUDY AREA

The study area is the Usutu to Mhlathuze Catchment that has been divided into six drainage areas and secondary catchment areas as follows (refer to the locality map provided as **Figure 1.1**):

- W1 catchment (main river: Mhlathuze).
- W2 catchment (main river: Umfolozi).
- W3 catchment (main river: Mkuze).
- W4 catchment (main river: Pongola) - part of this catchment area falls within Eswatini.
- W5 catchment (main river: Usutu) - much of this catchment falls within Eswatini.
-
- W7 catchment (Kosi Bay estuary and Lake Sibaya).

Note that all assessments within Eswatini are excluded apart from the hydrological modelling required to assess any downstream rivers in South Africa that either run through Eswatini or originate (source) in Eswatini.

River Ecological Water Requirements (EWR) sites are shown on **Figure 1.1**.

[1] A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention, also known as "The Convention on Wetlands", an intergovernmental environmental treaty established in 1971 by UNESCO in the Iranian city of Ramsar, which came into force in 1975.

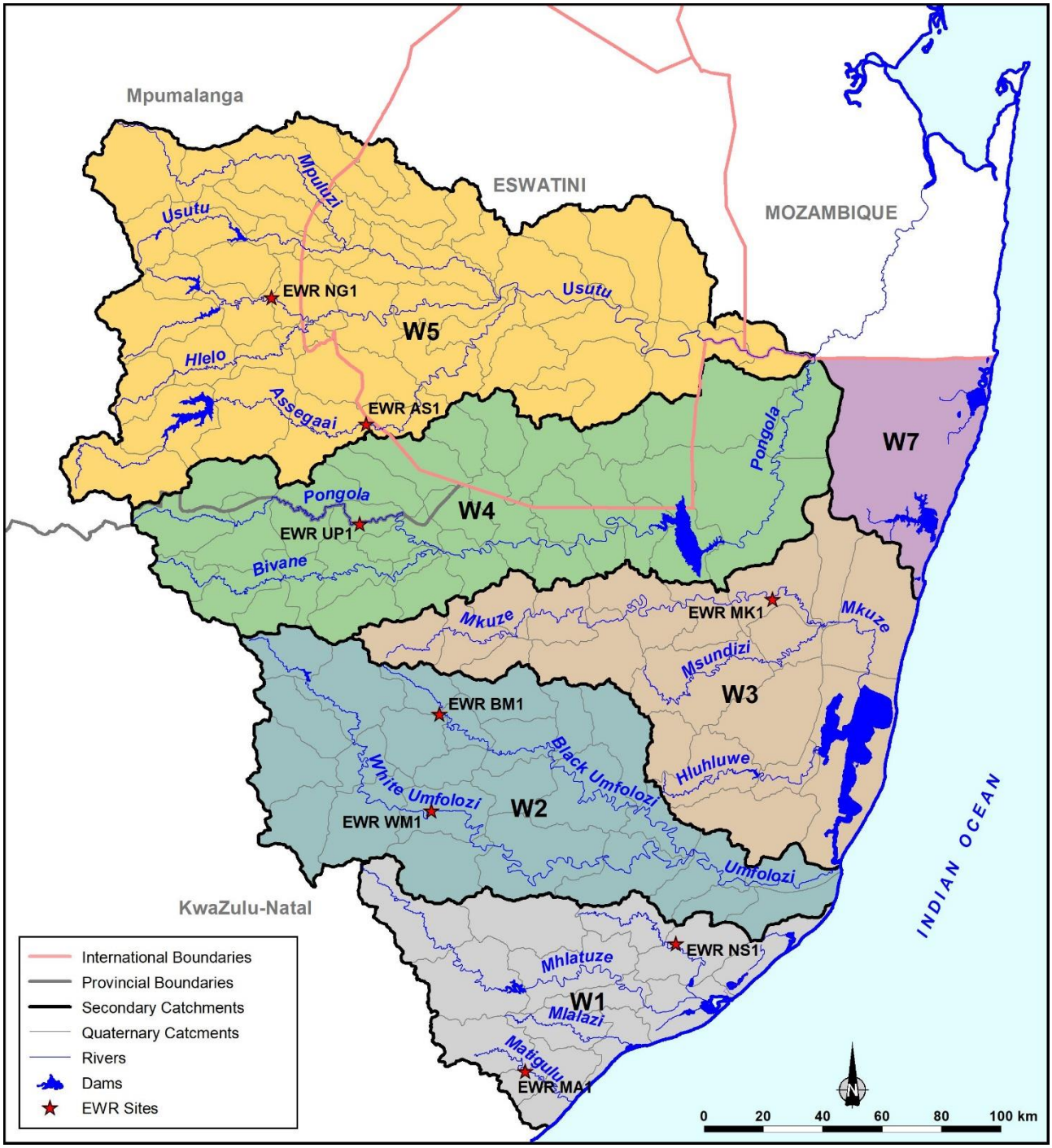


Figure 1.1 Locality Map of the Study Area

1.3 PURPOSE OF THIS REPORT

The purpose of this report is to document the water Resource Class. The results forms part of Task 5: Determine Water Resource Classes (based on catchment configuration for the identified scenarios) (**Figure 1.2**).

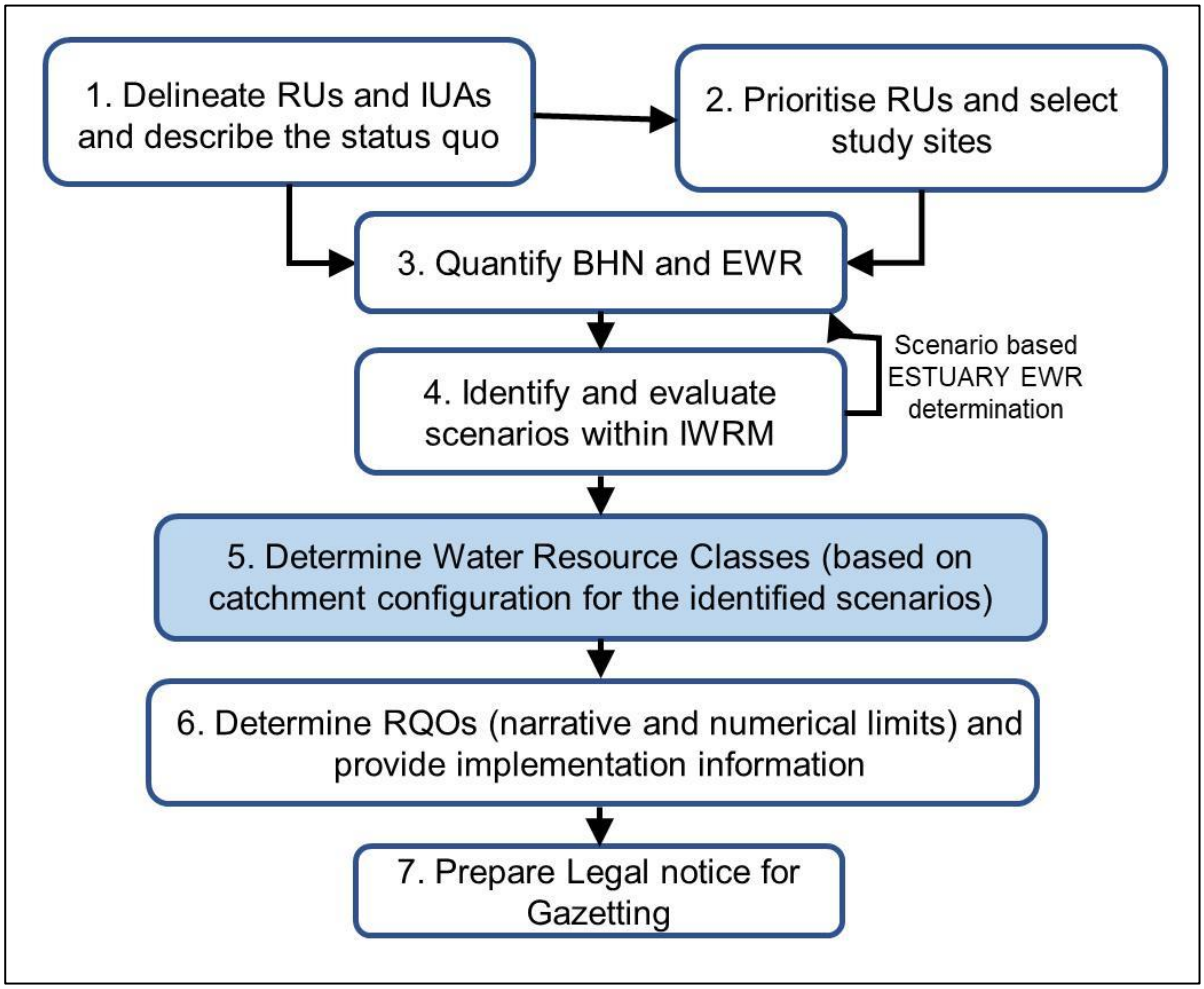


Figure 1.2 Project Plan for the Usutu-Mhlathuze Classification study

1.4 REPORT OUTLINE

The report outline is as follows:

- **Chapter 1** provides general background information on the study area and the Project Plan.
- **Chapter 2** outlines the approach to integrating the consequences of scenarios of the different components assessed; the application of multi criteria analysis for scenario evaluation and comparison, and determination of water resource classes.
- **Chapter 4 - 7** summarises the consequences of operational scenarios on the economic, riverine, estuarine and ecosystem services for selected rivers and estuaries.
- **Chapter 8** provides the integrated multi-criteria analysis results of the Usutu to Mhlathuze Catchment.
- **Chapter 9** outlines the Class and catchment configuration results of the Usutu to Mhlathuze Catchment.
- **Chapter 10** explains how the current information will be applied during the the final phase of the study, i.e., the determination of Resource Quality Objectives.
- **Chapter 11** lists the references used in the report.

2 INTEGRATED CONSEQUENCES EVALUATION APPROACH

2.1 OVERVIEW OF THE SCENARIOS EVALUATION PROCESS

Considering that the core purpose of the Classification process is to determine the Class (DWAF, 2007) for a water resource, the scenario evaluation process provides the information needed to assist in arriving at a recommendation that will be considered by the Minister of the DWS or delegated authority to make the final decision.

The overarching aim of the scenario evaluation process is to find the appropriate balance between the level of environmental protection and the use of the water to sustain socio-economic activities. Once the preferred scenario has been selected, the Class is defined by the level of environmental protection embedded in that scenario.

There are three main elements (variables) to consider in this balance, namely the ecology, ecosystem services and the economic benefits obtained from the use of a portion of the water resource. The scenario evaluation process therefore estimates the consequences that a plausible set of scenarios will have on these variables. The evaluation process uses the quantification of selected metrics to compare the scenarios on relative basis with one another.

During the evaluation process stakeholders are engaged at various stages and aid in defining and selecting the scenarios for evaluation and finally to assess the consequences with the aim to make a recommendation of which Class should be implemented.

The scenario evaluation process entails a sequence of activities followed during the study and are illustrated schematically in **Figure 2.1**.

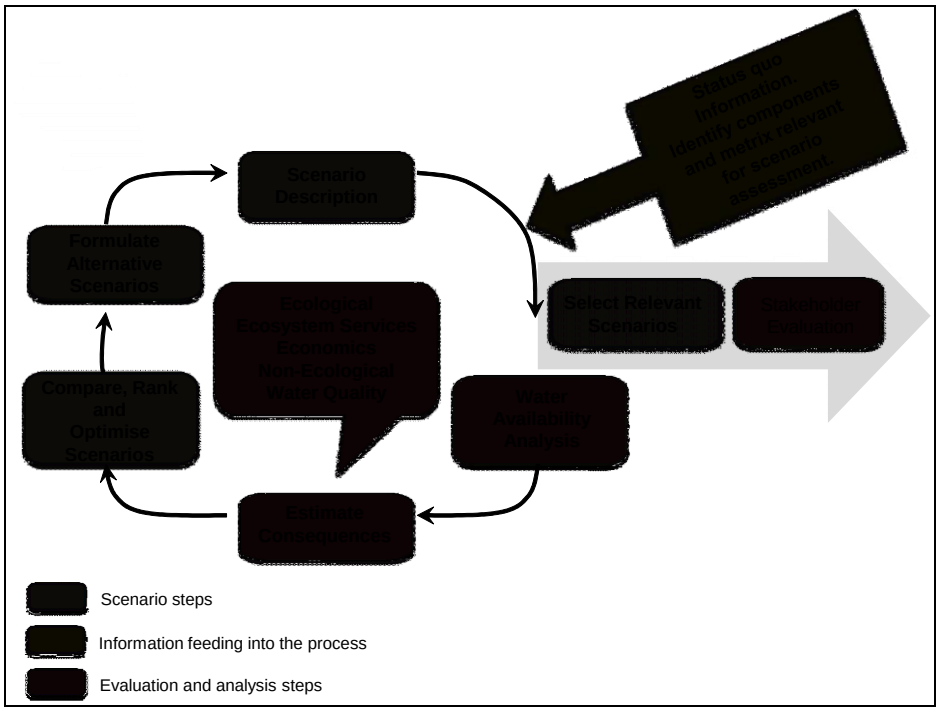


Figure 2.1 Schematic representation of the scenario evaluation process

Each activity presented in **Figure 2.1** is briefly described in the following sections.

2.1.1 Scenario description

The definition and evaluation of scenarios were undertaken in the context of the prevailing and proposed water resource management activities in the study area. Scenarios, in the context of water resource management and planning, are plausible definitions (settings) of all the factors (variables) that influence the water balance and water quality in a catchment and the system as a whole. The development options were already well established as part of several previous studies and the preliminary list was presented to stakeholders for their consideration (Discussion Document: Description of Operational Scenarios) after which a final list was compiled for evaluation (see **Chapter 3** for a description of the scenarios that were evaluated). Although the focus, when scenarios are defined, is primarily on identifying alternative operational aspects relating to the water resources, the results of the assessment of present day conditions (usually simulated with a water resource model) and the associated Present Ecological State (PES) for the biophysical nodes and EWR sites is in essence also a scenario that can be compared with the other alternatives. Similarly, a scenario where the Recommended Ecological Category (REC) is implemented as the driver for the water requirements in a river, is also a scenario.

2.1.2 Assign attributes to EWR nodes (includes estuaries)

Applying the Status Quo information (DWS, 2022a), all the relevant properties (attributes) were defined for the biophysical nodes with respect to the ecology, ecosystem services as well as the economic characteristics (in context of the Integrated Unit of Analysis - IUA). A key aspect of this activity was to incorporate these nodes into the water resource simulation model to enable the generation of monthly time series of flow data for the scenarios where appropriate. At selected nodes (key biophysical nodes or EWR sites) the flows required to achieve a particular ecological state were also defined, along with rules to make releases from upstream weirs and dams.

2.1.3 Water resource analysis

This activity applied the water resource models configured for each catchment to determine the volume of water that is available for abstraction from the water resource for economic use, given that the flow regime in the river is maintained to achieve a certain ecological state. Appropriate discharges are also simulated as part of the volumetric analyses. The ecological state is defined by the particular Ecological Category (EC) specified for the scenario under consideration, which could be the REC, PES or any other appropriate EC.

2.1.4 Estimate consequences

The simulated flow regimes at the nodes and the water available for abstraction form the basis for evaluating and estimating the consequences of each scenario. The text box in the centre of **Figure 2.1** indicates the aspects that were evaluated. **Table 2.1** lists these aspects and provides a brief description of the evaluation method and purpose as well as references to where further detail information are provided.

Table 2.1 Variables considered in the scenario comparison and evaluation process

Component	Evaluation purpose and method
Ecological	Determine the EC and indicate the degree in which the scenario achieves the REC.
Ecosystem services	Determine the extent that each scenario changes the ecosystem services relative to the current conditions.
Economy	Determine the economic benefit of utilising the available water (abstractions) in terms of Gross Domestic Product (GDP) and employment (jobs) and evaluate how this changes the status quo.
Non-ecological or user water quality	Consider the consequences of having to achieve elevated water quality standards for users other than the ecology (fitness for use or user specifications). This may involve determining the economic implications of such elevated standards. This was not brought into consideration for this catchment in terms of consequences as the scenarios did not have any influence on non-ecological or user water quality. Note that this aspect is considered outside of the Water Resource Class-Decision Support System (WRC-DSS). Including it would result in double-accounting as water quality is considered during all other components of the WRC-DSS.

2.1.5 Compare, rank and optimise

The consequences from the above-mentioned activity are expressed numerically for the scenarios and compared separately for each component and then the results are combined for all components to derive overall scores which give effect to the ranking of scenarios. The methodology employed for this is based on a Multi Criteria Analysis (MCA) approach where weighting factors are applied, firstly to give effect that certain nodes are more important than others and secondly that the components listed in **Table 2.1** may differ in their relative importance (refer to **Section 2.2** for further details on the MCA methodology)).

2.1.6 Formulate alternative scenarios

This activity involves the formulation of alternative scenarios, usually consisting of adjustment to the initial list (rather than completely different scenarios) for further consideration. The other steps are then repeated as indicated by the circular arrows depicting the information flow from one activity to the next.

2.1.7 Select scenario subset for stakeholder evaluation

The technical study team assessed several scenarios of which the results defined the boundaries of the variable settings and point to the aspects that are important to consider in the study area. A relevant subset of the full list of scenarios was selected for discussion with stakeholders.

2.2 MULTI CRITERIA ANALYSIS FOR SCENARIO EVALUATION AND COMPARISON

2.2.1 Components

As discussed in **Section 2.1,** three components (*viz*. ecological state, ecosystem services and socio-economics) are included when assessing the balance between achieving ecological objectives versus socio-economic benefits.

The ecological state (or health) rating is expressed relative to the extent to which the scenario achieves the REC (termed ‘ecological protection’). This is quantified numerically as a percentage,

with a (maximum) value of 100% indicating that the scenario achieves the REC; reduced values signify reduced ecological condition (relative to the REC).

The rating of the ecosystem services for a scenario is expressed relative to the baseline ecosystem services available under current conditions. A score of 1.0 indicates the scenario will provide the same services as under present conditions; a score of 1.2 implies there is 20% more utility in terms of ecosystem services, whereas 0.8 indicates a reduction of 20% in the services provided by the scenario.

In terms of the socio-economic component, two aspects are evaluated, namely the GDP and Employment (the number of jobs) that will be supported by the volume of water that is abstracted from or discharged into the system. The GDP is calculated in monetary terms (ZAR) and employment through the number of jobs supported. As for ecosystem services, the numeric values are expressed as a ratio relative to the baseline condition.

Further explanations on the scoring of metrics for the components, and integration of component metrics for the IUA are provided in the next sections.

2.2.2 Ecological metric

a) Rivers

The ecological protection afforded by scenarios were evaluated for the EWR sites[2]. For the study area, there is a maximum of one EWR site per IUA, and thus it has not been necessary to integrate scores for multiple EWR sites (per IUA). Certain IUAs, however, contain river EWR sites and estuaries, and the integration of these is discussed below.

b) Estuaries

Deriving a single metric (one number), that reflects the ecological health relative to the REC for the Estuary, requires a number of steps. Broadly, the rationale is to achieve a single rating where each scenario is ranked on the basis of the degree to which the scenarios meet the REC for the estuary. The following approach was applied:

The following approach was applied:

- **Apply the Estuary Health Index (EHI) to each scenario by first determining individual health scores for each of the abiotic and biotic components, expressed as a percentage similarity to a reference condition (i.e. pristine state).**
- **Combine these individual scores into a single overall EC for the estuary linked to a scenario.**
- Calculate the degree to which each scenario meets the ecological objectives for the estuary as represented by the REC (i.e., expressed as the percentage difference between the EC of the scenario and the REC).
- Normalise the score of each scenario to obtain a rating that is one (1) if the REC is achieved, above one if the REC is exceeded (e.g. 1.1), or between one and zero if the score (EC) is below the REC (e.g. 0.8).
- Rank the scenarios in terms of a numerical scale with values zero and one (typically, where one ‘1’ indicates the scenario achieves the REC and a ‘0’ represents the situation where the scenario results in an EC of ‘F’).

[2] Excludes biophysical nodes.

- Normalise the ranking of scenarios across estuaries where there is more than one estuary in a RU in terms of their relative ecological importance and ecological health.

c) Integration of rivers and estuaries

To produce an overall ecological protection score for the IUA, the river and estuary RUs are combined. This is achieved by weighting the river and estuary RUs relative to one-another. Considerations in the weightings are ecological and conservation importance; the PES; the functionality of the estuary; the sensitivity of the estuary to scenario changes, and the relative length of the river and size (area) of the estuary respectively.

2.2.3 Ecosystem services

Natural habitats and ecosystems provide a range of environmental goods and services that contribute to human well-being. River systems and estuaries and their associated use values are of particular importance in many instances. For operational purposes this study followed the approach defined in the 2005 Millennium Ecosystem Assessment (MEA, 2005) and classifies ecosystem services along functional lines using categories of provisioning, regulating, cultural, and supporting services.

With this in mind, an analysis of EWRs for the rivers and estuary was undertaken. Ecosystem services associated with the sites and estuary, bearing in mind that they represent a wider area, were listed, and where they were deemed to generate value, they were evaluated against the scenarios applicable to the site. Each site was evaluated under the impact against a base value of 1, representing the status quo. Anticipated change was evaluated against the base value with a negative impact represented as a score lower than 1 and an overall positive score represented as greater than 1. The process to determine an integrated ranking of the different scenarios required determining the relative importance of the categories of ecosystem services. Here the perceived vulnerability of households dependent on the provisioning aspect of ecosystem services played a major role.

The scenario impact on various ecosystem services were then amalgamated into overall categorisation of provisioning, regulating, cultural, and supporting services. The scenarios are also weighted with respect to the importance of the services at each EWR site and estuary. As such the score given to each of the services when the Sub-quaternaries (SQs) are evaluated is examined against the nature of the particular EWR site and associated area. In an instance where regulating services, for example are deemed to be important, then these services are given a higher weight. The same goes for the other services. All weightings are normalised against a base score of 1. For example, where all four services are deemed to be of equal importance then a score of 0.25 would be allocated to each.

2.2.4 Economics

The first aspect considered in deriving the overall ranking for each scenario is the method employed to normalise each set of variable results. This is necessary to remove the effect of the different dimensions (Rand for the socio-economic measurement, number of jobs for employment and the different rating scales for the ecology and ecosystem services) and make the scores of each variable comparable. The second aspect is to make provision to vary the importance each variable has in the overall ranking. Both these are described further below.

2.2.5 Overall ranking metric

Two aspects are considered to arrive at an overall ranking of metrics from the different components: relative importance and ranking methods.

- Relative importance of components

The importance of the components is determined by using relative weightings. Examples of how different weights would result in a pre-selected bias are presented in **Table 2.2** for illustration purposes. The actual weight scheme applied in this study used is neutral (the default), where 50% is allocated to ecological protection and the balance divided equally between the socio-economic components.

