water and sanitation

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Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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

MAIN REPORT

FINAL
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Department of Water and Sanitation

Chief Directorate: Water Ecosystems Management

PROJECT NUMBER**:** WP 11387

Main Report

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

MAY 2024

REFERENCE

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REPORT SCHEDULE

Index Number	DWS Report Number	Report Title
1	WEM/WMA3/4/00/CON/CLA/0122	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Inception Report including Gap Analysis chapter**
2	WEM/WMA3/4/00/CON/CLA/0222	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Status Quo and Delineation of Integrated Units of Analysis and Resource Unit Report**
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**
4	WEM/WMA3/4/00/CON/CLA/0422	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Hydrology Systems Analysis Report**
5	WEM/WMA3/4/00/CON/CLA/0522	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **River EWR estimates for Desktop Biophysical Nodes Report**
6	WEM/WMA3/4/00/CON/CLA/0622	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **River Survey Report**
7	WEM/WMA3/4/00/CON/CLA/0722	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Basic Human Needs Report**
8	WEM/WMA3/4/00/CON/CLA/0822	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Groundwater Report**
9	WEM/WMA3/4/00/CON/CLA/0922	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **River specialist meeting Report**
10	WEM/WMA3/4/00/CON/CLA/1022	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Estuary Survey Report**
11	WEM/WMA3/4/00/CON/CLA/1122	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Wetland Report**
12	WEM/WMA3/4/00/CON/CLA/1222	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecological Water Requirements Report**
13	WEM/WMA3/4/00/CON/CLA/1322	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Scenario Description Report**

Index Number	DWS Report Number	Report Title
14	WEM/WMA3/4/00/CON/CLA/0123, volume 1	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecological Consequences Report, Volume 1: Rivers**
	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**
15	WEM/WMA3/4/00/CON/CLA/0323	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecosystem Services Consequences Report**
16	WEM/WMA3/4/00/CON/CLA/0423	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Economic & User water quality Consequences Report**
17	WEM/WMA3/4/00/CON/CLA/0523	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Water Resource Classes Report**
18	WEM/WMA3/4/00/CON/CLA/0623, volume 1	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 1: Rivers**
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21	WEM/WMA3/4/00/CON/CLA/0224	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Issues and Responses Report**
22	WEM/WMA3/4/00/CON/CLA/0324	Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Close out Report**

Shaded Grey indicates this report.

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 several 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 provide a consolidated summary of all the work that has been