Table 2.2 Explanation of the application of variable weights

Pre-selected importance bias	Weights assigned			
	Ecological protection	Ecosystem services	Economic indicator (GDP)	Employment indicator (jobs)
Neutral[1]	0.5	0.167	0.167	0.167
Preference for ecology	0.7	0.1	0.1	0.1
Preference for socio-economy	0.3	0.233	0.233	0.233
Preference for socio-economy with emphasis on employment	0.3	0.2	0.2	0.3
Preference for socio-economy with emphasis on economy	0.3	0.2	0.3	0.2

1 Since ecological protection and socio-economic components are weighted equally; 'ecological protection' refers to rivers, wetlands and estuaries.

- Scenario ranking methods

Two scenario ranking methods are allowed for: rank order (with average) and normalised score. The sensitivity of the final ranking to each of these methods should be assessed. Generally, for Resource Units (RUs) with a limited number of scenarios being assessed, and/or where there is little deviation between scores, resolution can be lost with the rank order method, and thus the normalised score method is preferable. The overall ranking provides a normalised score, where 0 represents the lowest and 1 the highest.

2.3 WATER RESOURCE CLASS DETERMINATION

In accordance with the WRCS guidelines (DWAF, 2007), the Class for an IUA is defined by the distribution of the selected ECs for the biophysical nodes in an IUA. In general, if the nodes are in 'A' or 'B' ECs the IUA is in a Class I, a Class II will be assigned if most nodes are in a C EC and if the nodes mostly fall in a D EC the IUA is in a Class III.

It is recommended that the scheme presented in **Table 2.3** (adjusted from the guideline rules) is used as the criteria to determine the Class (modified from guidelines). The 'units' applied in the table is the percentage of river length (associated with a biophysical node) falling in each of the indicated ECs.

An IUA is in Class I if the following applies:

- No requirement for any % of units being greater than or equal to an A/B EC;
- 60% of the units are greater than or equal to a B EC;
- 80% of the units are greater than or equal to a C EC;
- 95% of the units are greater than or equal to a D EC; and

- it follows that < 5% of the units can be in an E EC.

Table 2.3 Guidelines for the calculation of the IUA Class for a scenario (adjusted from DWAF, 2007)

		% EC representation at units represented by biophysical nodes in an IUA				
		≥ A/B	≥ B	≥C	≥ D	< D
Class 1		0	60	80	95	5
Class 2			0	70	90	10
Class 3	**Either**			0	80	20
	Or				100	

The rules in **Table 2.3** only refer to 'full' categories and do not include 'half' categories (e.g., EC of a B versus an EC of a B/C). Half categories indicate those that can be either a high C or a low B (in the B/C example). Consequently, half categories are split equally into higher and lower full categories. For example, if there is 150 km of river in a B/C category, then 75 km will be allocated to each of B and C categories. This is relevant for B/C, C/D and D/E half categories.

The relative contribution of river RUs to the Water Resource Class of an IUA is weighted by representative length. These weightings are, however, user-specified for RUs represented by EWR sites and estuaries.

3 SCENARIO DESCRIPTION

During the course of the study, scenarios (Sc) were identified, presented to the Project Steering Committee for comments and subsequently evaluated, compared and ranked as a means to determine the appropriate balance between water use and ecological protections for deriving the Classes. When identifying and formulating scenarios for analysis the following aspects are considered:

- Identify the pertinent operational water resource and developments in the system.
- Define a range of scenarios that will, on the one hand, provide high levels of ecological protection and on the other hand, maximise the utility from the water resource – usually resulting in lower levels of protection.
- Typically, the water uses that are considered for scenarios include: the taking of water (abstraction), storing of water (dams) as well as the utilisation a water resource for discharging waste.

Table 3.1 provides a summary of the scenarios evaluated by the river and estuary specialists. The details of each scenario configuration are included in the Scenario Description Report (Report 13 of this Study – DWS, 2022b).

Table 3.1 Description of flow related scenarios (DWS, 2022b)

IUA	Scenario			Type
	#	Abbrev.	Description	
W11	1	CC	Climate Change.	Both, including MA1
	2	-20%MAR	Reduction of present day (PD) Mean Annual Runoff (MAR) by 20%.	Matigulu Estuary
	3	-30%MAR	Reduction of PD MAR by 30%.	Matigulu Estuary
	4	+15%MAR	Increase of PD MAR by 15%.	Matigulu Estuary
	5		Present with non-flow restoration interventions including active restoration of the riparian area undertaken in conjunction with a reduction in harvesting and grazing pressures on the macrophytes. Fishing pressure (especially illegal gill netting) is reduced and recreational activities such as boating are controlled. Recreational activities in the lower reaches are curbed through zonation and improved compliance.	Matigulu Estuary
W12-a	1	CC	Climate Change.	Rivers
W12-b	1	CC	Climate Change.	Rivers, including NS1
W12-c	1	CC	Climate Change.	Both
	2	+15%MAR	Increase of PD MAR by 15%.	uMhlathuze Estuary
	3	2030	2030 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw).	uMhlathuze Estuary
	4	2040	2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw).	uMhlathuze Estuary
W12-d	1	CC	Climate Change.	Both
	2	EWR	PD including EWR releases from Lake Nhlabane as obtained from Mhlathuze Water Availability Assessment Study (MWAAS - DWAF, 2009).	iNhlabane Estuary
	3	Rest	Restoration Sc 1 to allow for mouth breaching each year.	iNhlabane Estuary
	4	Rest/Int	Restoration and interventions Sc 2.	iNhlabane Estuary
W12-e	1	CC	Climate Change.	Rivers and Lake Msingazi
W13	1	CC	Climate Change.	Both
	2	-15%MAR	Reduction of PD MAR by 15% (SIYAYA).	Mlalazi and Siyaya estuaries
	3	+15%MAR	Increase of PD MAR by 15% (SIYAYA).	Mlalazi and Siyaya estuaries

IUA	Scenario			Type
	#	Abbrev.	Description	
	4	WWTW	PD including the upgrade of the Mtunzini Waste Water Treatment Works (WWTW) increased to a 1.5 Ml/d plant (Mlalazi).	Mlalazi and Siyaya estuaries
	5	Sc1	PD including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million m^3 (Mlalazi).	Mlalazi and Siyaya estuaries
	6	Sc2	PD reduced by 10% through abstraction from lower reaches of river (Mlalazi).	Mlalazi and Siyaya estuaries
	7	Sc3	PD reduced by 20% through abstraction from lower reaches of river (Mlalazi).	Mlalazi and Siyaya estuaries
	8	Sc4	Scenario 3 including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 20 million m^3 (Mlalazi).	Mlalazi and Siyaya estuaries
	9	Sc5	Restoration/Intervention Scenario 1: Mlalazi Estuary= REC; Siyaya Estuary= PES.	Mlalazi and Siyaya estuaries
	10	Sc6	Restoration/Intervention Scenario 2: Mlalazi Estuary= REC; Siyaya Estuary= REC.	Mlalazi and Siyaya estuaries
W21	1	CC	Climate Change.	Rivers, including. WM1
	2	HFY-noEWR	Historic Firm Yield (HFY) abstracted from upstream dams, no EWR.	Rivers, including. WM1
	3	HFYEWR	HFY abstracted from upstream dams, with EWR.	Rivers, including. WM1
	4	KLPEWR	Raised Klipfontein HFY abstracted from upstream dams, with EWR.	Rivers, including. WM1
W22	1	CC	Climate Change.	Rivers, including BM1
W23	1	CC	Climate Change.	Rivers
W31-a	1	CC	Climate Change.	Rivers
W31-b	1	CC	Climate Change.	Rivers, including MK1
	2	2040	PD with increased upstream domestic use.	Rivers, including MK1
	3	IRR	PD with increased return flows due to increased irrigation supplied from Pongolapoort Dam.	Rivers, including MK1
W32-a	1	CC	Climate Change.	Rivers
W32-b	1	CC	Climate Change.	Rivers
W41	1	CC	Climate Change.	Rivers
W42-a	1	CC	Climate Change.	Rivers, including UP1
	2	2040	PD with increased upstream domestic use (upgraded Frischgewaad Water Treatment Works - WTW).	Rivers, including UP1
W42-b	1	CC	Climate Change.	Rivers

IUA	Scenario			Type
	#	Abbrev.	Description	
W44	1	CC	Climate Change.	Rivers
W45	1	CC	Climate Change.	Rivers and Pongola Floodplain
W51-a	1	CC	Climate Change.	Rivers
W51-b	1	CC	Climate Change.	Rivers
W52	1	CC	Climate Change.	Both, including AS1 and NG1
	2	2040	PD with increased upstream domestic use.	Rivers, including AS1 and NG1
	3	EWR	PD with EWR included.	Rivers, including AS1 and NG1
	4	noEWR	PD with no EWR.	Rivers, including AS1 and NG1
W55	1	CC	Climate Change.	Rivers, including Pans and Chrissiesmeer
W57	1	CC	Climate Change.	Rivers, including Ndumo Pans
W70-a	1	CC	Climate Change.	Both, including Kosi Lakes and Estuary
W70-Muzi Swamps	1	CC	Climate Change.	Muzi Swamps
W-70b	1	CC	Climate Change.	Both, including Lake Sibaya, uMgobezeleni Estuary
St Lucia	1	CC	Climate Change.	St Lucia, W2 and W3 feeder streams. W32-Mkuze Floodplain/Swamp

Below follows tables with more details and statistics of the estuary scenarios.

Four flow and one non-flow scenario were evaluated for the aMatigulu/iNyoni Estuary (**Table 3.2**).

Table 3.2 aMatigulu/iNyoni Estuary: Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Remaining from Natural
Reference	Natural (~1750)	141.17	
Present	Present day	113.77	80.59
Scenario 1	Climate Change (CC)	94.79	67.14
Scenario 2	20% reduction	98.97	70.10
Scenario 3	30% reduction	92.46	65.49
Scenario 4	15% Increase	125.65	89.00
Scenario 5	Present day with non-flow restoration interventions including active restoration of the riparian area undertaken in conjunction with a reduction in harvesting and grazing pressures on the macrophytes. Fishing pressure (especially illegal gill netting) is reduced and recreational activities such as boating are controlled. Recreational activities in the lower reaches are curbed through zonation and improved compliance.	113.77	80.59

Six flow and one non-flow scenario were evaluated for the uMlalazi Estuary (**Table 3.3**).

Table 3.3 uMlalazi Estuary: Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Remaining from Natural
Natural	Natural (~1750)	119.34	
Present	Present day	99.55	83.4
Scenario 1	Climate Change	69.08	57.9
Scenario 4	Increased WWTW discharged.	99.25	83.2
Scenario 5	Present day but includes an additional demand which is approximately 10% of the present MAR (13 Mm^3) supplied by the upstream dam which has an increased capacity of 15 Mm^3.	95.95	80.4
Scenario 6	Present day reduced by 10% through abstraction from lower reaches of the river.	88.92	74.5
Scenario 7	Present day reduced by 20% through abstraction from lower reaches of the river.	79.12	66.3
Scenario 8	Same as Scenario 7 except an additional demand of 10% MAR is taken out of the upstream catchment from a dam with a capacity of 20 Mm^3 (over and above the 20% demand taken directly from the river).	75.67	63.4
Scenario 9	Present day with non-flow restoration interventions: Create interventions within the buffer zone that would improve the nutrient status and reduce sediment inputs. Reduce fishing pressure through eradicating illegal gill netting, as well as illegal seine and cast netting to improve the nursery function. Undertake active restoration of the uMlalazi estuary functional zone and reduce agriculture impacts in the supratidal area of the system, including the controlling of harvesting and grazing pressures. Restore intertidal habitat in lower reaches. Control recreational activities in the lower reaches through zonation and improved compliance. Manage disturbance to birds (e.g., closed areas, boating controls such as speed zones), including control and management of	99.55	83.4

Scenarios	Description	MAR ($X10^6$ m^3)	% Remaining from Natural
	vehicle access at the mouth to minimise the disturbance to birds. Promote tourism (bird guides etc.) to reduce impacts on other activities in the system. Implement strategic planning and management of land-use in and around the Estuary Functional Zone (EFZ). Monitor and control sand mining in the upper reaches of the system.		

Three flow scenarios were evaluated for the iSiyaya Estuary (**Table 3.4**).

Table 3.4 iSiyaya Estuary: Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity
Reference	Natural (~1750)	4.70	100.00
Present	Present day	3.39	72.0
Scenario 1	Climate change	2.21	47.1
Scenario 2	Increased abstraction (-15 %)	2.89	61.4
Scenario 3	Restoration of baseflows (+15%)	3.91	83.0

Three flow scenarios were evaluated for the iNhlabane Estuary (**Table 3.5**).

Table 3.5 iNhlabane Estuary: Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity
Reference	Natural (~1750)	30.40	100.0
Present	Present day	21.31	70.1
Scenario 1	Climate change	10.09	33.2
Scenario 2	Historical EWR	21.33	70.2
Scenario 3	Restoration of flow	26.35	86.7
Scenario 4	Restoration of flow and non-flow interventions	26.35	86.7

Four flow scenarios were evaluated for the uMhlatuze Estuary (**Table 3.6**).

Table 3.6 uMhlatuze Estuary: Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Similarity
Reference	Natural (~1750)	470.08	100.0
Present	Present day	289.59	61.6
Scenario 1	Climate change	219.07	46.6
Scenario 2	Restoration (15% increase)	333.00	70.8
Scenario 3	2030 Development	281.44	59.9
Scenario 4	2040 Development	278.31	59.2

4 ECONOMIC CONSEQUENCES

The results of the different scenarios, as they impact on the different economic sectors, are presented in this chapter. The impact on GDP, as well as labour, is provided for integration into the final results.

4.1 RESULTS PRESENTATION

A socio-economic baseline was established and the results for the different scenarios were measured against this baseline.

4.1.1 Socio-Economic baseline summary results

The socio-economic values that follow (**Table 4.1** to **Table 4.3**) provide the total sector impacts of the different sectors in the secondary catchments dependant and driven by the availability of the water. The tables also identify the ratio between the direct and total impacts of each sector. The total reflects what the direct impacts of the total catchment are compared to the total impacts of the total catchment.

Table 4.1 Gross domestic impacts in the Usutu to Mhlathuze catchment (Rand Millions)

Sector	W1	W2	W3	W4	W5	W7	Catchment		
	Mhlathuze	Umfolozi	Mkuze	Pongola	Usutu	Kosi Bay and Lake Sibaya	Total	Direct	Direct/ Total
	R Million	R Million	R Million	R Million	R Million	R Million	R Million	R Million	
Agriculture	R 1 415	R 288	R 331	R 558	R 31	-	**R 2 623**	R 1 763	67.2%
Commercial Forestry	R 405	R 127	R 214	R 397	R 1 088	R 170	**R 2 402**	R 1 012	42.1%
Saw Mills	R 248	R 156	-	-	R 1 854	-	**R 2 258**	R 1 050	46.5%
Paper Mills	R 1 099	-	-	-	R 330	-	**R 1 428**	R 587	41.1%
Heavy Industry	R 2 444	-	-	-	-	-	**R 2 444**	R 1 137	46.5%
Mining	R 669	R 51	R 22	R 18	R 69	R 0	**R 829**	R 416	50.1%
Sugar Mills	R 4 431	R 3 030	-	R 3 481	-	-	**R 10 942**	R 5 978	54.6%
Eco-Tourism	R 1 000	R 60	R 338	R 37	R 184	R 20	**R 1 640**	R 517	31.5%
Total	**R 11 712**	**R 3 711**	**R 905**	**R 4 492**	**R 3 556**	**R 191**	**R 24 567**	**R 12 459**	**50.7%**

The results summarised (**Table 4.1**), the two most economic active secondary catchments are the Mhlathuze with value added contributions in all the different sectors and the Usutu catchment with most being industries. The direct contribution to the total impact is 50.7% (R12 459 million/R24 567 million). The direct impacts compared to the total impacts on Agriculture is 67.2%, almost 17% higher than the total catchments' direct to total GDP ratio of 50.7%. The GDP that consists of payments to employees, gross operating surplus and net taxes is mostly applicable to farming where the direct impact takes place. The other sectors direct/total ratios are less, but not necessarily less important as it contributes to the indirect and induced impacts of the economy.

Table 4.2 Employment impacts of the Usutu to Mhlathuze catchment (Numbers)

Sector	W1	W2	W3	W4	W5	W7	Catchment		
	Mhlathuze	Umfolozi	Mkuze	Pongola	Usutu	Kosi Bay and Lake Sibaya	Total	Direct	Direct/ Total
Agriculture	16 445	3 646	2 478	4 829	214	-	**27 612**	24 720	89.5%
Commercial Forestry	5 276	3 415	2 640	4 950	13 171	2 107	**31 558**	30 796	97.6%
Saw Mills	704	442	-	-	5 256	-	**6 401**	1 794	28.0%
Paper Mills	3 292	-	-	-	988	-	**4 280**	1 243	29.0%
Heavy Industry	5 491	-	-	-	-	-	**5 491**	1 404	25.6%
Mining	1 148	88	37	32	118	0	**1 422**	273	19.2%
Sugar Mills	10 445	7 143	-	8 206	-	-	**25 794**	7 354	28.5%
Eco-Tourism	3 413	2	1 155	127	629	70	**5 598**	1 851	33.1%
Total	**46 214**	**14 937**	**6 310**	**18 144**	**20 375**	**2 176**	**108 156**	**69 436**	**64.2%**

From **Table 4.2**, the total employment impacts on the Mhlathuze catchment consist of 64.2% (69 436/108 156) compared to the other sub-catchments. The eco-tourism sector provides 33.1% (1 851/5 598) of employees' jobs at lodges and nature reserves as direct employees. This is also a labour-intensive industry and provides income not only to the urban areas but also to smaller communities in the catchment area.

Table 4.3 Household income impacts of the Usutu to Mhlathuze catchment (Rand Millions)

Sector	W1	W2	W3	W4	W5	W7	Catchment		
	Mhlathuze	Umfolozi	Mkuze	Pongola	Usutu	Kosi Bay and Lake Sibaya	Usutu to Mhlathuze	Low	Low/ Total
	R million	R million	R million	R million	R million	R million	R million	R million	
Agriculture	R 441.7	R 184.3	R170.8	R 338.6	R 16.8	-	**R 1 152.2**	R 397	34.4%
Commercial Forestry	R 19.3	R 13.1	R10.2	R 18.9	R 51.6	R 8.1	**R 121.3**	R 32	26.2%
Saw Mills	R 104.1	R 65.3	-	-	R 777.6	-	**R 947.1**	R 209	22.1%
Paper Mills	R 600.1	-	-	-	R 180.0	-	**R 780.2**	R151	19.4%
Heavy Industry	R 891.8	-	-	-	-	-	**R 891.8**	R 167	18.8%
Mining	R 327.5	R 25.2	R10.6	R 9.0	R 33.6	R 0.0	**R 405.8**	R 73	18.1%
Sugar Mills	R 1 715.4	R 1 173.1	-	R 1 347.8	-	-	**R 4 236.2**	R 875	20.6%
Eco-Tourism	R 495.5	R29.6	R167.7	R 18.4	R 91.4	R 10.1	**R 812.7**	R 159	19.6%
Total	**R 4 595.5**	**R1 490.5**	**R 359.2**	**R 1 732.7**	**R 1 151.0**	**R 18.2**	**R 9 347.2**	**R 2 063**	**22.1%**

The total households consist of the low, medium, and high-income groups of which 49.2% (R4 595.5 million/R9 347.2 million) are earning an income in the Mhlathuze secondary catchment (**Table 4.3**). The ratio between low and the total households is 22.1%. This imply that economic activities in the catchment provides a household income for low-income households 22.1% (R 2 063 million).

4.2 SCENARIO IMPACTS

The economic consequences are expressed as quantitative (numbers) and qualitative (non-numerical) analysis. The quantitative analysis is applied to scenarios that have an economic impact

due to water changes on irrigation agriculture, commercial forestry and physical numbers that were calculated. By calculating water use per hectare and then the number of hectares curtailed, an estimation of the employment and GDP loss can be determined. Although it is a difficult process to mitigate and apply, it is easier to remove hectares than remove a portion of an aluminium smelter or a portion of an urban communities' water. The possible impact of water changes in the industries and urban community sectors, were analysed on a qualitative level where the impacts of scenarios relating to a reduction or increase of water is described.

4.2.1 Quantitative Analysis: Irrigation agriculture and commercial forestry

The following tables show the scenarios and associated consequences relating to impact on direct GDP and labour.

The colour scheme used in **Table 4.4** to **Table 4.6** shows the severity of the curtailment of the economic impacts and are outlined below:

- Dark green indicates the least curtailment when comparing the rest of the specific indicators in the specific table.
- Yellow shows the mid-range comparing the rest of the specific indicators in the specific table.
- Dark red shows the highest curtailment comparing the rest of the specific indicators in the specific table.

The scenarios resulting from the present flow situation is expressed as direct GDP and labour (employment) indicators.

Table 4.4 Irrigation agriculture quantitative economic analysis of the river scenarios

Catchment / River	Scenario	Baseline Impact		Scenario Impact		Percentage Change (Curtailment)	
		Direct GDP	Direct Labour	Direct GDP	Direct Labour	Direct GDP	Direct Labour
		Rand Millions	Numbers	Rand Millions	Numbers	%	%
White Umfolozi	Sc 1 - WM1_CC Natural inflow files scaled for **climate change**	73.01	1 714	71.71	1 690	1.78%	1.42%
Mkuze	Sc 1 - MK1_CC: Natural inflow scaled for **climate change**	137.63	1 872	136.74	1 856	0.65%	0.89%
Mkuze	Sc 2 - MK1_2040: PD scenario **with increased upstream domestic use**	137.63	1 872	137.55	1 871	0.06%	0.08%
Pongola	Sc 1 - UP1_CC: Natural inflow scaled for climate change scenario	148.50	4 119	148.34	4 116	0.11%	0.07%
Pongola	Sc 2 - UP1_2040: PD scenario with **increased upstream domestic use** (upgraded Frischgewaad WTW)	148.50	4 119	148.49	4 119	0.01%	0.00%
Assegaai	Sc 1 - AS1_CC: Natural inflow scaled for **climate change** scenario	109.52	3 070	109.52	3 070	0.00%	0.00%
Assegaai	Sc 2 - AS1_2040: PD scenario with **increased upstream domestic use**	109.52	3 070	106.97	3 022	2.33%	1.56%
Ngwempisi	Sc 1 - NG1_CC: Natural inflow scaled for **climate change** scenario	276.64	8 168	276.37	8 163	0.10%	0.06%
Ngwempisi	Sc 2 - NG1_2040: PD scenario with **increased upstream domestic use**	276.64	8 168	276.64	8 168	0.00%	0.00%
Ngwempisi	Sc 3 - NG1_EWR: **PD scenario with EWR as provided included** (Yield of Jericho drops)	276.64	8 168	276.56	8 166	0.03%	0.02%

As the present water situation (MAR) has already made provision for irrigation, the curtailment effect was in context of labour, where lay-off of farm workers will take place or in the context of the GDP indicator, where the Gross Operating Surplus (GOS) will possibly decrease, and labour remuneration and net taxes will not be that substantial.

The relatively highest curtailment calculated was Sc 2 - AS1_2040 of which 3 070 – 3 022 = 48 possible job opportunities can be lost. The highest climate change scenario of curtailment in the river scenarios was in the White Mfolozi catchment (Sc 1 - WM1_CC) where the GDP is reduced by 1.78% (about R1 million) and direct employment by 1.42% (24 jobs).

Table 4.5 Irrigation agriculture and commercial forestry quantitative economic analysis of the Estuary scenarios – Water curtailed

Catchment / River	Scenario	Baseline Impact		Scenario Impact		Percentage Change (Curtailment)	
		Direct GDP	Direct Labour	Direct GDP	Direct Labour	Direct GDP	Direct Labour
		Rand Millions	Numbers	Rand Millions	Numbers	%	%
Amatigulu	Sc 1 - MA1 CC: Natural inflow scaled for **climate change**	23.1	404	20.0	380	13.4%	6.1%
Nseleni	Sc 1 - NS1 CC: Natural inflow scaled for **climate change**	187.4	3 112	164.6	2 919	12.2%	6.2%
Mlalazi	**Sc 1 CC: Climate Change**	8.2	251	8.2	250	0.8%	0.4%

From **Table 4.5**, the estuary scenarios that resulted in curtailment of irrigation and commercial forestry were the climate change scenarios of Amatigulu (Sc 1 - MA1 CC) and Nseleni (Sc 1 - NS1 CC) rivers of which the scenarios were identified at the point of the inflow to the estuary. The GDP was reduced by about 13.4% and 12.2% respectively. The relatively high curtailment percentage change of Amatigulu is due to citrus curtailment which has a high value crop and is cultivated upstream of the estuary. Wattle was the first ranking tree species to be curtailed as it is the closest to an alien tree crop and removed first with the forestry water changes. Sc 1 - NS1 CC resulted in a high reduction of available water for irrigation agriculture where all the vegetables had to be curtailed and then a portion of the sugar cane according to the ranking table.

In an estuary scenario where the water volume was extended for irrigation agriculture, a proxy was developed with the increased water available (**Table 4.6**).

Table 4.6 Irrigation agriculture and forestry quantitative economic analysis of the Estuary scenarios – Water extended

Catchment / River	Scenario	Baseline Impact		Scenario Impact		Percentage Change (Extended)	
		Direct GDP	Direct Labour	Direct GDP	Direct Labour	Direct GDP	Direct Labour
		Rand Millions	Numbers	Rand Millions	Numbers	%	%
Mhlathuze	Sc 4: 2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)	87.0	2 130	88.1	2 146	1.3%	0.8%

If it was economically feasible to expand irrigation, using irrigation sugar cane, as it is the main crop already cultivated in the area, the direct GDP increases to 1.3% (about R1.1 million) and direct employment to 0.8% (16 job opportunities) (**Table 4.6**).

If this scenario was not economically feasible with the available water as driver, but more water was available for the long term, the farmers have more security to carry on with current farming practices. There is then no need to invest in other irrigation systems or consider other crops to cultivate in order to use the water optimally and efficiently, but with a huge cost that is part of the future to produce sugar cane.

4.2.2 Qualitative Analysis: Urban and Industries

The following tables provide qualitative descriptions of what the curtailment or water augmentation will have on the future of the rivers and estuaries (**Table 4.7**).

Table 4.7 Urban and industry qualitative economic analysis of the river scenarios

Catchment / River	Scenario	Urban or Industries Actions	Qualitative scenario impact
Black Umfolozi	Natural inflow files scaled for **climate change** scenario	No impact	No economic change.
White Umfolozi	Natural inflow files scaled for **climate change** scenario	Urban water reduction	Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations.
White Umfolozi	HFY abstracted from upstream dams, **no EWR**	No impact	No economic change.
White Umfolozi	HFY (12.9) abstracted from upstream dams, with EWR on (**yield is not affected by EWR**)	No impact	No economic change.
White Umfolozi	Raised Klipfontein HFY (14.3) abstracted from upstream dams, with EWR on (**yield is not affected by EWR**)	No impact	No economic change.
Mkuze	Natural inflow files scaled for **climate change** scenario	Urban water reduction	Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations.
Mkuze	PD scenario with **increased upstream domestic use**	Urban water increased	As water supply is increased, towns able to expand on housing as light industries will come as demand for services, thus job opportunities and GDP contributions is possible.
Mkuze	PD scenario with increased return flows due to increased irrigation supplied from Pongolapoort Dam	No impact	If more water is available, farmers can have the opportunity of expansion if all economic conditions with arable land are suitable. However, it is not applicable for the Mkuze River. The Mkuze River water is reserved for the St. Lucia Lake and irrigation farmers received their water from the Pongolapoort Dam.
Pongola	Natural inflow files scaled for **climate change scenario**	Urban water reduction	Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations.
Pongola	PD scenario with increased upstream domestic use (upgraded Fritz WTW)	Urban water increased	As water treatment works is upgraded, improve water quality provides better reticulation to homes, improve ease of living.
Assegaai	Natural inflow files scaled for **climate change scenario**	Eskom (Heyshope yield) water reduced	Will have an influence on Eskom's water use if demand for water is increased.
Assegaai	PD scenario with increased upstream domestic use	Urban water increased	As water supply is increased, towns can expand on housing as light industries will come as demand for services, thus job opportunities and GDP contributions is possible.
Assegaai	PD scenario with EWR as provided included (**no impact on yield of Heyshope**)	No impact	No economic change.
Assegaai	PD scenario with **no EWR**	No impact	No economic change.
Ngwempisi	Natural inflow files scaled for **climate change** scenario	Urban water reduction	Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations.

Catchment / River	Scenario	Urban or Industries Actions	Qualitative scenario impact
Ngwempisi	PD scenario with **increased upstream domestic use**	Urban water increased	As water supply is increased, towns are able to expand on housing as light industries will come as demand for services, thus job opportunities and GDP contributions is possible.
Ngwempisi	PD scenario with EWR as provided included (**Yield of Jericho drops** from 58 to 49)	No current impact	Can have a problem with water supply to users if demand increase.

From the river in **Table 4.7** scenarios where the water will be available for domestic use, security for future developments is provided if the funding is available. If this is not the situation, it does however provide water security for continuous use to accommodate gradual demand in population, and other urbanisation factors.

Where water is reduced, economic growth and sustainability of the communities and industries is at risk (**Table 4.8**).

Table 4.8 Urban and Industry qualitative economic analysis of the estuary scenarios

Catchment / River	Description	Urban or Industries Actions	Qualitative scenario impact
Amatigulu	Natural inflow files scaled for climate change scenario	No changes	No economic change.
Amatigulu	Reduction of present-day MAR by 10%	No impact	No economic change.
Amatigulu	Reduction of present-day MAR by 20%	No Impact	No economic change
Amatigulu	Reduction of present-day MAR by 30%	No Impact	No economic change.
Amatigulu	Increase of present-day MAR by 15%	No Impact	No economic change.
Nseleni	Natural inflow files scaled for climate change scenario	No Impact	No economic change.
Mlalazi	Climate Change	No Impact	No economic change.
Mlalazi	Increase of present-day MAR by 15%	No Impact	No economic change.
Mlalazi	Reduction of present-day MAR by 15%	No Impact	No economic change.
Mlalazi	Climate Change	No Impact	No economic change.
Mlalazi	Present day including the upgrade of the Mtunzini WWTW increased to a 1.5 Ml/d plant	No Impact	No economic change.
Mlalazi	Present day including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million m^3.	No Impact	No economic change.
Mlalazi	Present day reduced by 10% through abstraction from lower reaches of river	No Impact	No economic change.
Mlalazi	Present day reduced by 20% through abstraction from lower reaches of river	No Impact	No economic change.
Mlalazi	Scenario 3 including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 20 million m^3.	No Impact	No economic change.
Mhlathuze	Climate Change	Urban water reduction	Economic growth might be restricted as expansion in supply of water for housing will be reduced, and light industries such as shopping malls will not be considered to expand due to water limitations.

Catchment / River	Description	Urban or Industries Actions	Qualitative scenario impact
Mhlathuze	Increase of present-day MAR by 15%	No Impact	No economic change.
Mhlathuze	Increase of present-day MAR by 10%	No Impact	No economic change.
Mhlathuze	2030 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)	No Impact	No economic change.
Mhlathuze	2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)	Urban water increased	As water supply is increased, towns can expand on housing as light industries will come as demand for services, thus job opportunities and GDP contributions is possible.
Nhlabane	Climate Change	No Impact	No economic change.
Nhlabane	Present Day including EWR releases from Lake Nhlabane as obtained from MWAAS (DWAF, 2009)	No Impact	No economic change.
Nhlabane	Restoration Scenario	No Impact	No economic change.

It must be noted in **Table 4.8** that water acts as the driver in the analysis and is taking into account possible changes in economic conditions. Thus, if this is the only factor to consider, when water volumes are increased, the urban and industrial water can be more sustained for the economic opportunities in the future.

However, availability of water will not necessarily generate economic growth but without the availability of water no economic growth can take place.

The scenarios that cause reduction in water volumes will decrease the economic sustainability that will therefore put pressure on the water use of the current water systems.

4.3 ECONOMIC CONCLUSIONS AND RECOMMENDATIONS

South Africa is a water stressed country and the Usutu to Mhlathuze catchments are no exception. Thus, management of the water systems is crucial in preserving water, including good water quality as well. Unfortunately, in certain rivers or catchments, the natural state deviates from the present day measurements with such a large range that to make water improvements, investigation into the areas where sources of deterioration are present need to be identified.

The Usutu to Mhlatuze catchment has sub-catchments with active economic land use, and the scenarios suggested that in certain rivers and estuaries water needs to be curtailed so the status of the water flow can be maintained and if possible improve to a higher class. In context with the production output of the various water dependant economic sectors, slight adjustments need to be made where water was curtailed with quantitative analysis of the agriculture and commercial forestry sectors in the primary sector of the economy. With the urban and industry sectors, reducing water to the natural state, results in more difficult practical implications than those produced per hectare and maize, sugar cane, vegetables or citrus are crops that might be removed if those scenarios are chosen and applied.

If that might ultimately be the decision, the economic consequences will result in contraction to the economy. It might only be felt directly on a sugar cane farm with reduction of the farmer's profit that is part of the direct GDP, but will probably result in job cuts as a result and reduced income to the low-income households will have not only an economic, but also socio-economic consequence. In

Table 4.9 the number of employment opportunities dependant on availability of water in the catchment is presented.

Table 4.9 Number of employment opportunities dependant on water availability in the Usutu to Mhlathuze catchment

Sector	W1	W2	W3	W4	W5	W7	Catchment		
	Mhlathuze	Umfolozi	Mkuze	Pongola	Usutu	Kosi Bay and Lake Sibaya	Total	Direct	Direct/Total
Agriculture	1 718	512	795	1 158	64	-	**4 247**	1 354	31.9%
Commercial Forestry	170	113	86	164	419	68	**1 020**	258	25.4%
Saw Mills	704	442	-	-	5 256	-	**6 401**	1 794	28.0%
Paper Mills	3 292	-	-	-	988	-	**4 280**	1 243	29.0%
Heavy Industry	5 491	-	-	-	-	-	**5 491**	1 404	25.6%
Mining	1 148	88	37	32	118	0	**1 422**	273	19.2%
Sugar Mills	10 445	7 143	-	8 206	-	-	**25 794**	7 354	28.5%
Eco-Tourism	3 413	2	1 155	127	629	70	**5 598**	1 851	33.1%
Total	26 381	8 500	2 073	9 687	7 473	**138**	**54 252**	**15 533**	**28.6%**

Table 4.9 shows that over 50 000 total job opportunities or more depend on the availability of the current water assurance of supply. The total irrigated sugar production is used in the calculations which include the production by subsistence farmers.

To summarise, the impacts of the economic consequences result in the following:

- Where there is a curtailment in water availability, regardless of the application of the different scenarios e.g., climate change or domestic use, it will cause uncertainty in continuation of economic activities and undisturbed use of water by households. It can be proposed that change of business practices to optimise water use, or from the domestic side install JoJo tanks, however this will have financial implications that not all users could bear without government support.
- Additional water available in the systems that is identified from the various scenarios, river systems or estuary, will not necessarily generate increase in economic growth with increased GDP, employment opportunities or contribution to the different households groups. It will however provide more assurance to continue with the current situation undisturbed.

5 ECOLOGICAL CONSEQUENCES: RIVERS

There are few major operational and development scenarios that would impact on rivers and EWR sites, and therefore require evaluation. Of those identified, Sc CC was often marginally 'worse' than the other scenarios. All scenarios meet the REC and it will therefore be recommended that the REC becomes the Target Ecological Category (TEC) and that Resource Quality Objectives (RQOs) are set for the REC.

The ecological consequences are summarised for the changes in components below.

5.1 ECOLOGICAL CONSEQUENCES: EWR MAT1 (MATIGULU RIVER)

EWR MA1: Matigulu River

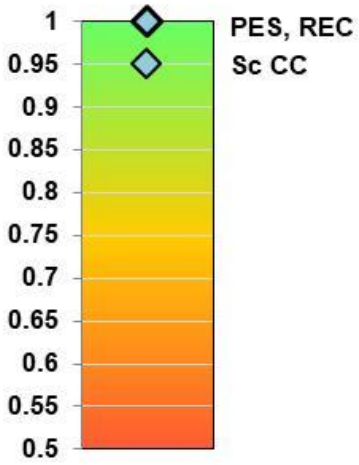
Coordinates	S29.02010 E31.47040
SQ[1] code	W11A-03612
RU[2]	RU W11-2
IUA[3]	IUA W11
Level 2 EcoRegion	17.01
Geomorph Zone[4]	Upper foothills

PES = REC

I IHI[5]	R IHI[6]	PC (WQ)[7]	Geom[8]	Rip Veg[9]	Fish	Inverts[10]	Instream	EcoStatus
B/C (80%)	B/C (78%)	B (84.5%)	B (87%)	B/C (79.4%)	B (86.4%)	B/C (80.9%)	B (83.3%)	B/C (81.3%)

SCENARIO CONSEQUENCE

Ranking of scenarios							
	B/C (80.6%)	B (81.7%)	B/C (78.7%)	B/C (79.4%)	B/C (78.5%)	B/C (78.9%)	B/C (79.2%)

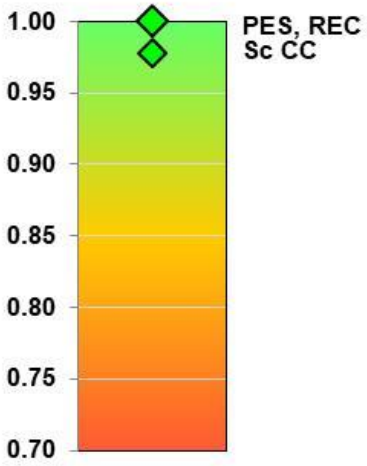


1 Sub-quaternary reach
2 Resource Unit
3 Integrated Unit of Analysis
4 Geomorphological zone
5 Instream component of Index of Habitat Integrity
6 Riparian component of Index of Habitat Integrity
7 Physico-Chemical (Water Quality)
8 Geomorphology
9 Riparian Vegetation
10 Macro-invertebrates

Scenario MA1_CC maintains the EcoStatus of a B/C at a lower percentage. The PES of all components are maintained, except fish and water quality which reflect a small drop in percentage. Fish and water quality decrease from a B to a B/C EC.

5.2 ECOLOGICAL CONSEQUENCES: EWR NS1 (NSELENI RIVER)

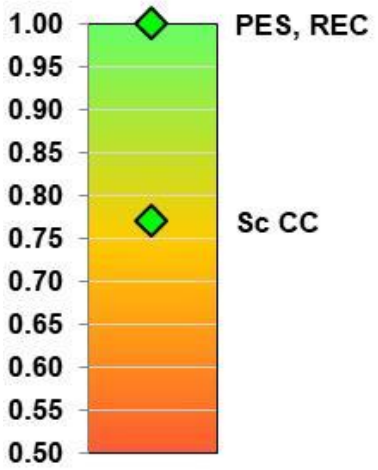
EWR NS1: Nseleni River								
							Coordinates	S28.63410 E31.92517
							SQ code	W12G-03229
							RU	RU W12-8
							IUA	IUA W12-b
							Level 2 EcoRegion	13.03
							Geomorph Zone	Lower foothills
PES = REC								
I IHI	R IHI	PC (WQ)	Geom	Rip Veg	Fish	Inverts	Instream	EcoStatus
B/C (81%)	C (70.3%)	B (82.7%)	B (85%)	C (64.4%)	C (67.9%)	B/C (79.4%)	C (74.3%)	C (68.4%)
SCENARIO CONSEQUENCE								
Ranking of scenarios		B/C (80.6%)	B (82%)	C (64.2%)	C (65.8%)	B/C (77.9%)	C (72.53%)	C (67.5%)



Scenario NS1_CC maintains the EcoStatus of a C at a lower percentage. The PES of all components is maintained, except geomorphology and water quality which reflected a small drop in percentage. Water quality and geomorphology decrease from a B to a B/C Category.

5.3 ECOLOGICAL CONSEQUENCES: EWR BM1 (BLACK MFOLOZI RIVER)

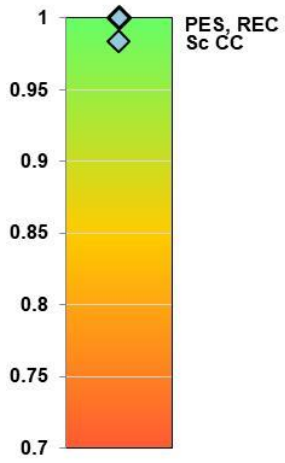
EWR BM1: Black Mfolozi River								
						Coordinates	S27.93890 E31.21030	
						SQ code	W22A-02610	
						RU	RU W22-1	
						IUA	IUA W22	
						Level 2 EcoRegion	3.1	
						Geomorph Zone	Upper foothills	
PES = REC								
I IHI	**R IHI**	**PC (WQ)**	**Geom**	**Rip Veg**	**Fish**	**Inverts**	**Instream**	**EcoStatus**
B/C (77.7%)	**C (74.4%)**	**B/C (81.8%)**	**A (93%)**	**C (74.9%)**	**C (75.9%)**	**B/C (81.2%)**	**B/C (78.9%)**	**C (76.9%)**
SCENARIO CONSEQUENCE								
Ranking of scenarios		**C/D (61.8%)**	**C (73.5%)**	**C (68.5%)**	**D (55.5%)**	**C/D (58%)**	**D (57.4%)**	**C (62.9%)**



Even though the EcoStatus stays a C, the percentage has dropped significantly. The PES is close to a B/C and the scenario evaluation results in a PES close to a C/D. Water quality, fish and macro-invertebrates all drop one category whereas geomorphology drops with two categories. In conclusion, this Climate Change scenario will have a significant impact on the Ecological Status.

5.4 ECOLOGICAL CONSEQUENCES: EWR WM1 (WHITE MFOLOZI RIVER)

EWR WM1: White Mfolozi River								
						Coordinates	S28.23146 E31.18666	
						SQ code	W21H-02897	
						RU	RU W21-5	
						IUA	IUA W21	
						Level 2 EcoRegion	14.05	
						Geomorph Zone	Lower foothills	
PES = REC								
I IHI	**R IHI**	**PC (WQ)**	**Geom**	**Rip Veg**	**Fish**	**Inverts**	**Instream**	**EcoStatus**
B/C (79.3%)	**B/C (77.4%)**	**B (84.5%)**	**B/C (78.8%)**	**B/C (81.3)**	**C (73%)**	**B/C (81.1%)**	**C (77.1)**	**B/C (79.2%)**
SCENARIO CONSEQUENCE								
Ranking of scenarios		**B (84.5%)**	**C (75%)**	**B/C (78.9)**	**C (72%)**	**B/C (80.6%)**	**C (76.3)**	**B/C (77.6%)**



Only geomorphology drops by half a category resulting in the EcoStatus to also drop from a B/C to a C. The changes are minor and largely related to the increase in sedimentation. There is also a marginal reduced availability of fast habitats during the dry season, which may have an impact on some key fish species.

5.5 ECOLOGICAL CONSEQUENCES: EWR MK1 (MKUZE RIVER)

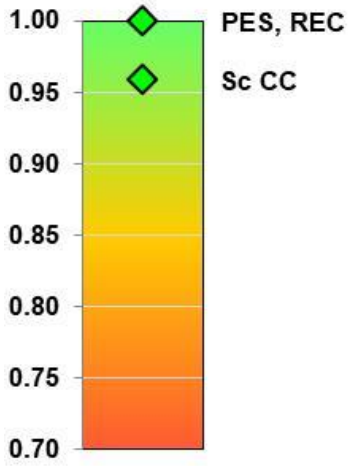
All scenarios were evaluated, and it was found that there is no discernible difference between scenarios, with all scenarios being similar to PD. During the EWR assessment it was observed that the PD hydrology appears very low during dry months (note that the Present Day hydrology is currently being updated through other studies). Due to this uncertainty, the Revised Desktop Reserve Model (RDRM) used to produce the EWRs was therefore not constrained to PD. This implies that the EWR for low flows appear higher than modelled PD, even though NO improvement is required in terms of flow, i.e., higher flows than PD are not required. This makes the yield model output impossible to evaluate as the FDCs all show the EWR and scenarios to be much higher than PD. The only conclusion that can be made is that as all scenarios are similar to the modelled PD, the Ecological Category will remain the same for all scenarios.

It must be noted that EWR MK1 (Mkuze River) requires improvement to achieve the REC, but these improvements are NON-FLOW RELATED. These improvements will be identified, and recommendations made as part of the RQO process.

5.6 ECOLOGICAL CONSEQUENCES: EWR UP1 (PONGOLO RIVER)

EWR UP1: Pongola River		
	Coordinates	S27.36413 E30.96962
	SQ code	W42E-02221
	RU	RU W42-2
	IUA	IUA W42-b
	Level 2 EcoRegion	3.1
	Geomorph Zone	lower/upper foothills

PES = REC								
I IHI	**R IHI**	**PC (WQ)**	**Geom**	**Rip Veg**	**Fish**	**Inverts**	**Instream**	**EcoStatus**
B/C (80.5%)	**B/C (77.8%)**	**A/B (88.3%)**	**A/B (89.8%)**	**C (70%)**	**C (73.9%)**	**B/C (79.5%)**	**C (77%)**	**C (73.5%)**
SCENARIO CONSEQUENCE								
Ranking of scenarios		**B (85.5%)**	**B (84.3%)**	**C (68.7%)**	**C (68.7%)**	**B/C (77.5%)**	**C (73.6%)**	**C (71.1%)**



Only water quality and geomorphology drop a half a category drop which results in a small change in the C category rating for the CC scenario.

5.7 ECOLOGICAL CONSEQUENCES: EWR AS1 (ASSEGAAI RIVER)

EWR AS1: Assegaai River

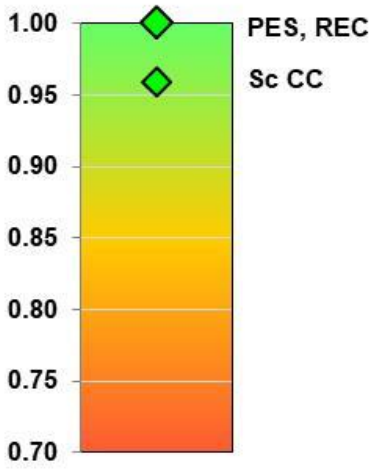
Coordinates	S27.06230 E30.98880
SQ code	W51E-02049
RU	RU W51-3
IUA	IUA W52
Level 2 EcoRegion	4.06
Geomorph Zone	lower/upper foothills

PES = REC

I IHI	R IHI	PC (WQ)	Geom	Rip Veg	Fish	Inverts	Instream	EcoStatus
C/D (59.1%)	C/D (58.7%)	B/C (80.6%)	C (70.8%)	C (69.9%)	C (69.2%)	B/C (78.6%)	B/C (77.8%)	C (74.2%)

SCENARIO CONSEQUENCE

Ranking of scenarios	PC (WQ)	Geom	Rip Veg	Fish	Inverts	Instream	EcoStatus
	B/C (80.6%)	C (65.5%)	C (65.8%)	C (68.8%)	B/C (77.2%)	C (73%)	C (69.7%)



All Scenarios are an improvement on the EWR and close to PD, meaning that all scenarios will maintain the REC. There are minor decreases within category due to decreased spilling from the large upstream dams under Sc UP_CC.

5.8 ECOLOGICAL CONSEQUENCES: EWR NG1 (NGWEMPISI RIVER)

EWR NG1: Ngwempisi River

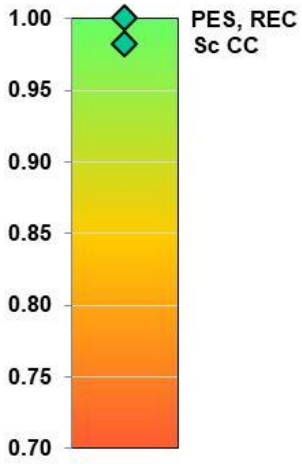
Coordinates	S26.679448 E30.70213
SQ code	W53E-01790
RU	RU W53-3
IUA	IUA W52
Level 2 EcoRegion	11.04/4.06
Geomorph Zone	Upper foothills/ Transitional

PES = REC

I IHI	R IHI	PC (WQ)	Geom	Rip Veg	Fish	Inverts	Instream	EcoStatus
C (64.3%)	C/D (61.8%)	B (85.5)	B/C (83.3%)	B/C (77.4%)	C (72.8%)	B (87.3%)	B/C (80.36%)	B/C (79.8%)

SCENARIO CONSEQUENCE

Ranking of scenarios							
	B (85.5)	B (80.2%)	B/C (77.4%)	C (69.6%)	B (85.6%)	B/C (78%)	B/C (77.8%)



Although there are minor geomorphological changes, all component RECs are maintained and the EcoStatus for Sc UP_CC are very similar to the PES EcoStatus.

5.9 SUMMARY AND COMPARISON OF CONSEQUENCES

A summary of the results showing the scenarios compared to the REC is provided in **Table 5.1** and **Figure 5.1**.

Table 5.1 Scenario consequences results

	Sc MA1	Sc NS1	Sc BM1	Sc WM1	Sc MK1	Sc UP1	Sc AS1	Sc NG1
Sc value	0.95	0.98	0.77	0.98	1.00	0.96	0.98	0.98
REC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

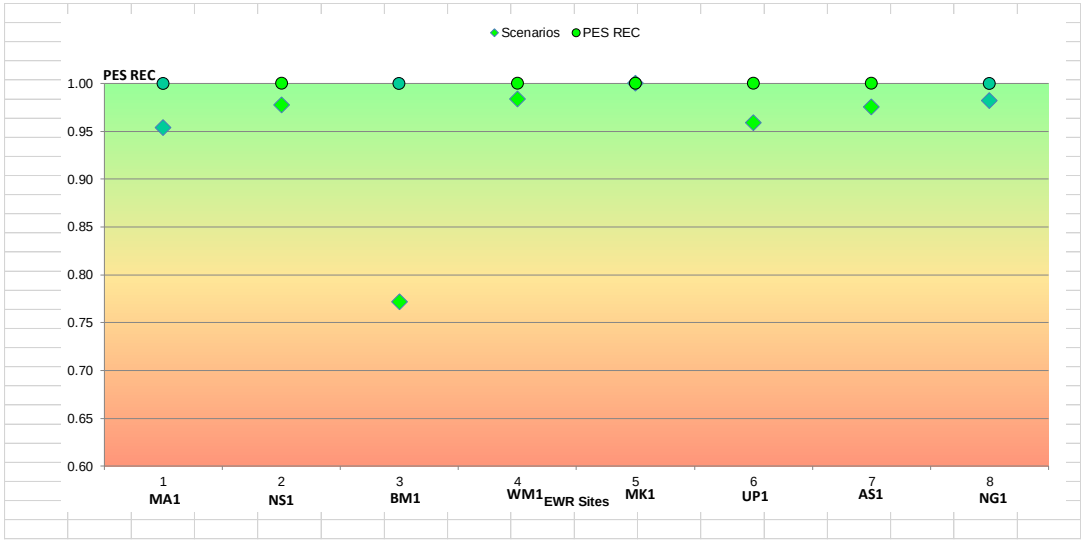


Figure 5.1 Summary traffic diagram of scenario consequences results

6 ECOLOGICAL CONSEQUENCES: ESTUARIES

6.1 ECOLOGICAL CONSEQUENCES: aMATIGULU/iNYONI ESTUARY

The PES for the aMatigulu/iNyoni Estuary is a B/C, but the estuary is of high biodiversity and conservation importance (in a protected area) and should therefore be in an A Category. However, the reversibility of the impacts into account, the Recommended Ecological Category for the system is a B Category. The individual Estuarine Health Index (EHI) scores, as well as the corresponding ecological category under different scenarios, are provided below in **Table 6.1**.

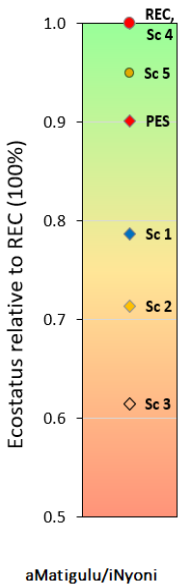
Table 6.1 aMatigulu/iNyoni: EHI scores and corresponding Ecological Categories under the different runoff scenarios

Component	PES	Scenarios				
		1	2	3	4	5
Hydrology	73	57	48	41	93	73
Hydrodynamics and mouth condition	84	72	54	39	98	84
Water quality	63	63	64	65	64	63
Physical habitat alteration	83	65	65	56	90	87
Habitat health score	**76**	**64**	**58**	**50**	**86**	**77**
Microalgae	79	62	70	65	80	79
Macrophytes	78	68	58	48	85	85
Invertebrates	70	65	55	45	80	80
Fish	65	65	55	45	70	75
Birds	70	65	60	50	75	80
Biotic health score	**72**	**65**	**60**	**51**	**78**	**80**
ESTUARY HEALTH SCORE	**74**	**65**	**59**	**51**	**82**	**78**
PRESENT ECOLOGICAL STATUS	**B/C**	**C**	**C/D**	**D**	**B**	**B**

Scenario 1, Climate Change, will result in deterioration by 9% from the PES causing the estuary to degrade to a C Category. Under Sc 2 the Estuary will rapidly decline by 15% to a C/D Category, while there will be an additional 8% decline under Sc 3 to a D Category. Scenarios 1 to 3 will have a major impact on the cueing effect as the signal to the marine environment and will be substantially reduced. Under Sc 5 the estuary will improve by 8% to a Category B.

NON-FLOW Sc 5 represents a restoration scenario in which no effort is made to improve baseflows or water quality, but active restoration of the riparian area is undertaken in conjunction with a reduction in harvesting and grazing pressures on the macrophytes. Fishing pressure (especially illegal gill netting) is reduced and recreational activities such as boating are controlled. These, in turn, result in a significant gain in ecological health lifting the system into a low Category B. The small improvement in baseflows and water quality would assist further in restoring this system even more.

The Recommended Flow Scenario is Sc 5 (Restoration scenario).



6.2 ECOLOGICAL CONSEQUENCES: uMLALAZI ESTUARY

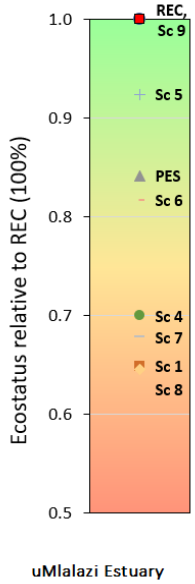
The PES for the uMlalazi Estuary is a B/C, but the estuary is of high biodiversity and conservation importance (in a protected area) and should therefore be in an A Category. However, the reversibility of the impacts into account, the REC for the system is a B Category. The individual EHI scores, as well as the corresponding EC under different scenarios are provided below in **Table 6.2**.

Table 6.2 uMlalazi: EHI scores and corresponding Ecological Categories under the different runoff scenarios

Component	PES	Scenarios						
		1	4	5	6	7	8	9
Hydrology	72	41	71	69	55	41	39	72
Hydrodynamics and mouth condition	84	61	84	83	71	61	59	84
Water quality	66	48	42	66	54	46	45	66
Physical habitat alteration	85	55	60	85	70	55	50	85
Habitat health score	**77**	**51**	**64**	**76**	**62**	**51**	**48**	**77**
Microalgae	72	55	34	72	70	65	63	72
Macrophytes	70	40	40	65	60	50	50	75
Invertebrates	75	60	40	75	65	55	50	85
Fish	80	50	55	75	75	55	55	85
Birds	60	45	55	55	55	50	45	80
Biotic health score	71	50	45	68	65	55	53	79
ESTUARY HEALTH SCORE	**74**	**51**	**55**	**72**	**64**	**53**	**50**	**78**
PRESENT ECOLOGICAL STATUS	**B/C**	**D**	**D**	**C**	**C**	**D**	**D**	**B**

Scenario 1, the Climate Change scenario will also result in a 23% decline in condition to a Category D. While under Sc 4, the WWTW option, it will degrade by 19% resulting in Category D, however, under this scenario much of the ecology will be in a highly degraded state and most ecosystem services are severely compromised. Under Sc 5 the estuary will decline by 2% to a C Category. There will be an additional 10% decline under Sc 6, but the estuary will remain in a Category C state. Sc 7 and 8 will result in severe further deterioration by 21% and 24% respectively from the PES causing the uMlalazi Estuary to degrade to a D Category. Development Sc 6 to 8 will also have major impacts on the cueing effect as the signal to the marine environment will be substantially reduced. Under most future scenarios increased/extended mouth closures will result in salinities gradually decreasing from the open marine phase. Consequently, lower salinities will become distributed almost throughout the system and this will have major impacts on the marine and estuarine fauna within the estuary. An additional impact related to this situation is that alien invasive species such as the freshwater snail *Teribia granifera* would have increased invasive potential. Decreased salinities would also impact the breeding success of freshwater *Macrobrachium* prawns which require a certain minimum salinity for successful larval development.

The NON-FLOW Scenario 9 represents a restoration scenario in which no effort is made to improve baseflows or water quality, but active restoration of the EFZ is undertaken in conjunction with a reduction in harvesting, grazing and fishing pressure (especially illegal gill netting). Recreational activities such as boating are controlled. These in turn result in a significant gain in ecological health lifting the system into a low Category B. The small improvement in baseflows and water quality would assist further in restoring this system even more.



6.3 ECOLOGICAL CONSEQUENCES: iSIYAYA ESTUARY

The iSiyaya Estuary is currently in a D/E Category. Taking the current conditions, the reversibility of the impacts, the ecological importance, and the conservation requirements of the iSiyaya Estuary into account, the REC for the system is a C Category. The individual EHI scores, as well as the corresponding ecological category under different scenarios are provided below **Table 6.3**.

Table 6.3 iSiyaya: EHI scores and corresponding Ecological Categories under the different runoff scenarios

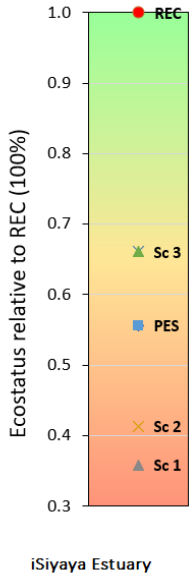
Component	Present	Scenarios		
		1	2	3
Hydrology	74	52	44	100
Hydrodynamics and mouth condition	57	27	51	57
Water quality	53	62	47	56
Physical habitat alteration	30	10	20	30
Habitat health score	**53**	**38**	**40**	**61**
Microalgae	51	27	36	71
Macrophytes	30	15	20	40
Invertebrates	15	5	10	20
Fish	15	10	10	20
Birds	50	30	40	55
Biotic health score	**32**	**17**	**23**	**41**
ESTUARINE HEALTH SCORE	**43**	**28**	**32**	**51**
PRESENT ECOLOGICAL STATUS	**D/E**	**E**	**E**	**D**

Under Sc 1 (Climate Change) and 2 (flow reduction) the estuary will further decline in condition by 15% and 9% respectively to a Category E state. These scenarios will have a major impact on the average water levels in the system and overall marine connectivity. While under Sc 3, the Restoration scenario, the estuary will improve by 7% to a D Category. None of the flow scenarios achieve the REC.

For the iSiyaya Estuary, only Sc 3 improved the estuary condition. Thus, an ecosystem-based adaptation restoration project embedded in an Estuary Management Plan (required under the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008) is needed to restore the iSiyaya Estuary's functionality. In the short term several mechanical interventions are needed to restore estuarine functionality such as: remove accumulated organic sludge through dredging of bottom substrate to improve water quality, i.e. increase oxygen in water column (this is a once-off measure that may need repeating every 10 to 20 years if the marine connectivity is not reinstituted); mechanical removal of reeds in lower reaches to increase open water area (once-off); revegetate the dune at the mouth; and when required mechanical removal of sediment that buildup at the mouth to allow for overwash recruitment. This may also require deepening the estuarine channel and /or bringing the openwater area forward by removing marine sand at the mouth when flow reduction have resulted in loss of marine connectivity (closed for more than 2 - 3 years). Given that the removal of 5 m^3 of sediment at a estuary trigger the EIA process (National Environmental Management Act (No. 107 of 1998), this will require the development of an Estuary Mouth/Maintenance Plan to guide the management authority on when such an action is needed. The plan also needs to consider the submarine cable to the north of the system.

In the long-term, a "catchment-to-coast" approach needs to be taken given this small river basin including: Mitigate the impacts of mining by ensuring a buffer zone of riparian vegetation around the estuary to reduce the turbidity signal and sediment input from mining. Note: Forestry in and around

the EFZ has removed the natural buffer capacity riparian vegetation provides. Reduce the direct impact of forestry on the estuary by instituting buffer zones around the EFZ (e.g. 1 km zone), while over longer time scales baseflows should be restored by an overall reduction in forested areas in the catchment. This also require the develop a groundwater-surface water model to protection of groundwater resources and estuary protection and management of the plantations. Pioneer different footpaths to the beach further north to reduce the disturbance of birds. Increase fishing compliance as fishing pressure will escalate if fish communities recover under restoration actions. Restore the upstream riparian zone and remove alien vegetation to assist with restoring baseflows and act as turbidity and nutrient filters.



6.4 ECOLOGICAL CONSEQUENCES: iNHLABANE ESTUARY

The PES for the iNhlabane Estuary is an E Category, however, as the estuary is severely degraded it should be in a D Category. The individual EHI scores, as well as the corresponding ecological category under different scenarios, are provided below in **Table 6.4**.

Table 6.4 iNhlabane: EHI scores and corresponding Ecological Categories under the different runoff scenarios

Component	PES		Estuary Scenarios			
	Estuary	North & South Lakes	1	2	3	4 (Sc 3 + NON-FLOW Interventions)
Hydrology	33	75	32	33	56	56
Hydrodynamics and mouth condition	59	29	53	60	59	59
Water quality	32	25	34	32	32	32
Physical habitat alteration	30	10	20	30	30	30
Habitat health score	**39**	**35**	**35**	**39**	**44**	**44**
Microalgae	31	56	27	28	46	46
Macrophytes	50	20	45	50	55	60
Invertebrates	10	15	5	10	10	30

Component	PES		Estuary Scenarios			
	Estuary	North & South Lakes	1	2	3	4 (Sc 3 + NON-FLOW Interventions)
Fish	5	15	5	5	5	30
Birds	20	30	15	20	25	45
Biotic health score	**23**	**27**	**19**	**23**	**28**	**42**
ESTUARINE HEALTH SCORE	**31**	**31**	**27**	**31**	**36**	**43**
PRESENT ECOLOGICAL STATUS	**E**	**E**	**E**	**E**	**E**	**D**

Note: The PES are also provided for South and North Lake to contextualise overall ecosystem condition (Low confidence)

Focussing on the iNhlabane Estuary, none of the future scenarios Sc 1 to 3 achieved the REC of a D Category. Scenario 3, the Restoration scenario, could only increase the PES by 5%, while Sc 2, the historical EWR scenario, showed less than 1% change. Under Sc 1, the Climate Change scenario, the estuary declined by an additional 4%. Scenario 4, increased flows (represented by Sc 3) coupled with interventions such as artificial breaching and dredging of the organic layer accumulated in the system, is required to elevate the estuary condition to a D.

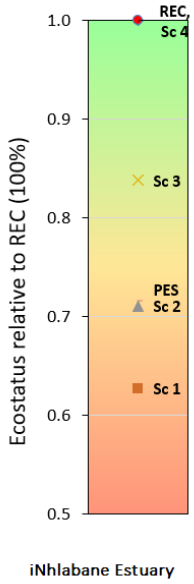
Key interventions required to improve the condition of the iNhlabane Estuary include: Develop an Estuary Management Plan for the iNhlabane Estuarine Lake System to identify key actions and coordinate restoration efforts. Develop an Estuary Mouth Management Plan (including an approved Maintenance Management Plan under National Environmental Management Act (No. 107 of 1998)) to facilitate skimming of the berm at the mouth (>3.0 m MSL) and/or artificial breaching of estuary. Note: Removal of 5 m^3 of sediment at estuary trigger need for EIA approval and development of an Estuary Mouth/Maintenance Management Plan. Removal of accumulated organic sludge with earth-moving equipment/dredging from the bottom strata to improve water quality (i.e. oxygen levels) in the system (may need repeating every 10 to 20 years). The current fishways are not functional. Increase connectivity between the estuary and various parts of the lakes by flow releases from the weir. The historic EWR indicate that the fish way should be supported by a continuous discharges 0.1 m^3/s. To improve marine connectivity the estuary requires 175 000 m^3 to fill up a breach, the historical EWR specify a 33m^3/s discharge for 9 hours every 2 years. Such flow release will result in variable lake levels which will also benefit water birds in the lakes. Prevent disturbance of riparian vegetation, including trampling, cattle, fire, and removal of alien vegetation.

Key interventions required to improve the condition of the larger Estuarine Lake system include: Control/reduce severe fishing efforts (i.e. illegal and legal fishing) in the lakes through increased compliance and ensure connectivity between the estuary and the various parts of the lakes. For example, draw down of the lakes should not be at levels that could separate North and South Lakes.

Proactive strategic planning to reduce the impact of future developments - for example, the disposal of waste is a key issue. Waste cannot run into the estuary or the lakes. Deteriorating water quality represents a significant threat to the ecological functioning of the system, the risk is especially high during the closed state. No municipal or industrial wastewater should be discharged into the system and agricultural best practices should be implemented to reduce nutrient-rich agriculture return flow. There is also a need to address diffuse runoff from housing not on formal reticulation systems. Look

into innovative ways to manage wastewater in this area, e.g., artificial reed beds. Increase freshwater runoff through management/removal of wood lots. This needs a study to verify the benefits and development of a management plan for the associated impacts and/or removal.

Recommended Flow Scenario is Sc 3 (Restoration Scenario) coupled with no -flow interventions such as artificial breaching and dredging of the organic layer accumulated in the system.



6.5 ECOLOGICAL CONSEQUENCES: uMHLATHUZE ESTUARY

The PES and REC for the uMhlathuze Estuary is a D. The individual EHI scores, as well as the corresponding Ecological Category under different scenarios are provided below in **Table 6.5**.

Table 6.5 uMhlathuze: EHI scores and corresponding Ecological Categories under the different runoff scenarios

Component	PES				Scenarios for uMhlatuze Estuary			
	Lake Mzingazi	Richards Bay	uMhlatuze	Lake Chubu	1	2	3	4
Hydrology	53	53	53	53	41	70	53	53
Hydrodynamics and mouth condition	10	18	39	10	40	38	39	39
Water quality	71	45	57	58	59	56	57	57
Physical habitat alteration	10	20	50	10	40	50	50	50
Habitat health score	**36**	**34**	**50**	**33**	**45**	**53**	**50**	**51**
Microalgae	31	41	55	30	50	54	55	55
Macrophytes	30	30	40	30	35	45	40	40
Invertebrates	55	15	20	50	15	25	20	20
Fish	25	25	40	35	35	45	40	40
Birds	70	20	60	70	40	65	50	50

Component	PES				Scenarios for uMhlatuze Estuary			
	Lake Mzingazi	Richards Bay	uMhlatuze	Lake Chubu	1	2	3	4
Biotic health score	42	26	43	43	35	47	41	41
ESTUARINE HEALTH SCORE	39	30	46	38	40	50	45	45
PRESENT ECOLOGICAL STATUS	D/E	E	D	E	D/E	D	D	D

Note: The PES are also provided for Lake Mzingazi, Richards Bay and Lake Cubhu to contextualise overall condition (Low confidence).

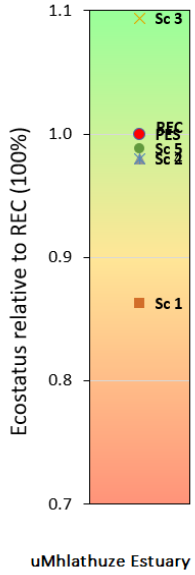
The estuary is currently in a D Category. Under Sc 1, the Climate Change scenario, the condition of the system will degrade by a further 6% to Category D/E. Under Sc 2, the Restoration scenario, the estuary will improve by 4% but remain in a D Category. While under Sc 3 (2030 development scenario) and 4 (2040 development scenario) the system will further decline in condition by 1% but also still remain in Category D. The REC for the uMhlathuze Estuary is Category D. The ecological flow scenario is Sc 2, however Sc 3 or 4 (the 2030 or 2040 development scenarios) with a range of non-flow interventions for the estuary, Richards Bay and the associated lakes implemented to offset flow impacts also achieve the criteria.

Non-flow management interventions are needed to improve the overall resilience of the system to future pressures, including climate change. Ecosystem-based adaptation restoration project is needed to offset and restore the impacts of port development and flow reduction. In the short term, several key interventions can yield immediate results in this important nursery area (e.g., sharks, rays and economically important fish species):

- Reduce very high fishing pressure (poaching and illegal gillnetting) by increasing compliance.
- Increase connectivity between the lakes and downstream waters by reinstalling/installing functional fishways.
- Identify and protect areas in which the endangered seagrass *Zostera capensis* reestablishment is occurring, and reestablish/restore this important habitat near the near yacht terminal.
- Improve access to uMhlathuze Estuary to allow for increased compliance, monitoring and research. Lack of access (need permission through Port) leads to no oversight and results in no awareness of the high level of illegal activities in the system or its general ecological importance.

In the long term, the uMhlathuze Estuary presents opportunities for bird tourism if access was to improve. This could provide livelihoods for local communities instead of illegal activities that benefit a few. Birding tourism is also known for spin-off benefits such as generating the need for accommodation. BirdLife SA could assist with training field guides - Zululand Birding Route. Declining water quality, especially in Lake Mzingazi and Chubu and uMhlathuze River catchment, is a growing concern and also needs urgent interventions in the form of formal reticulation for urban development and implementing agricultural best practices to reduce nutrient enrichment to all parts of the system. In addition, to compliment uMhlathuze Estuary functionality, the Port of Richards Bay should initiate projects that retain and restore estuarine ecosystem services, focussing on the Blue

Carbon Ecosystems (e.g., to offset the Port's Carbon footprint), and bio-enhancement opportunities in support of nursery function (e.g. hammerhead sharks) as part of its port plan.



7 ECOSYSTEM SERVICES CONSEQUENCES

This section examines the results of the analysis of the potential consequences of scenarios on Ecosystems Services following the method as described in **Section 2.2.3**.

As indicated an analysis of multiple sites within the study area was undertaken. This included a profile of Ecological Goods and Services Attributes (EGSA) associated with each site, keeping in mind they represent a wider area, and thereafter assessed against the planning scenarios applicable to the site.

Specifically, an analysis of the sites on the Amatigulu River, Nseleni, Black Mfolozi, White Mfolozi, Mkuze, Pongola, Assegai and Ngwempisi was undertaken. For the Estuaries, the aMatigulu/Nyoni, iSiyaya, uMLalalzi, uMhlathuze and iNhlabane were examined.

A list of the relevant EGSA that were found in the various reaches examined, and deemed to be significant, was generated as a table. These were cross checked with the biophysical experts that formed part of the project team at a specialist (remote) workshop held during 2023.

The biophysical specialists then identified the potential change that each of the key Ecosystems Services (ESS) may undergo in each of the scenario clusters. The potential change was noted as a factor and used in later calculations. For example, no change = 1, a 50% increase = 1.5, and a 20% decrease = 0.8.

The scenario impact on various ESS (including botanical or fish species) were then amalgamated into overall categorisation of provisioning, regulating, cultural, and supporting services. The scenarios are also weighted with respect to the importance of the services at each EWR site. As such the score given to each of the services when the SQ catchments are evaluated is examined against the nature of the particular EWR site and associated area. In an instance where regulating services, for example are deemed to be important, then these services are given a higher weight. The same goes for the other services. All weightings are normalised against a base score of 1. Where all four services are deemed to be of equal importance then a score of 0.25 would be allocated to each. In this instance, given the relatively homogenous nature of the sites and the socio-economic dependant the weightings given remained constant across sites.

The process to determine an integrated ranking of the different scenarios required determining the relative importance of the different EWR sites was undertaken. The perceived vulnerability of households dependent on the provisioning aspect of ESS played a major role. Again, all scores were normalised against a base score of 1.

Given the relatively high abundance of natural resources within the WMA and the moderate and high utilisation of these resources, the provisioning services are given the highest weighting of 0.4. Regulating and cultural services are provided an equal weighting of 0.2 and 0.3 respectively. Supporting services are given the lowest weighting of 0.1.

In the main, and for the River analysis, the scenarios that were examined showed only marginal to moderate envisaged changes from the baseline. For the Amatigulu, Nseleni and Black Mfolozi Rivers only the climate change scenario was analysed. Change from baseline for the river reaches

assessed was largely marginally negligible. For the White Mfolozi Rover four scenarios were assessed. All were deemed to be positive, albeit marginally against baseline. For the Mkuze River three scenario were assessed. Again, all were deemed to be positive, albeit marginally against baseline. For the Pongolo River two scenario were assessed and both returned positive results against baseline. The Sc 2 (Present Day scenario with increased upstream domestic use and upgraded Frischgewaad WTW) was the more markedly positive in its scoring. For the Assegai River four scenarios were assessed and returned similar positive results. For the Ngwempisi River three scenarios were assessed and all returned marginally negative results.

The Estuary results were more marked. Some of the estuaries, notably the iNhlabane, are in a very poor state and scenarios that examined a programme of restoration interventions showed a dramatic potential for recovery of Ecological Goods and Services. The restoration scenarios for the uMlalazi and Amatigulu/Nyoni Estuaries also showed positive returns as assessed. Climate change scenarios, and those that were linked to developmental inputs that require reduced flows to the estuaries, had notable significant negative impacts on Ecological Goods and Services.

8 INTEGRATED MULTI-CRITERIA ANALYSIS RESULTS

The MCA model was compiled for each of the IUAs in the study area. The methodology is described in **Section 2.2**, and the results for each IUA are available in the 'Water Resource Class Decision Support System'[3]

For the study area, the MCA is relevant to eight IUAs for which more than one scenario (excluding the PES and REC) has been evaluated. In this study, the evaluation of scenarios is not particularly complex, since for the most part, the economic indicators are scored 1.0 (i.e., as for the baseline condition). Consequently, the integrated ranking does not deviate substantially from the ranking derived for ecological protection alone.

This is best illustrated using IUA W13 as an example, since it has the greatest number of scenarios of the IUAs considered. The graphical output of the MCA analyses are traffic signal plots as shown in **Figure 8.1**. Lines connect individual scenario scores, and opposing consequences result in crossed lines between components. Note that the normalised scores are ~1.0 for the 'GDP' and 'Employment' components for all scenarios, and thus there are few opposing consequences.

Figure 8.1b illustrates the integrated scenario ranking using the ranking order method. Notice that some resolution is lost in terms of the relative scoring between scenarios (i.e., they are more equally spaced). Also, the "Climate Change" (CC) and "Sc1"[4] Scenarios are ranked equally, whereas the latter is ranked slightly higher using the normalised score method. The "-15%MAR" Scenario is ranked slightly higher than the "WWTW" Scenario in **Figure 8.1a**, whereas they are equally ranked in **Figure 8.1b**. Overall, the best three scenarios are (both ranking methods and in reducing order): Sc 6[5], Sc 5[6] and "+15%MAR".

[3] Excel Visual Basic Applications file (saved in binary format: *.xlsb).
[4] Present day including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million m^3 (Mlalazi).
[5] Mlalazi Estuary= REC; Siyaya Estuary= REC.
[6] Mlalazi Estuary= REC; Siyaya Estuary= PES.

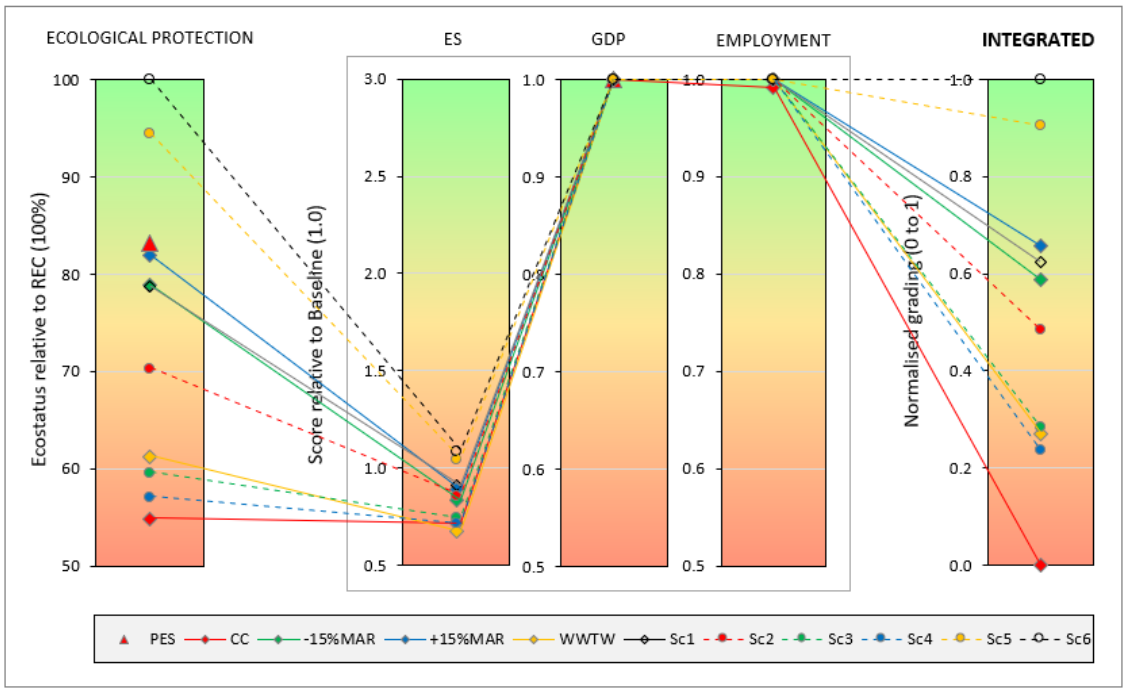


Figure 8.1a Graphical results of individual components and integrated ranking using the normalised score method for IUA W13

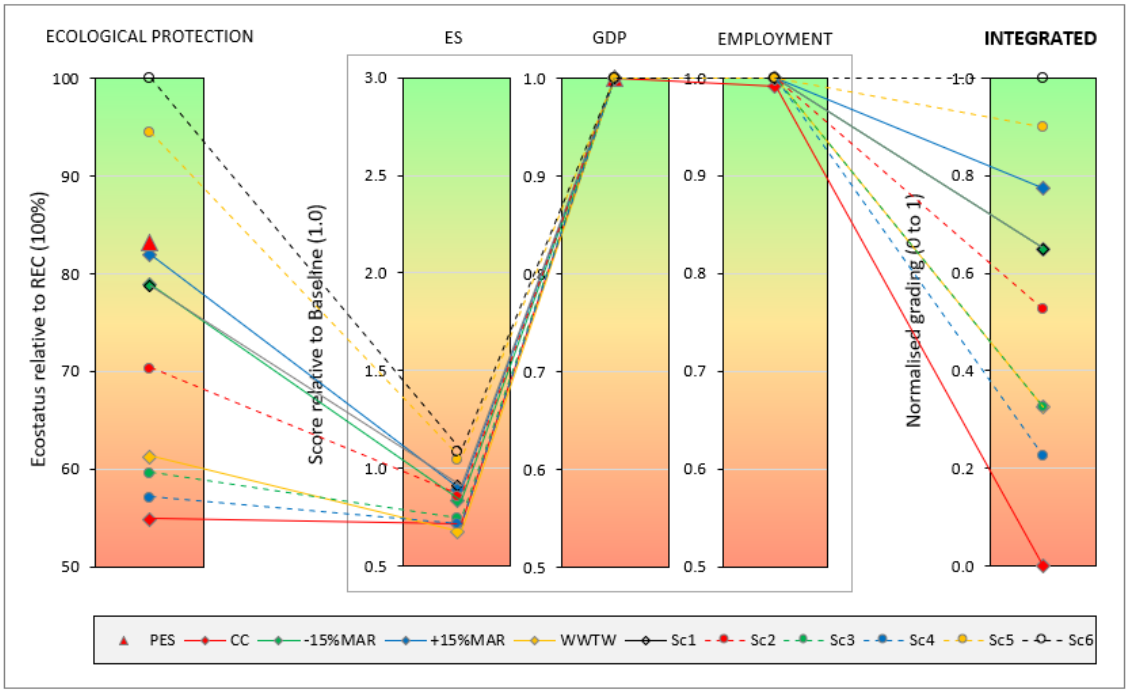


Figure 8.2b Graphical results of individual components and integrated ranking using the ranking order method for IUA W13

Due to the lack of a range of scenarios at most of the IUAs as well as the fact that there are no IUAs with more than one EWR site, the rest of the graphical results are not presented as they do not provide significant additional information. However, the ranking is considered when determining the Class and TEC which represents that Catchment Configuration. This information is provided in the next chapter.

9 WATER RESOURCE CLASS AND CATCHMENT CONFIGURATION

The Class and catchment configuration results are the recommendations that were presented at the Project Steering Committee meeting held on 4 April 2023 for consultation with the stakeholders. After this report has been reviewed and comments addressed, the final scenario and results will be prepared for gazetting.

9.1 WATER RESOURCE CLASS CRITERIA TABLE

The following criteria parameters presented in **Table 9.1** (see **Section 2.3**) was applied to determine the Classes.

Table 9.1 Recommended Water Resource Class criteria table

		% EC representation at units represented by biophysical nodes in an IUA				
		≥ A/B	≥ B	≥ C	≥ D	< D
Class 1		0	60	80	95	5
Class 2			0	70	90	10
Class 3	**Either**			0	80	20
	Or				100	

The above table was applied to both rivers and estuaries and the resulting Classes and catchment configuration are provided in the next sections.

9.2 RECOMMENDED CLASSES PER IUA

The Water Resource Classes IUAs as determined by applying the criteria presented in **Table 9.1** are provided in **Table 9.2** for the various scenarios. **Note, that the grey shaded cells indicate that the scenario is not relevant for the IUA. Red font in the TEC column indicates where the TEC is a different Class than the REC.** Details and reasoning for the Catchment Configurations making up the Class are provided in **Section 9.3**.

Table 9.2 Resulting IUA Water Resource Classes for each scenario

IUA		PES	REC	CC	-15%MAR	-20%MAR	-30%MAR	+15%MAR	2030	2040	EWR	No EWR	Rest	Rest/Int	WWTW	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	HFYnoEWR	HFYEWR	KLPEWR	IRR	New Restoration	TEC
W11	Matigulu	II	I	II		III	III	I																		I	I
W12-a	Upper Mhlathuze	I	I	I																							I
W12-b	Mfule, Mhlatuzane, Nseleni Tributary systems	II	II	II																							II
W12-c	Lower Mhlathuze	III	III	X*				III	III	III																	III
W12-d	Lake Nhlabane	X	III	X							X		X	III													III
W12-e	Lake Msingazi	X	III	III																							III
W13	Mlalazi	II	I	III	II			II							III	II	II	III	III	I	I					II	I
W21	Upper and Middle White Umfolozi	II	II	II																		II	II	II			II
W22	Upper Black Umfolozi	II	II	II																							II
W23	Umfolozi-Hluhluwe Game Reserve	I	I	I																							I
W31-a	Upper Mkuze	II	I	II																							I
W31-b	Lower Mkuze	II	I	II						II															II		II
W32-a	Upper Hluhluwe	I	I	I																							I
W32-b	Nyalazi and Mzinene Tributaries	II	II	II																							II
W41	Bivane River	II	I	II																							I
W42-a	Upper Pongola	II	II	II						II																	II
W42-b	Middle Pongola (Ithala)	I	I	I																							I
W44	Middle Pongola (Grootdraai)	III	III	III																							III
W45	Lower Pongola (Floodplain)	III	II	III																							III
W51-a	W5 Upstream major dams (Assegaai)	III	II	III																							II

IUA		PES	REC	CC	-15%MAR	-20%MAR	-30%MAR	+15%MAR	2030	2040	EWR	No EWR	Rest	Rest/Int	WWTW	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	HFYnoEWR	HFYEWR	KLPEWR	IRR	New Restoration	TEC
W51-b	W5 Upstream major dams (Ngwempisi, Usuthu)	III	III	III																							III
W52	W5 Downstream major dams & Hlelo River	II	II	II						II	II	II															II
W55	Mpuluzi & Lusushwana River systems	I	I	I																							I
W57	Lower Usutu River	I	I	I																							I
W70-a	Kosi Bay	I	I	I																							I
W70-Muzi Swamps	Muzi Swamps	II	II	II																							II
W70-b	Sibaya	I	I	I																							I
St. Lucia	St Lucia	III	I	III																							III→II→I

* An X indicates that the criteria do not comply to any Class, i.e. the majority of RUs in the IUA will be in a Category below a D EC.

9.3 WATER RESOURCE CLASSES AND CATCHMENT CONFIGURATION

Given the results and scenario presented in the section above (**Table 9.2)**, the following recommended Water Resource Class and Catchment Configuration are recommended (**Table 9.3**). These recommendations are based on specialist, DWS input and stakeholder discussions. The Catchment Configuration is expressed in terms of the Target Ecological Categories (TECs). The TEC may represent the PES, REC or any other category if socio-economic requirements require such a deviation. It must be noted that an attempt will always be made as a first target to achieve the REC. In the tables following, rationale and actions are provided for the TEC if it is different than the PES.

For every Secondary Catchment the first table provides the recommended Class in the last column (colour shaded) for all IUAs. The next table provides the Catchment Configuration associated with the recommended Class.

The results are also summarised in **Figures 9.1 – 9.6**.

9.3.1 W1 Recommended Classes and Catchment Configuration

Table 9.3 W1 Recommended Classes

IUA		PES	REC	CC	-15%MAR	-20%MAR	-30%MAR	+15%MAR	2030	2040	EWR	No EWR	Rest	Rest/Int	WWTW	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	New Sc	Recommended Class based on TEC
W11	Matigulu	II	I	II		III	III	I														I	I
W12-a	Upper Mhlathuze	I	I	I																			I
W12-b	Mfule, Mhlatuzane, Nseleni Tributary systems	II	II	II																			II
W12-c	Lower Mhlathuze	III	III	X				III	III	III													III
W12-d	Lake Nhlabane	X	III	X							X		X	III									III
W12-e	Lake Msingazi	X	III	III																			III
W13	Mlalazi	II	I	III	II			II							III	II	II	III	III	I	I	I	I

Table 9.4 W1 Catchment Configuration

IUA & RECOMMENDED CLASS: W11 (MATIGULU) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W11-1	Matigulu	B	B	**B**	N/a	None
W11-2	Matigulu	B/C (81.3%)	B/C (81.3%)	**B/C**	N/a	None
W11-3	Nyoni	C/D	C/D	**C/D**	N/a	None
W1-aMatigulu/ iNyoni Estuary	Matigulu	B/C (74%)	B (82.1%)	**B (78%)**	This RU carries 70% of the weight in determining the Class. To achieve the REC, a range of non-flow related interventions must be implemented. It is not possible to increase the flows significantly as there are no major water resource developments in the catchment. No additional base flows can be removed from the catchment as the TEC will not be achieved.	The following non-flow interventions will result in halting downwards trajectory and achieving TEC: 1) Undertake restoration of estuarine floodplain (EFZ) and reduce agriculture impacts in the supratidal area of the system. 2) Control/manage harvesting of *Juncus* and *Phragmites* to prevent over exploitation (management plan in place). 3) Curb/control illegal fishing activities (e.g. gill netting,) to improve nursery function and prawn abundance (bycatch). 4) Control recreational activities in the lower reaches through zonation and improved compliance (e.g. development of Estuary Management Plan and zonation map). 5) Improve protection levels through Contracted Conservation on the North Bank - part of Department of Forestry and Fisheries and Environment (DFFE) 30 x 30 Estuary Protection Priorities which include expanding uThukela Marine Protected Area (MPA). 6) Promote tourism (e.g., bird guides) to reduce impacts and provide benefits to community. 7) Create interventions within catchment (e.g. agricultural best practise, development of farm plans) and institute a buffer of natural vegetation along river to improve the nutrient status and help with sedimentation issues. 8) Remove invasive aliens to improve baseflows.
IUA & RECOMMENDED CLASS: W12-a (UPPER MHLATHUZE) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W12-1	Mhlatuze	B	B	**B**	N/a	None
W12-2	Mhlatuze	B	B	**B**	N/a	None
W12-3	Mhlatuze	C	B	**C**	Interventions required would be difficult as flow as well as non-flow related, and water quality impacts must be addressed. There are no means of operating flow and the non-flow related impacts are widespread and diffuse.	None
W12-4	KwaMazula	C	B	**B**	To achieve the B, flow will require improvement by removing forestry species that have encroached or recruited in the riparian vegetation zone. This will improve from a C to a B/C and if non-flow impacts are addressed, it is possible to improve the PES to B.	Remove forestry species that have encroached or recruited the riparian zone and the required corridor adjacent to the river. Manage the riparian zone by removing alien vegetation, preventing access and ensure bank stabilisation.

IUA & RECOMMENDED CLASS: W12-b (MFULE, MHLATUZANE, NSELENI TRIBUTARY SYSTEMS) - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W12-5	Mfule	C	B	**B**	Mitigation will have to focus on non-flow related aspects.	Address all non-flow related impacts that impacts on the river. This includes amongst others impacts from Melmoth in terms of water quality, grazing pressure, removal of alien vegetation and impacts associated with vehicle tracks.
W12-7	Mhtatuzana	B	B	**B**	N/a	None
W12-8	Nseleni	C (68.4%)	C (68.4%)	**C**	N/a	None
IUA & RECOMMENDED CLASS: W12-c (LOWER MHLATHUZE) - CLASS III						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W12-6	Mhlathuze	C	C	**C**	N/a	None
W12-uMhlathuze Estuary	Mhlathuze	D	D	**D**	This system is in a provincial park and on a downwards trajectory.	The following non-flow interventions will result in halting downwards trajectory and maintaining TEC: Short term (1 – 5 years) key interventions needed to restore/protect this important nursery area (e.g., sharks, rays and economically important fish species): 1) Reduce very high fishing pressure (poaching and illegal gillnetting) by increasing compliance. 2) Increase connectivity between lakes and downstream waters by reinstalling/installing functional fishways. 3) Identify and protect areas in which the seagrass *Zostera capensis* reestablishment is occurring and reestablish/restore this important habitat near the near yacht terminal. 4) Improve access to uMhlatuze Estuary to allow for increased compliance, monitoring and research. Lack of access (need permission through Port) leads to no oversight and results in no awareness of the high level of illegal activities or its general ecological importance. Long term (5-10 years): 5) Develop bird tourism (will also improve access) that could provide livelihoods for local communities (e.g. Zululand Birding Route.). 6) Halt/restore declining water quality by instituting formal reticulation for urban development and implementing agricultural best practices to reduce nutrient enrichment to estuary, lakes and port. 7) To compliment uMhlatuze Estuary functionality, the Port of Richards Bay should retain and restore estuarine ecosystem services, focussing on importance of the Blue Carbon Ecosystems (e.g., to offset the Port's Carbon footprint); and b) bio-enhancement of key habitats in support of nursery function (e.g. hammerhead sharks) as part of its port plan.
IUA & RECOMMENDED CLASS: W12-d (LAKE NHLABANE) - CLASS III						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W12-9	Nhlabane	C	C	**C**	N/a	None

RU	River/Estuary	PES	REC	TEC	Rationale	Actions
W12-iNhlabane Estuary	Nhlabane	E (30.9%)	D (43.2%)	**D (43.2%)**	To achieve a Class III the REC of a D needs to be achieved for the estuary. However, to achieve the REC, a range of flow and non-flow related interventions must be implemented to ensure estuary connectivity is re-established. No additional base flows can be removed from the catchment as the TEC will not be achieved.	1) Develop an Estuary Management Plan (requirement of the Integrated Coastal Management Act) for the iNhlabane Estuarine Lake System to identify key actions and coordinate restoration efforts. 2) Develop an Estuary Mouth/Maintenance Management Plan to facilitate skimming of the berm at the mouth (>3.0 m MSL) and/or artificial breaching of estuary. Note: Removal of 5 m^3 of sediment at estuary trigger need for EIA approval. 3) Remove accumulated organic sludge with earth-moving equipment/dredging from the bottom strata to improve water quality (i.e., oxygen levels) in the system. Once-off intervention if water quality and marine connectivity improves, else may need repeating every 10 – 20 years. 4) Prevent disturbance of riparian vegetation, including trampling, cattle, fire, and removal of alien vegetation. 5) Ensure connectivity between the estuary and the various parts of the lakes. The current fishways are not functional. Increase connectivity between the estuary and various parts of the lakes by flow releases from the weir and possible reengineering of the fishway. Historical EWR: Fish way continuous discharges 0.1 m^3/s. To improve marine connectivity the estuary requires 175 000 m^3 to fill up a breach, historical EWR specify 33m^3/s for 9 hours every 2 years. Such flow release will also result in variable lake levels which will also benefit water birds in the lakes. Draw down of the lakes should not be at levels that could separate North and South Lakes. 6) Deteriorating water quality represents a significant threat, the risk is especially high during the closed state. Address diffuse runoff from housing not on formal reticulation systems. Look into innovative ways to manage wastewater in this area, e.g., artificial reed beds. No wastewater discharges (sewage or industrial) should be discharged into the lakes or estuary. Institute agricultural best practices (through development of farm plans) should be implemented to reduce nutrient-rich agriculture return flow. Proactive regional strategic planning is needed in the area to reduce the impact of future developments - for example, the disposal of waste is a key issue -waste cannot run into closed estuaries and lakes. 7) Increase freshwater runoff to estuary and lakes through management/removal of illegal wood lots/plantations and removal of invasive alien vegetation species.
IUA & RECOMMENDED CLASS: W12-e (LAKE MSINGAZI) - CLASS III						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W12-10	Msingazi	C	C	**C**	N/a	None
W12-Lake Msingazi	Msingazi	D/E	D	**D**	Notwithstanding that the Lake was historically saline and connected to the estuary and is now segregated and is a freshwater system, it is possible to make improvements by addressing connectivity, over utilisation, water quality and importance to biodiversity which would improve the lake to a D REC.	The following actions would result in improvement: 1) Re-establish connectivity by way of a fish ladder to enable fish movement between upstream freshwater habitats and downstream estuarine habitats. 2) Regulate and reduce gill netting pressure and possibly regulate catch sizes. 3) Reduce water bird deaths from gill nets and promote birding as ecotourism. 4) Eutrophication of the lake from surrounding runoff needs to be monitored and rectified where necessary.

IUA & RECOMMENDED CLASS: W13 (MLALAZI) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W13-1	Mlalazi	C	B	**B**	Difficult but can be achieved through non-flow mitigation and improvement of WWTW.	Improve the WWTW. Address grazing, trampling, sand mining and alien vegetation amongst others.
W13-2	Manzamnyama	B/C	B	**B/C**	Decision to maintain PES as achieving the REC will require removal of commercial forestry.	None
W13-Mlalazi Estuary	Mlalazi	B/C (74.1%)	B (78%)	**B (78%)**	This system is in a provincial park and forms part of the uThukela MPA and on a downwards trajectory.	The following non-flow interventions will result in halting downwards trajectory and achieving TEC: 1) Deteriorating water quality represents a significant threat to the ecological functioning of the system, the risk is especially high during the closed state. No wastewater should be discharged into the system and agricultural best practices should be implemented to reduce nutrient-rich agriculture return flow. Address diffuse runoff from housing not on reticulation. 2) Where possible, i.e. not build up - create interventions (e.g. replanting of natural vegetation, artificial wetlands, manage grazing) within a 500 m buffer zone around the EFZ to improve the nutrient status and reduce sediment inputs. 3) Curb illegal fishing (e.g. gill netting) impacting nursery function and prawns (part of the bycatch). 4) Undertake restoration of the uMlalazi EFZ and reduce agriculture impacts in the supratidal area of the system. Rewild banks and restore gentle slopes where possible along the banks of estuary (investigate option to remove hard structures of aquaculture facilities). 5) Manage/control harvesting of *Juncus* and *Phragmites* (refinement of exiting plan). 6) Curb recreational activities in the lower reaches through zonation and improved compliance (i.e., development of an Estuary Management Plan). 7) Realign the protected area delineation with the EFZ to increase protection levels, including options for Stewardship/Contracted Conservation being undertaken on the North Bank. DFFE 30 x 30 Priority Estuary for as part of uThukela MPA expansion. 8) Manage disturbance to birds (e.g., closed areas, boating controls such as speed zones), including control of vehicle access at the mouth and promoting tourism (bird guides etc.) to reduce impacts and ensure flow of benefits to community. 9) Remove/control sandmining in the upper reaches of the system. 10) Maintain hydrological connectivity by ensuring that roads and bridges do not impact tidal and river flows. 11) Manage and control fires of riparian vegetation to protect mangroves. 12) Remove invasive aliens in the catchment to safeguard base flows to prevent mouth closure for periods longer than six to eight weeks and prevent the water levels from going beyond 4 m mean sea level.

RU	River/Estuary	PES	REC	TEC	Rationale	Actions
W13-Siyaya Estuary	Siyaya	D/E (43%)	C (63%)	**D (50%)**	This system is in a provincial park and forms part of the uThukela MPA and on a downwards trajectory. Regardless of TEC non-flow interventions needs to be instituted.	Ecosystem-based adaptation restoration project embedded in an Estuary Management Plan is needed to restore the iSiyaya Estuary's functionality and address downwards trajectory: In the short term several mechanical interventions are needed to restore estuarine functionality: 1) Remove accumulated organic sludge through dredging of bottom substrate to improve water quality, i.e., increase oxygen in water column. Once-off intervention but may need to be repeated every 1- - 20 years if marine connectivity and water quality do not improve. 2) Mechanical removal of reeds in lower reaches to increase open water area (once-off). 3) Revegetate the dune at the mouth. 4) When the mouth has been closed for long periods, it may require mechanical removal of sediment that buildup at the mouth to allow for overwash recruitment. This may also require deepening the estuarine channel and /or bringing the openwater area forward by removing marine sand at the mouth. Given that the removal of 5 m^3 of sediment at an estuary trigger the EIA process (National Environmental Management Act (No. 107 of 1998), removal of organic sludge and skimming/reshaping of the berm will require the development of an Estuary Mouth/Maintenance Plan to guide the management authority on when such an action is needed. The plan also needs to consider the submarine cable to the north of the system. In the long-term, a "catchment-to-coast" approach needs to be taken given this small river basin including: 5) Mitigate the impacts of mining by ensuring a 1 km buffer zone of riparian vegetation around the estuary to reduce the turbidity signal and sediment input from mining. Note: Forestry in and around the EFZ has removed the natural buffer capacity riparian vegetation provides. 6) Reduce the direct impact of forestry on the estuary by instituting buffer zones around the estuary (e.g., 1 km zone), while over longer time scales baseflows should be restored by an overall reduction in forested areas in the catchment. 7) Pioneer different footpaths to the beach further north to reduce the disturbance of birds. 8) Increase fishing compliance as fishing pressure will escalate if fish communities recover under restoration actions. 9) Restore the upstream riparian zone and remove alien vegetation to assist with restoring baseflows and act as turbidity and nutrient filters. 10) Develop a groundwater-surface water model to protection of groundwater resources and estuary protection and guide management of the plantations and woodlots. Note that a reduction of community woodlots may require establishment of alternative livelihoods.

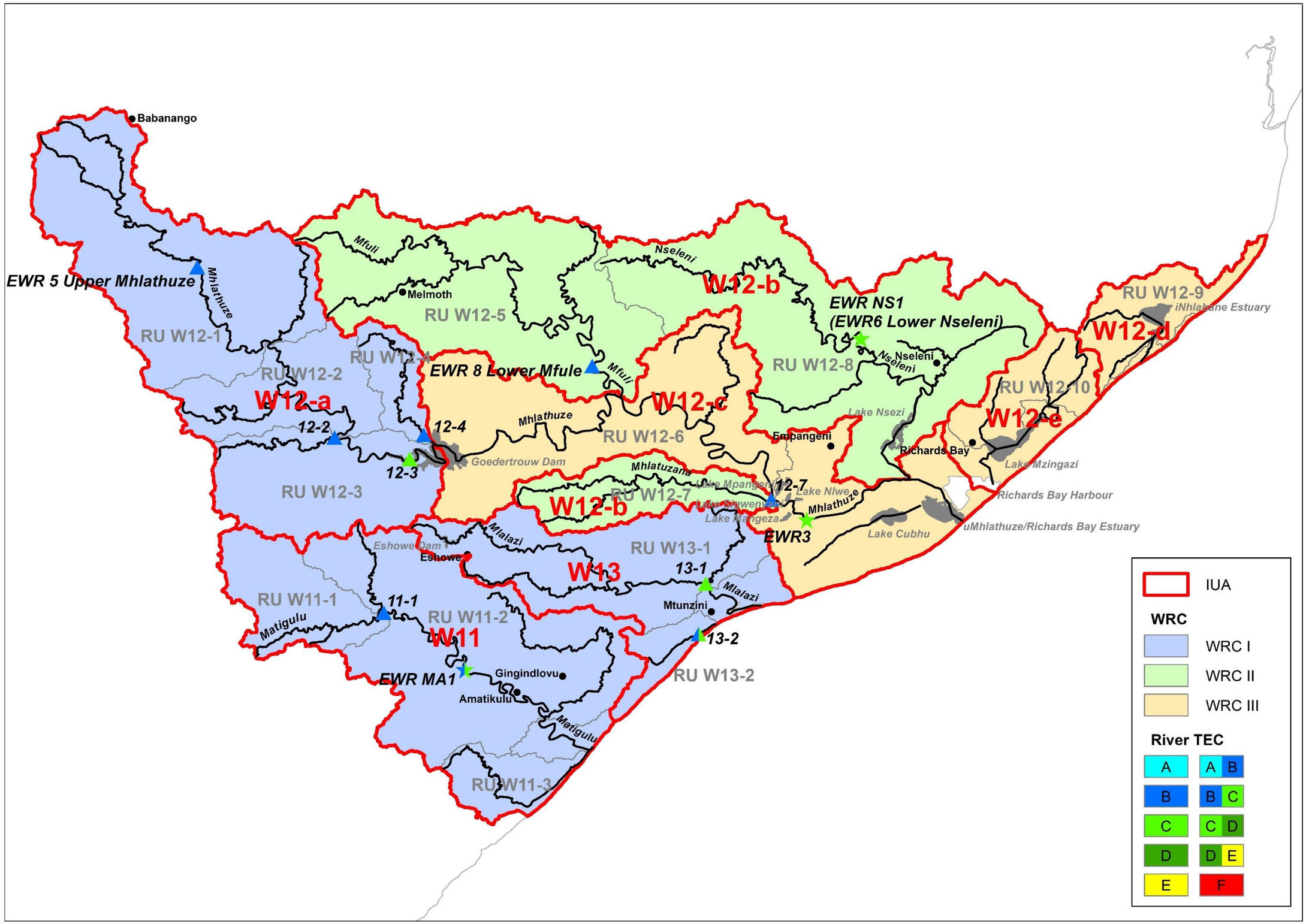


Figure 9.1 W1 Classes and Catchment Configuration

9.3.2 W2 Recommended Classes and Catchment Configuration

Table 9.5 W2 Recommended Classes

IUA		PES	REC	CC	HFYnoEWR	HFYEWR	KLPEWR	Recommended Class based on TEC
W21	Upper and Middle White Umfolozi	II	II	II	II	II	II	II
W22	Upper Black Umfolozi	II	II	II				II
W23	Umfolozi-Hluhluwe Game Reserve	I	I	I				I

Table 9.6 W2 Catchment Configuration

IUA & RECOMMENDED CLASS: W21 (UPPER AND MIDDLE WHITE MFOLOZI) - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W21-1	White Mfolozi	C	B	**B**	REC achieved by combination of flow and non-flow mitigation.	Address impacts that can be managed such as: Water quality impacts such as spills from mine to be addressed. Remove agriculture within delineated wetlands, as per the NWM5, 2018. Improve flows by managing instream dams.
W21-2	White Mfolozi	B	B	**B**	N/a	None
W21-3	White Mfolozi	C	B	**C**	Impacts linked to forestry, grazing and erosion. Restoration where possible will be insufficient to achieve the REC.	None
W21-4	Mvunyane	D	D	**D**	N/a	None
W21-5	White Mfolozi	B/C (79.2%)	B/C (79.2%)	**B/C**	N/a	None
W21-6	White Mfolozi	B/C	B/C	**B/C**	N/a	None
W21-7	White Mfolozi	B/C	B/C	**B/C**	N/a	None

IUA & RECOMMENDED CLASS: W22 (UPPER BLACK MFOLOZI) - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W22-1	Black Mfolozi	C (76.9%)	C (76.9%)	**C**	N/a	None
W22-2	Black Mfolozi	B/C	B/C	**B/C**	N/a	None
W22-3	Sikwebezi	C	C	**C**	N/a	None
W22-4	Black Mfolozi	C	C	**C**	N/a	None
IUA & RECOMMENDED CLASS: W23 (UMFOLOZI-HLUHLUWE GAME RESERVE) – CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W21-8	White Mfolozi	B	B	**B**	N/a	None
W22-5	Black Mfolozi	B	B	**B**	N/a	None
W23-1	Mfolozi	B	B	**B**	N/a	None
W23-2	Ntobozi	B	B	**B**	N/a	None

Figure 9.2 W2 Classes and Catchment Configuration

9.3.3 W3 Recommended Classes and Catchment Configuration

Table 9.7 W3 Recommended Classes

IUA		PES	REC	CC	2040	IRR	Recommended Class based on TEC
W31-a	Upper Mkuze	II	I	II			I
W31-b	Lower Mkuze	II	I	II	II	II	II
W32-a	Upper Hluhluwe	I	I	I			I
W32-b	Nyalazi and Mzinene Tributaries	II	II	II			II

Table 9.8 W3 Catchment Configuration

IUA & RECOMMENDED CLASS: W31-a (UPPER MKUZE) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W31-1	Mkuze	C	B	**B**	REC achieved by combination of flow and non-flow mitigation.	Flow abstractions must be managed to achieve a B/C. Non-flow measures must be focused on the riparian zone.
W31-2	Mkuze	B	B	**B**	N/a	None
W31-3	Mkuze	B/C	B/C	**B/C**	N/a	None
IUA & RECOMMENDED CLASS: W31-b (LOWER MKUZE) - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W31-5	Mkuze	C (74.8%)	B	**B/C**	Improvements must be achieved by non-flow measures.	The detailed actions will be identified during the RQO phase of this study. A B EC could not be achieved, and the TEC was set as a B/C.
W31-4	Mkuze	C	C	**C**	N/a	None
W31-6	Msunduzi	B	B	**B**	N/a	None
W32-1	Mkuze	B/C	B/C	**B/C**	N/a	None

IUA & RECOMMENDED CLASS: W32-a (UPPER HLUHLUWE) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W32-2	Hluhluwe	B	B	**B**	N/a	None
IUA & RECOMMENDED CLASS: W32-b (NYALAZI & MZINENE TRIBUTARIES) - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W32-3	Nyalazi	B	B	**B**	N/a	None
W32-4	Nyalazi	C	C	**C**	N/a	None
W32-5	Mzinene	C	C	**C**	N/a	None
W32-6	Munywana	B	B	**B**	N/a	None

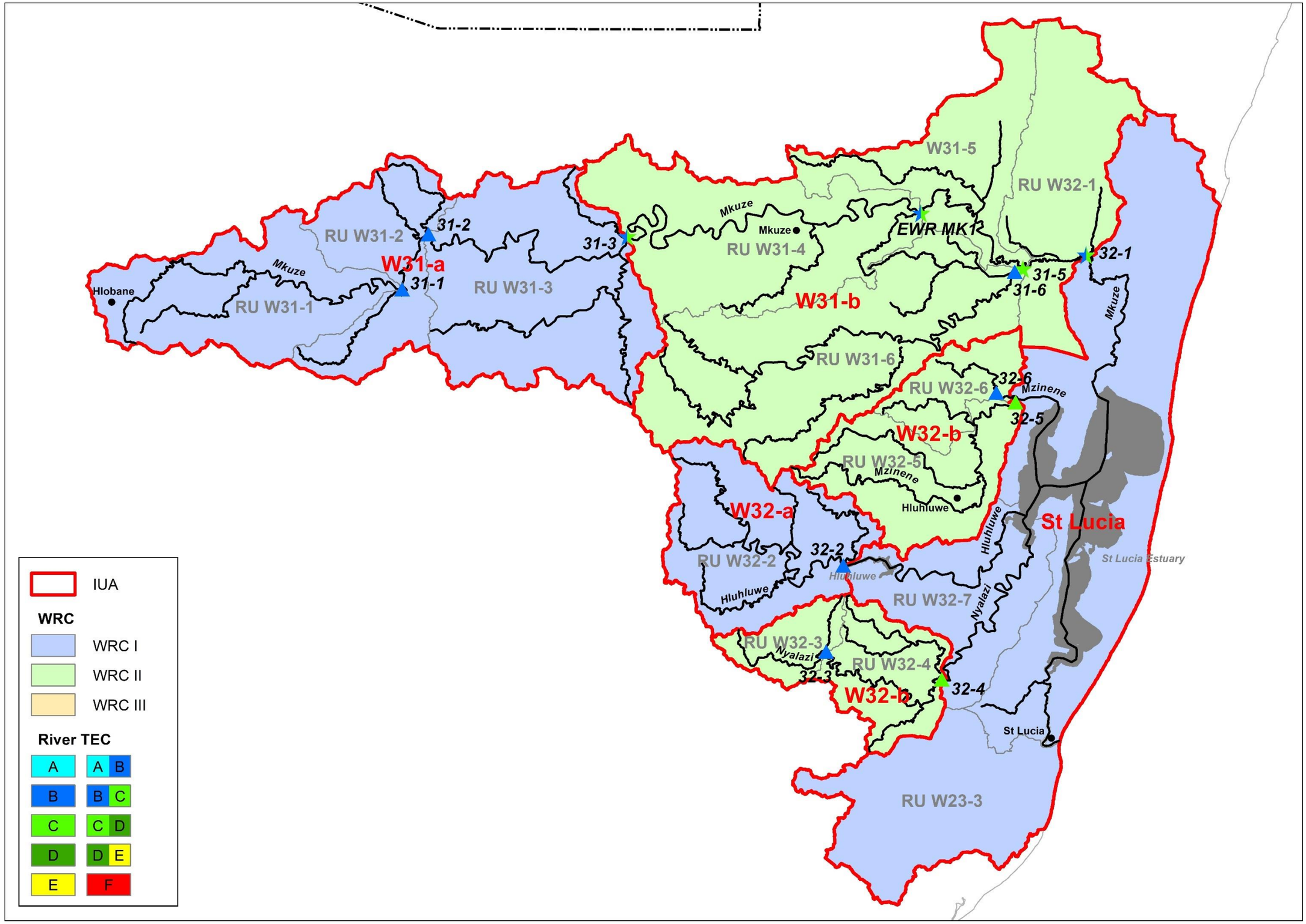


Figure 9.3 W3 Classes and Catchment Configuration

9.3.4 W4 Recommended Classes and Catchment Configuration

Table 9.9 W4 Recommended Classes

IUA		PES	REC	CC	2040	Recommended Class based on TEC
W41	Bivane River	II	I	II		I
W42-a	Upper Pongola	II	II	II	II	II
W42-b	Middle Pongola (Ithala)	I	I	I		I
W44	Middle Pongola (Grootdraai)	III	III	III		III
W45	Lower Pongola (Floodplain)	III	II	III		III

Table 9.10 W4 Catchment Configuration

IUA & RECOMMENDED CLASS: W41 (BIVANE RIVER) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W41-1	Bivane	C	B	**B/C**	Improvement will require both improvement in flow and non-flow related aspects. It is not possible to improve flows, therefore a half a category improvement can be achieved by non-flow required means.	Amongst others impacts in the riparian zone must be addressed. Some of the mitigation measures are removing aliens and forestry species that have encroached or recruited within the riparian zone, and to control and manage access to the riparian zone.
W41-2	Manzana	B	B	B (REC)	N/a	None
IUA & RECOMMENDED CLASS: W42-a (UPPER PONGOLA) - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W42-1	Phongolo	C	B	**C**	The downstream EWR site requires no improvement and therefore the TEC is set to maintain the PES at a C which is the same as at the EWR site.	None
W42-2	Phongolo	C (73.5%)	C (73.5%)	**C**	N/a	None

IUA & RECOMMENDED CLASS: W42-b (MIDDLE PONGOLA (ITALA)) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W41-3		C	C	C	N/a	None
W42-3	Phongolo	B	B	**B**	N/a	None
W42-4	Mozana	B	B	**B**	N/a	None
W42-5	Phongolo	B	B	**B**	N/a	None
IUA & RECOMMENDED CLASS: W44 (MIDDLE PONGOLA (GROOTDRAAI)) - CLASS III						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W44-1	Phongolo	D	D	**D**	N/a	None
IUA & RECOMMENDED CLASS: W45 (LOWER PONGOLA (FLOODPLAIN)) - CLASS III						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W43-1	Ngwavuma	C	C	**C**	N/a	None
W45-1	Phongola	C	C	**C**	N/a	None
W45-Pongola Floodplain	Phongola	D	C	**D**	The high EIS warrants improvement. However, improvement will be based on EWR releases from Pongolapoort Dam amongst other. There will however be a serious impact on the dependency of rural communities living on the floodplain and utilising the floodplain for subsistence agriculture.	None

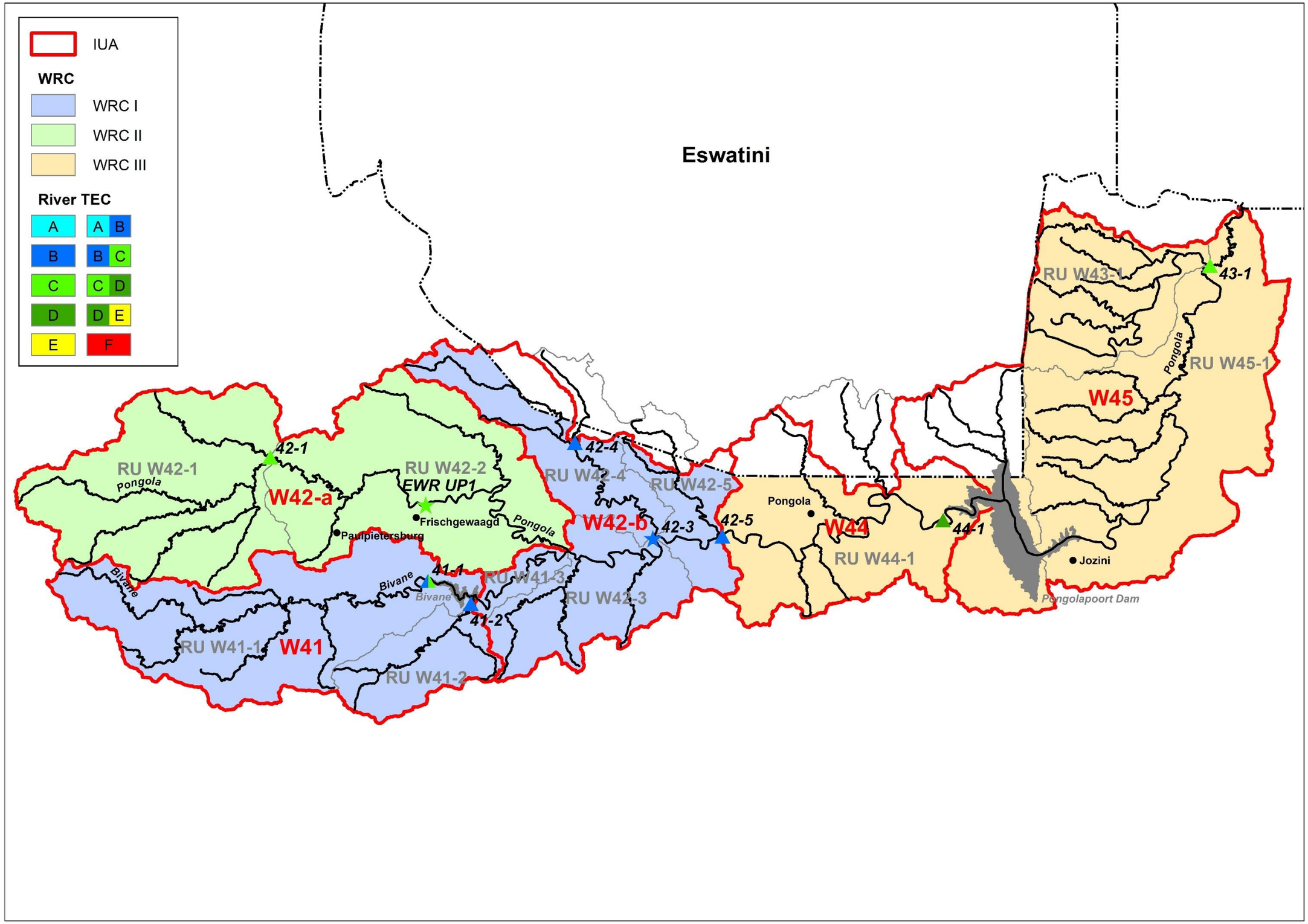


Figure 9.4 W4 Classes and Catchment Configuration

9.3.5 W5 Recommended Classes and Catchment Configuration

Table 9.11 W5 Recommended Classes

IUA		PES	REC	CC	2040	EWR	No EWR	Recommended Class based on TEC
W51-a	W5 Upstream major dams (Assegaai)	III	II	III				II
W51-b	W5 Upstream major dams (Ngwempisi, Usuthu)	III	III	III				III
W52	W5 Downstream major dams & Hlelo River	II	II	II	II	II	II	II
W55	Mpuluzi & Lusushwana River systems	I	I	I				I
W57	Lower Usutu River	I	I	I				I

Table 9.12 W5 Recommended Catchment Configuration

IUA & RECOMMENDED CLASS: W51-a (W5 UPSTREAM MAJOR DAMS (ASSEGAAI)) - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W51-1	Assegaai	C/D	B/C	**B/C**	REC achieved by combination of flow and non-flow mitigation.	Actions may include the following but are not limited to these mentioned: Improve flows to achieve a C by managing abstractions and controlling the numerous instream dams. Other actions required are addressing alien vegetation and dealing with mine spills.
IUA & RECOMMENDED CLASS: W51-b (W5 UPSTREAM MAJOR DAMS (NGWEMPISI, USUTU)) - CLASS III						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W53-1	Ngwempisi	D	D	**D**	N/a	None
W53-2		B/C	B/C	**B/C**	N/a	None
W54-1	uSuthu	B	B	**B**	N/a	None

IUA & RECOMMENDED CLASS: W52 (DOWNSTREAM MAJOR DAM S& HLELO RIVER) - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W51-2	Assegaai	C	C	**C**	N/a	None
W51-3	Mhkondvo	C (74.2%)	C (74.2%)	**C**	N/a	None
W51-4	Blesbokspruit	C	C	**C**	N/a	None
W52-1	Hlelo	B/C	B/C	**B/C**	N/a	None
W53-3	Ngwempisi	B/C (79.8%)	B/C (79.8%)	**B/C**	N/a	None
W54-2	uSuthu	C	C	**C**	N/a	None
IUA & RECOMMENDED CLASS: W55 (MPULUZI & LUSUSHANE RIVER SYSTEMS) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W55-1	Mpuluzi	B/C	B/C	**B/C**	N/a	None
W55-2	Lusushwana	C	C	**C**	N/a	None
W55-pans incl. Chrissiesmeer	W55 pans	B	B	**B**	N/a	None
IUA & RECOMMENDED CLASS: W57 (LOWER USUTU RIVER) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W57-1	uSuthu	B/C	B	**B/C**	The river is downstream of Eswatini. Flow is the most important impact to address to achieve the REC. As we have no control over the management of the river within Eswatini, the TEC is set to maintain the PES.	None
W57-Ndumo Pans	Ndumo Pans	A	A	**A**	N/a	None

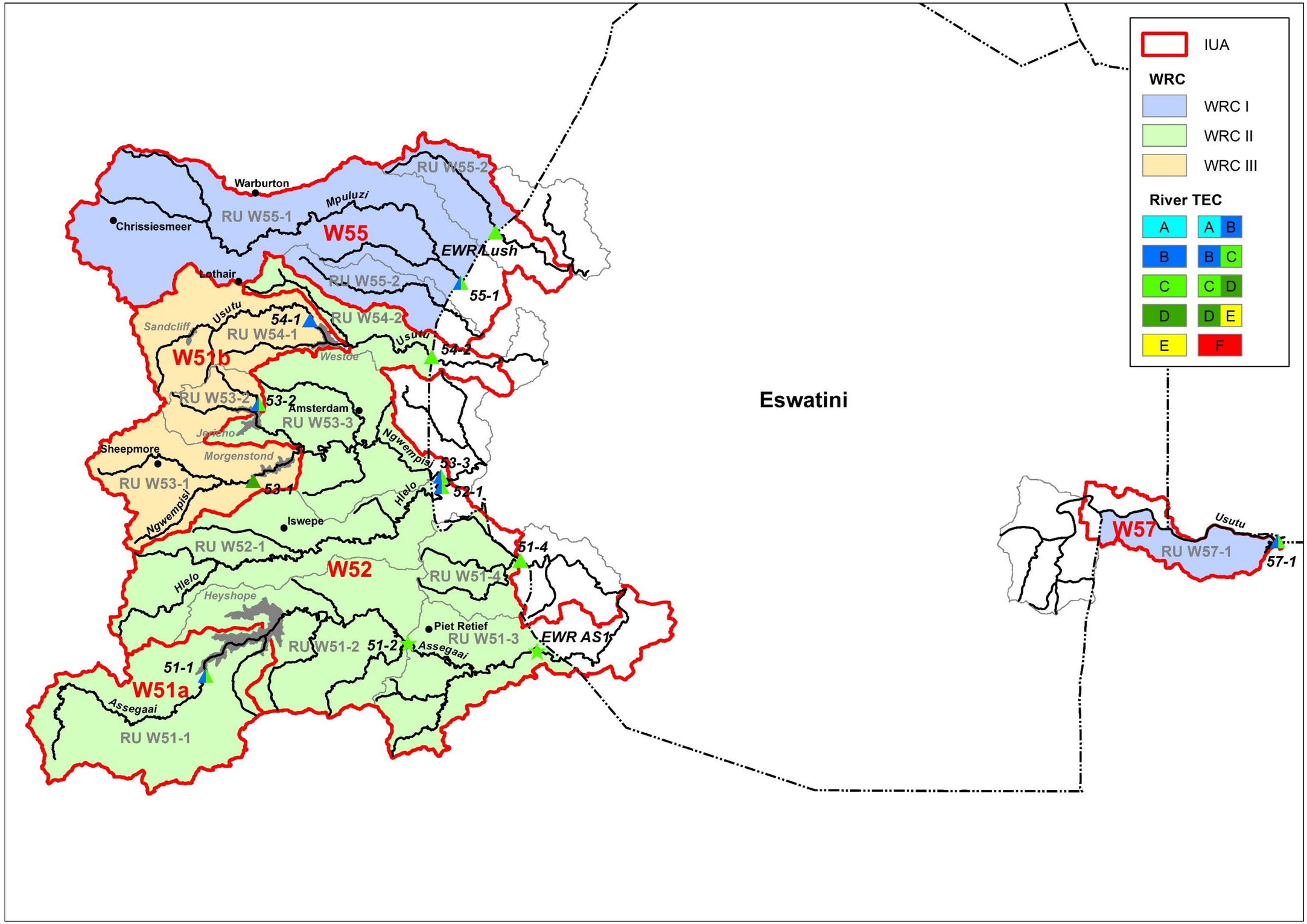


Figure 9.5 W5 Classes and Catchment Configuration

9.3.6 W7 Recommended Classes and Catchment Configuration

Table 9.13 W7 Recommended Classes

IUA		PES	REC	CC	Recommended Class based on TEC
W70-a	Kosi Bay	I	I	I	I
W70-Muzi Swamps	Muzi Swamps	II	II	II	II
W70-b	Sibaya	I	I	I	I

Table 9.14 W7 Catchment Configuration

IUA & RECOMMENDED CLASS: W70-a (KOSI BAY) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W70-1		D	D	**D**	N/a	None
W70-Lake Sibaya		B (87.4%)	B (87.4%)	**B**	The PES of Lake Sibaya should be maintained by implementing the EWR.	The EWR determined in 2015 (DWS, 2015), should be implemented as follows where Lake water levels should; 1) Reflect natural climate conditions, in particular five to six year averages in rainfall, as well as shorter term (one year) rainfall conditions; 2) Retain variability, including periods of high and low water levels; 3) Median water levels over a 30-year period should be between 17.39 and 18.48 masl; 4) Should not have more than five consecutive years <16.5 masl (drought water level threshold); 5) Should have at least six years in a 30-year cycle >19.2 masl.
W70-Kosi Lakes & Estuary		A/B	A	**A (93%)**	The system is in iSimangaliso Wetland Park and of very biodiversity and conservation importance. Largely groundwater and threatened by forestry.	In addition to capping the groundwater utilisation, especially during drought conditions, the following non-flow interventions will result in halting downwards trajectory and achieving TEC (DWS 2016b): 1) reducing plantations, that decrease the winter freshwater input. 2) In line with existing fisheries management guidelines for the Kosi Lakes maintain the subsistence fishery using methods at sustainable levels (methods refer to the back-facing traps and exclude gear such as diving masks and spear guns, augmented baskets (lined with nets) and gill nets). 3) Control and monitor crab harvesting (presently uncontrolled and sold in Durban). 4) Control resource utilisation of reeds, sedges, and mangroves through the introduction of rest areas (refinement of existing plan). 5) Control the burning of the flood plain vegetation, swamp forest and mangroves, e.g., education programme. 6) Prevent land-use change and control the clearing and draining of the peatlands for gardening. 7) Control the usage of DDT, herbicides and pesticides in the catchment (growing concern that the use of DDT and

IUA & RECOMMENDED CLASS: W70-a (KOSI BAY) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
						organic phosphates is having an impact because of their long resident time and vulnerability of the lake system); and 8) Where not build-up, create a 2 km buffer around the estuary functional zone to protect groundwater from the impact of woodlots and commercial plantations. In addition, a groundwater study is needed to guide what level of restrictions are needed on plantations and woodlots to not impact the groundwater input into Kosi Estuarine Lake system with regard to the wider groundwater utilisation in the catchment.
IUA & RECOMMENDED CLASS: W70-MUZI SWAMPS - CLASS II						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W70-Muzi Swamps		C	C	**C**	N/a	None
IUA & RECOMMENDED CLASS: W70-b (SIBAYA) - CLASS I						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
W70-3		D	D	**D**	N/a	None
W70-Lake Sibaya		B (87.4%)	B (87.4%)	**B**	N/a	None
W70-uMgobezeleni Estuary		B	A (93%)	**A/B (88%)**	The system is in iSimangaliso Wetland Park and more important than previously indicated. It is a fully functional estuarine lake system, e.g., new recruits of fish were recorded in uMgobezeleni Lake (< 2 weeks old freshwater mullet that recruited from the sea). New individuals of black mangroves were observed. Given the poor status and downward trajectory of most systems in the region, it is important to manage this system to the highest possible category.	The following non-flow interventions will result in halting downwards trajectory and achieving TEC: 1) Urgent action is needed to create awareness of the importance of mangroves and protect this threatened ecosystem types (e.g., road through mangroves). 2) Eradicate illegal gillnets in the lakes to enhance nursery function and support coastal fisheries. 3) Eradicate and monitor occurrence of alien invasive species, e.g., spotted bass *Micropterus punctulatus*. 4) Prevent land use clearing in the estuary functional zone. 5) Create interventions (e.g. restoring natural bank vegetation, artificial wetlands, reduce impact of grazing) within a 500 m buffer zone around the estuary functional zone to improve the nutrient status and reduce sediment inputs to the estuary and lakes. 6) . No municipal or industrial wastewater should be discharged into the system and agricultural best practices should be implemented to reduce nutrient-rich agriculture return flow. There is also a need to address diffuse runoff from housing not on formal reticulation systems. Look into innovative ways to manage wastewater in this area, e.g., artificial reed beds. 7) Prevent removal of bark from mangroves and other trees. 8) Maintain hydrological connectivity by ensuring that roads and bridges, e.g. crossing the estuary near the mouth, do not impact tidal and river flows. 9) Prevent undue disturbance of birds.

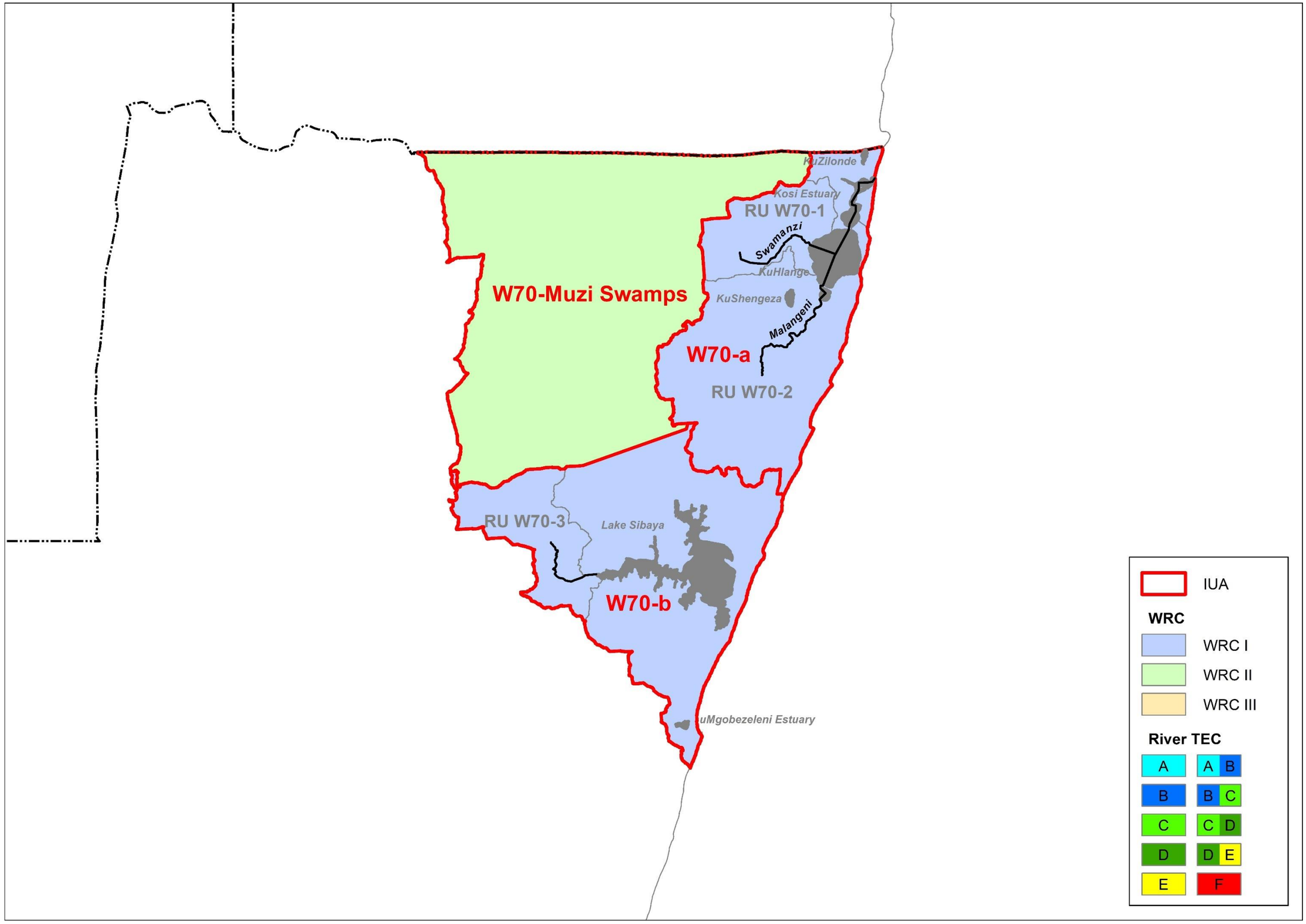


Figure 9.6 W7 Classes and Catchment Configuration

9.3.7 St Lucia Recommended Classes and Catchment Configuration

Table 9.15 St Lucia Recommended Class

IUA		PES	REC	CC	Recommended Class based on TEC
St Lucia	St Lucia	III	I	III	III→II→I

Table 9.16 St Lucia Catchment Configuration

IUA & RECOMMENDED CLASS: St Lucia - CLASS I (long term)						
RU	**River/Estuary**	**PES**	**REC**	**TEC**	**Rationale**	**Actions**
St. Lucia, W2 & W3 feeder streams	St. Lucia	D ↓↑	B	D→C→B	The system is in iSimangaliso Wetland Park and of very biodiversity and conservation importance. The DWS (2016a) overarching REC recommendation is 'Best Attainable State' of a B/C (~72) with a B Category is achievable in the long-term. The DFFE Ministerial Panel of Independent Experts also advocate for a REC of a B Category (DFFE, 2022).	DWS (2016a) provides minimum recommend flows for a B/C Category, namely include 1) cap minimum discharge in the Mfolozi at 3 m^3/s to maintain an open mouth. 2) Ensure a combined Mfolozi/Mkuze drought discharge of 5 m^3/s (including in 1.6 m^3/s in Mkuze); and 3) Improve the water quality coming from the Mkuze catchment. Non-Flow interventions include (DWS 2016a): a) St Lucia/uMfolozi should have a single mouth and with manipulation of the mouth (artificial breaching or closing) kept to a minimum as it increase drought/climate change vulnerability. b) Restore low-lying areas of the uMfolozi floodplain to natural vegetation to allow for natural processes (e.g., carbon sequestration, mouth closure). Detailed remote sensing study needed to identify these low-lying areas that is inundated during wetter cycle. c) Remove alien vegetation around the Lake, estuaries, and rivers. d) Limit further natural deforestation such as in the Dukuduku Forest. e) Eradicate illegal gillnetting from the system. f) Eradicate and monitor occurrence of alien invasive species (plants, inverts and fish). g) Strategic planning needed to prevent urbanization in the catchments feeding directly into the Lake and the Narrows. h) Reduce commercial forestation in the lake catchments to increase low flows as much as possible. i) In the uMfolozi River catchment, land care practices should focus on the most critical sub-catchment areas to limit future erosion and land degradation which could further reduce low flows. j) Unauthorised river abstractions on especially the Mkuze and uMfolozi Rivers must be eliminated. DWS will need to undertake further investigations into limiting further forestry applications in St Lucia and Mfolozi catchments and review license conditions in relation to buffer zones. Validation and verification of water use is required (compulsory licensing).
W32-Mkuze Floodplain/Swamp	Mkuze	B	B	**B**	None	N/a

10 THE WAY FORWARD

The proposed Classes and Catchment Configuration have been documented in the previous chapter and concludes the National Water Resource Classification phase of this study.

The information leads to the final phase, i.e., the determination of Resource Quality Objectives. All TEC at high priority RUs will be defined in terms of flow, water quality and habitat and riparian biota and habitat. Additional to this quantitative information, a suggested monitoring programme with ecological specification to achieve and maintain the RQOs (and TEC) will also be provided. This will also form part of information that will/can input into an implementation plan.

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12 APPENDIX A: COMMENTS AND RESPONSE REGISTER

No.	Section	Comment	From	Addressed?
1.	Table 9.2 Pg 9-2	Page 9.2, Table 9.2 – what does X represent?	M Sekoele M Maharaj	Yes
2.	Sec. 9.3.7 Pg 9-18	The resulting Classes configuration are shown in **Figure 10.1"**. There's no Fig. 10.1 in the report.	M Sekoele	Yes
3.	Sec. 3.1 Pg 3-2	I have gone through the report, and I am happy with the content. However, I have noted with concern that the report is silent about the groundwater component these catchments, yet groundwater plays a very critical role in these catchments either to augment supplies or for integrated ecosystems services. Is there a particular reason the groundwater component was not evaluated?	C Ngubo	The groundwater component is embedded in the Ecological categories and the groundwater Resource Quality Objectives which will be documented in a stand-alone report will provide the detail required.
4.	Exec sum Pg vii	The Table located on page vii shows the proposed classes associated with the TEC for IUA W13 as Class I but the table on page x records this as a Class II. Please clarify. Check Table 9.2, 9.3 and 9.4 for inconsistencies.	R Pillay M Maharaj	Yes (it must be Class I – has been changed).
5.	Exec sum Pg x	Table located on page x is missing IUA 22 (Upper Black Mfolozi) and 23 (Umfolozi-Hluhluwe Game Reserve). Please include as part of the executive summary.	R Pillay M Maharaj	No. The table is for Rus showing actions required or rationale. I have improved the heading and description of the table to be clearer.
6.	Exec sum Pg xi	Table located on page xi is missing IUA 42-b (Middle Pongola (Ithala), IUA 44 (Middle Pongola (Grootdraai) and IUA W70 (Mkuze Swamps).	R Pillay M Maharaj	See comment 5.
7.	Exec sum Pg xi	Table on located on page xi – St Lucia IUA. Should have it as shown in the table with both the short-, medium- and long-term proposed Class (i.e. III → II → I)	R Pillay M Maharaj	Yes
8.	Section 4.3 Pg 4-8	Scenarios that require curtailment of water use so that some rivers and estuaries can return to a natural state. The NWA recognizes the need to address historical disadvantages and promote social justice in water allocation. Curtailment of water use needs to be carefully evaluated so as not to inadvertently neglect the water needs of historically disadvantaged individuals and communities who have been denied equitable access to water resources in the past. It is essential to prioritize their needs and ensure their access to clean water for basic human rights and socio-economic development. Curtailing water use can have local economic impact. Limiting water use could lead to job losses and decreased productivity and economic growth at a local level. There needs to be a balance between restoring the system and equitable water allocation. It is important to explore other conservation measures such as sustainable water management practices, water efficient irrigation technologies, etc. Climate change impacts will impact on rainfall variability and patterns and will further impact on available water and mean annual runoff.	R Pillay M Maharaj	Yes. The socio-economic values that follow (**Table 4.1** to **Table 4.3**) provide the total sector impacts of the different sectors in the secondary catchments dependant and driven by the availability of the water.

No.	Section	Comment	From	Addressed?
9.	Section 6.3 Pg 6-4	Page 6-4: iSiyaya Estuary – *"This may also require deepening the estuarine channel and /or bringing the openwater area forward by removing marine sand at the mouth".* There is a need to model the hydrology and look the relationship between surface and groundwater. Interaction between hydrology and geohydrology. Estuary should not be seen in isolation from entire catchment. The once off dredging proposed is not sustainable as over time the system can revert to its previous state.	R Pillay M Maharaj	Text clarified and added: Ecosystem-based adaptation restoration project in an Estuary Management Plan is needed to restore the iSiyaya Estuary's functionality and address downwards trajectory. Short-term (1-5 years): Remove accumulated organic sludge through dredging of bottom substrate to improve water quality (once-off intervention, but may need repeating in 10 - 20 years if marine connectivity and water quality not improves); mechanical removal of reeds in lower reaches to increase open water area (once-off); and develop an Estuary Mouth/ Maintenance Management Plan, that considers/guide mechanical removal of sediment that build-up at the mouth to allow for overwash recruitment when closed for long periods (more than 2- 3 years) and sub-marine communication cable. Revegetate the dune at the mouth Long-term (5-10 years): Restore the upstream riparian zone (buffer) and remove alien vegetation. Institute 1 km mining and plantation buffer. Develop a groundwater-surface water model to protection of groundwater resources and estuary protection and management of the plantations.
10.	Section 6.3 Pg 6-6	Artificial breaching and dredging – is this proposed as a once off intervention or is this to form part of the mouth maintenance plan of the Estuary Management Plan. Bearing in mind that DFFE are not always in favour of artificial breaching in estuaries. Even if the system is breached how confident are we that the breach with result in flushing given the catchment size and marine dynamics? What would be the duration of the breach? Long term breaching is not sustainable. The removal of woodlots which are community woodlots is difficult to implement. What are the local socio-economic impacts of removing the community woodlots. If we want communities to remove woodlots, we need to provide them with equivalent activity/provide them with socio-economic alternatives. Removal of community woodlots will have a negative impact on the community.	R Pillay M Maharaj	Text added to clarify: Short-term (1-5 years): Remove accumulated organic sludge through dredging of bottom substrate to improve water quality (once-off intervention but may need repeating in 10 - 20 years if marine connectivity and water quality does not improve). Develop a groundwater-surface water model to protection of groundwater resources and estuary protection and guide management of the plantations and woodlots. Note that a reduction of community woodlots may require establishment of alternative livelihoods.
11.	Table 9.4 Pg 9-5	Page 9-5: RU W12-4 (KwaMazula): *"Remove forestry from the riparian zone and the required corridor adjacent to the river"* – This will need to be further investigated. The water use licence conditions will need to be reviewed to determine the areas approved for forestry plantations and undertaking enforcement conditions.	R Pillay M Maharaj	Yes. There are rules - so assuming there isn't formal forestry within the riparian zone delineation and additional buffers, I have changed the wording in the report to say that forestry species should not be allowed to encroach or recruit within the riparian zone and where this has occurred (due to close proximity of forestry to riparian edges) these should be removed.
12.	Table 9.4 Pg 9-7	Page 9-7: RU 12 (Inhlabane estuary): It is stated *that "no wastewater must be discharged into the system"* – What sanitation services currently exist for this catchment and is there currently any wastewater being discharged? Is the wastewater being referred to related to "sewage" or "industrial wastewater"? Is there any potential for wastewater to be	R Pillay M Maharaj	Currently no point source wastewater is being discharged. Neither sewage nor industrial waste should be discharged. Text refined to clarify: 6) Deteriorating water quality represents a significant threat, the risk is especially high during the closed state. Address diffuse runoff from

No.	Section	Comment	From	Addressed?
		treated to special standards for release into the system which would provide additional flow to the system?		housing not on formal reticulation systems. Look into innovative ways to manage wastewater in this area, e.g., artificial reed beds. No wastewater discharges (sewage or industrial) should be discharged into the lakes or estuary. Institute agricultural best practices (e.g. through development of farm plans) should be implemented to reduce nutrient-rich agriculture return flow. Proactive regional strategic planning is needed in the area to reduce the impact of future developments - for example, the disposal of waste is a key issue - waste cannot run into closed estuaries and lakes.
13.	Table 9.4 Pg 9-8	Page 9-8: RU W13 (Mlalazi estuary): Clarity if required regarding the following proposed intervention *"Create interventions within a 500 m buffer zone to improve the nutrient status and reduce sediment inputs"* – is the 500 m buffer zone required from the edge of the estuary. Please propose measures that can be taken to improve nutrient status and sediment reduction. What are the sources contributing to nutrient increases in the system. Another proposed intervention is *to "maintain hydrological connectivity by ensuring that roads and bridges do not impact tidal and river flows".* Please provide details on which roads and bridges are impacting on the system.	R Pillay M Maharaj	Text added to clarify: 5) Create interventions (e.g. restoring natural bank vegetation, artificial wetlands, reduce impact of grazing) within a 500 m buffer zone around the estuary functional zone to improve the nutrient status and reduce sediment inputs. 6) Prevent removal of bark from mangroves and other trees. 7) Maintain hydrological connectivity by ensuring that roads and bridges, e.g. crossing the estuary near the mouth, do not impact tidal and river flows.
14.	Table 9.4 Pg 9-8	Page 9-8: RU W13 (iSiyaya estuary): the proposed intervention *"This may also require deepening the estuarine channel and /or bringing the openwater area forward by removing marine sand at the mouth"* – this will need to be discussed with DFFE to determine feasibility. Please refer to comment 10 above.	R Pillay M Maharaj	Text added: Given that the removal of 5 m^3 of sediment at an estuary trigger the EIA process (National Environmental Management Act (No. 107 of 1998), removal of organic sludge and skimming/reshaping of the berm will require the development of an Estuary Mouth/Maintenance Plan to guide the management authority on when such an action is needed. The plan also needs to consider the submarine cable to the north of the system.
15.	Table 9.6 Pg 9-9	Page 9-9: RU W21-1 (White Mfolozi) – the requirement to *"remove agriculture from wetlands"*. The Department will need to investigate this and look at licence conditions issued for the agriculture sector. Will require enforcement action and a review of existing licence conditions.	R Pillay M Maharaj	No. I have not changed this in the report. There are several areas where agriculture is within a wetland, as delineated in the NWM5, 2018. This is a common cause of wetland deterioration, not only in this catchment, so if this action is to be pursued then the Department will have to investigate.
16.	Table 9.6 Pg 9-11	Page 9-11: RU W31-1 (Mkuze) – The proposed intervention is that *"Flow abstractions must be managed to achieve a B/C"* – This will require a review of existing licences in the catchment and enforcement of licence conditions. This will require further investigations.	R Pillay M Maharaj	No. This RU is a low or medium priority RU. As such, RQOs will not be set for this site apart from a desktop EWR. As there is no detailed information available for these RUs, RQOs will not be gazetted.
17.	Table 9.10 Pg 9-12	Page 9-12: W41-1 (Bivane): one of the mitigation measures proposed is to *"remove forestry from the riparian zone"* – This will require further investigation and review of license conditions. Review of planting plans. The Department will need to look at the enforcement of setbacks in relation to existing license conditions.	R Pillay M Maharaj	See comment 11.
18.	Table 9.6 Pg 9-13	Page 9-13: W45 (Pongola floodplain): The following statement bears reference*, "However, improvement will be based on EWR releases from*	R Pillay M Maharaj	No. Agree with the comment. That is why an improvement has not been recommended. The TEC is the same as the PES.

No.	Section	Comment	From	Addressed?
		Pongolapoort Dam amongst other. There will however be a serious impact on the dependency of rural communities living on the floodplain and utilising the floodplain for subsistence agriculture". Please identify the zones that could impact be impacted by EWR releases. Please identify and quantify all the impacts to communities if EWR releases are fully implemented. The release of water for ecological purposes can disrupt the timing of farming activities of these communities and there will need to be a proper procedure in place.		
19.	Table 9.14 Pg 9-16	Page 9-16: W70 (Kosi lakes and estuary): The area is largely dependent on groundwater and capping groundwater utlisation could have socio economic impacts on communities living in the area and who are dependent on groundwater. One of the interventions proposed is to *"reduce plantations"* - Are these commercial or community plantations. Please geolocate and delineate these plantations. Community plantations are a source on livelihood. If these are indeed community plantations, they need to be provided with socio- economic alternatives. According to Mr B Mdluli (DWS KZN Office), DWS Head Office did try to reduce plantations through enforcement, but this was not successful. The second intervention proposed, *"Maintaining the traditional subsistence fishery using traditional methods at sustainable levels (traditional methods refer to the back-facing traps and exclude gear such as diving masks and spear guns, augmented baskets (lined with nets) and gill nets)"* - This implementation method must be consulted with local communities. This is a high tourism area and tourists/recreational users would most likely not utilize traditional fishing methods and this could often lead to exploitation. If Tourists/recreational users are engaging in fishing, a catch and release system should be imposed, or they should be subject to the same traditional fishing methods. Irrespective of method of fishing there should also maintain sustainable quota. Eco tourism as a socio- economic activity in these areas. Please confirm if DDT is still being used in this area. This will need to be phased out and consultations need to be held with the Department of Agriculture and other relevant Departments in this regard. The following intervention bears reference *"Introduce a 2 km buffer around forestry to protect groundwater"* – Please clarify what is meant/required by this statement. Does this pertain to existing forestry located around the estuary or any further Stream Flow Reduction Activites? Is this natural or commercial forestry/woodlots or is the PSP referring to maintaining and protecting the natural swamp/coastal forest by implementing a 2 km buffer around the forestry?	R Pillay M Maharaj	Text added: Remove commercial plantations. Were impact is being caused by community plantations alternative livelihoods will need to be provided. Text changes to reflect that these are not new requirements: In line with existing fisheries management guidelines for the Kosi Lakes maintain the traditional artisanal fishery using traditional at sustainable levels (traditional methods refer to the back-facing traps and exclude gear such as diving masks and spear guns, augmented baskets (lined with nets) and gill nets). There is some recreational fishing at the mouth of the estuary and from boats in the lakes, but there is little conflict between the traditional and recreational fishing as they are active in different areas. Publish literature indicate the DDT is still being used in the catchment. The publication did not refer to DDX (which indicate historical use). Text refined to clarify: 8) Where not build-up, create a 2 km buffer around the EFZ to protect groundwater from the impact of woodlots and commercial plantations. In addition, a groundwater study is needed to guide what level of restrictions are needed on plantations and woodlots to not impact the groundwater input into Kosi Estuarine Lake system with regard to. the wider groundwater utilisation in the catchment.
20.	Table 9.14 Pg 9-17	Page 9-17: W70 (uMgobezeleni Estuary): The proposed intervention which states, "*Create interventions within a 500 m buffer zone to improve the nutrient status and reduce sediment inputs"* - Is this around the lake? What is driving the nutrient status – sources? Please delineate the buffer zone around the lake/estuary. What level/type of sanitation is provided	R Pillay M Maharaj	Text added to clarify: 5) Create interventions (e.g. restoring natural bank vegetation, artificial wetlands, reduce impact of grazing) within a 500 m buffer zone around the estuary functional zone to improve the nutrient status and reduce sediment inputs to the estuary and lakes. 6) . No municipal or

No.	Section	Comment	From	Addressed?
		in this area? The other intervention proposed is to "*Maintain hydrological connectivity by ensuring that roads and bridges do not impact tidal and river flows"* - Please provide details on which roads and bridges are impacting on the system. Culverts etc. will have to be maintained and depending on whether this is a national, provincial or local road/bridge, there are different institutions responsible to maintain culverts, etc.		industrial wastewater should be discharged into the system and agricultural best practices should be implemented to reduce nutrient-rich agriculture return flow. There is also a need to address diffuse runoff from housing not on formal reticulation systems. Look into innovative ways to manage wastewater in this area, e.g., artificial reed beds. 7) Prevent removal of bark from mangroves and other trees. 8) Maintain hydrological connectivity by ensuring that roads and bridges, e.g. crossing the estuary near the mouth, do not impact tidal and river flows.
21.	Table 9.16 Pg 9-18	Page 9-18: St Lucia W2 and W3 feeder streams: Is the 1.6 m^3/s required from the Mkuze River included as part of the combined Mfolozi/Mkuze drought discharge of 5 m^3/s or is this addition to the combined Mfolozi/Mkuze discharge? To achieve the long term goal of a B category, what is flow requirement to achieve this as the recommended flow is for a B/C category? There are no impoundments on the Mfolozi and Mkhuze at this stage so how does one ensure maintenance of the drought discharge. Is the PSP implying that no further water allocations can be made from both the Mfolozi and Mkuze system? One of the proposed interventions states *"Restore low-lying areas of the uMfolozi floodplain to natural vegetation to allow for natural processes"* – Please delineate the low-lying areas. There is already existing agricultural activity located approximately 8 – 10 km from the mouth of the estuary along the uMfolozi River. The other intervention proposed is to *"Reduce commercial forestation in the lake catchments to increase low flows as much as possible"* - DWS will need to undertake further investigations into limiting further forestry applications in this catchment. Review is required of license conditions in relation to buffer zones. Compulsory licensing will need to be implemented. Enforcement action is also required. Mr B. Mdluli (DWS KZN office) has indicated that sand accumulation is increasing the berm height which is also preventing flow of water to the marine environment.	R Pillay M Maharaj	Reworded to clarify: Ensure a combined Mfolozi/Mkuze drought discharge of 5 m^3/s (including in 1.6 m^3/s in Mkuze B/C and B flow requirements are the same, it it the level of non-flow interventions that drives the improvement in conditions, rewilding of Mfolozi flood plain. Text added: Detailed remote sensing study needed to identify these low-lying areas that is inundated during wetter cycle. Text added: DWS will need to undertake further investigations into limiting further forestry applications in St Lucia and Mfolozi catchments and review license conditions in relation to buffer zones. Validation and verification of water use is required (compulsory licensing).
22.	Table 9.14 Pg 9-17	Page 9-18: W70 (Lake Sibaya) - Mr B. Mdluli (DWS KZN office) has communicated that the level of the lake is dropping and has recommended that the PSP include recommendations/interventions as part of this Classification Study.	R Pillay M Maharaj	Yes. I have included the EWR requirements for the Lake in the report.
23.	Exec sum PG viii	St Lucia: How was the Present E.S. determined?	R Cedras	See DWS (2016a) for detail on PES determination. Department of Water and Sanitation (DWS) 2016a. Chief Directorate – Water Ecosystems: Reserve determination study of selected surface water and groundwater resources in the Usuthu/Mhlathuze Water Management Area. Lake St Lucia Intermediate EWR Assessment Report – Volume 1: Ecoclassification and EWR Assessment. Prepared by Tlou Consulting (Pty) Ltd and Anchor Environmental Consultants (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/2213.

No.	Section	Comment	From	Addressed?
24.	Table 4.1 Pg 4-1	**R 191** - How does the GDP come to this value, when in Tables 4.9, 4.3, 4,2 for employees etc are lower than that those in the others, unless this is not millions but rather thousands in rands?	R Cedras	Yes. Impacts driven by the availability of water that is used with the allocated multiplier to obtain the impacts.
25.	Table 9.16 Pg 9-16	W70-Kosi Lakes and Estuary: Interventions - Where is the data that supports these actions?	R Cedras	See DWS (2016b) for detail on recommended interventions. Department of Water & Sanitation (DWS). 2016b. Resource Directed Measures: Reserve determination study of selected surface water and groundwater resources in the Usutu/Mhlathuze Water Management Area. Kosi Estuary Rapid Environmental Water Requirements Determination. Report produced by CSIR on behalf of Tlou Consulting (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/2613.
26.	Table 9.16 Pg 9-18	St. Lucia, W2 & W3 feeder streams: Interventions - Where is the data that supports these actions? How was this determined?	R Cedras	See DWS (2016a) for detail on PES determination – Comment 23.
27.	Exec Sum Pg ix	W12-iNhlabane Estuary: A **range of flow** and non-flow related interventions must be implemented to ensure estuary connectivity is re-established - What actions are required with regard to the flow interventions?	M Maharaj	Text added to reflect required interventions: Increase freshwater runoff to estuary and lakes through removal of alien vegetation, controlling/removing of commercial plantations.
28.	Exec Sum Pg x	W31-1: Mkuze - REC achieved by combination of **flow** and non-flow mitigation - What flow mitigation is required?	M Maharaj	See comment 16.
29.	Exec Sum Pg ix	W51-1: Assegaai - **managing abstractions** - Please be specific on how the abstractions are to be managed to achieve the REC?	M Maharaj	No. See comment 16.
30.	Section 6.4 Pg 6-6	The current fishways are not functional. Increase connectivity between the estuary and various parts of the lakes by **flow releases from the weir** - How much is required and when? What are the impacts of such releases on other water users?	M Maharaj	Text added to indicate: Historical EWR: Fish way continuous discharges 0.1 m^3/s. To improve marine connectivity the estuary requires 175 000 m^3 to fill up a breach, historical EWR specify 33m^3/s for 9 hours every 2 years.
31.	Table 9.16 Pg 9-18	St. Lucia, W2 & W3 feeder streams: 3 m^3/s - As part of the reconciliation study a Screening report for possible dam developments were undertaken for the Mfolozi and surrounding areas. Please have a look at this report.	M Maharaj	Noted.
32.	Sec 1.2 Pg 1-1	W5 catchment (main river: Usutu) - much of this catchment falls within Eswatini - So why then must we breakdown the subsystems to: Umpuluzi, Hlelo, Usuthu and Assegai etc	T Sawunyama	No. Eswatini is not evaluated in this study. The breakdown is to manage the sections of the river within South Africa. These Rus were also documented and approved at the beginning of the study (See Task 1 and 2 reports)
33.	Table 4.8 Pg 4-7	Urban and Industry qualitative economic analysis of the estuary scenarios - Why not using quantitative methods?	T Sawunyama	Yes. Refer to Section 4.2: Although it is a difficult process to mitigate and apply, it is easier to remove hectares than remove a portion of an aluminium smelter or a portion of an urban communities' water. The possible impact of water changes in the industries and urban community sectors, were analysed on a qualitative level where the impacts of scenarios relating to a reduction or increase of water is described.

No.	Section	Comment	From	Addressed?
34.	Section 5-7 Pg 5-1	How are cross border flows factored? On the subsystems flowing into eSWATINI.	T Sawunyama	No. The focus is only on the areas in South Africa. The resulting cross-border flows are then relevant for the Usuthu downstream of Eswatini and this natural and present day hydrology is available and has been modelled accordingly. Please note the Task 3 Hydrology report.
35.	Additional comments	On 12 September 2023, additional comments were received by the Water Quality Licensing Team (KZN) which included: Haseena Aboobaker Ivor Hoareau Michael Maluleke Vukani Tshabalala Krishnee Naidoo. General editorial comments where applicable were addressed. Many of the queries (e.g. buffers; concerns around capping groundwater utilization, especially during droughts and the implications on ceasing discharge within certain areas) have been forwarded to the specialists and will be addressed in the RQO and Implementation/monitoring reports (e.g. recommendations around MoA). Important concerns from the reviewers that will be addressed in the RQO and Implementation/monitoring reports are listed below.		
		The Proto CMA is expected to implement measures to ensure the class is maintained. A key aspect is monitoring, which requires extensive resources such as gauging stations, adequately trained staff, sampling gear, traveling to site/labs, laboratory analyses, etc. These are all to be backed by finance. With the moratorium on appointment of new staff, and recent budgetary cuts, it is unclear how the classes may be met.	H Aboobaker	Recommendations will be made in the monitoring/implement report.
		In terms of increased compliance, monitoring and research - An intergovernmental MoA will be required by various Ministers (DWS, DFFE), eZemvelo and Transnet). Will this be the responsibility of the Proto CMA or Head Office?	H Aboobaker	Recommendations will be made in the monitoring/implement report.
		I would like to enquire on the rationale used for the scientific buffers and its applicability to Water Use Licensing for the future. Some of the quaternary catchments that stipulate proposed scientific buffers should be clearly detailed in terms of area and width of the proposed buffer. We should also establish if the buffer proposed translates to a no go area or can development proceed with mitigations within such buffers for low to no risk activities.	K Naidoo	Buffer zones will be discussed in the RQO and monitoring/implement report.
		We need to look at the implications on ceasing discharge within certain water use areas. This may have detrimental impacts on future licenses and compliance monitoring going forward. We will be implementing the waste discharge standards which could assist in regulation of discharge. We need to be able to scientifically justify our decisions which may have social and economic ramifications for future development in those areas.	K Naidoo	The issue of managing the implications of the Classes and how DWS or the Proto-CMA should manage it, is not directly relevant to this study team. However, recommendations will be made in the monitoring/implement report.

No.	Section	Comment	From	Addressed?
		Maybe we should look at limiting discharge at certain points of the resource with a particular water quality standard.		
		Scientific research for areas lacking water quality data can be utilized to better inform the land use activities that may persist in the area and the quality of the water resource. This should only be done using published and verified sources where possible.	K Naidoo	This issue is covered in the principles of the RQO report, WQ section.
		W70-Kosi Lakes & Estuary: It is not advisable to cap ground water abstraction for domestic / potable use as this is a primary source for many rural inhabitants which they abstract via wells by hand.	I Horeau	Forwarded to relevant specialists and will be refined in in the RQO and monitoring/implement report.
		St. Lucia, W2 & W3 feeder streams: Might not have sufficient flow to achieve the required discharges. Might have to investigate curbing irrigation abstractions.	I Horeau	Forwarded to relevant specialists and will be refined in in the RQO and monitoring/implement report.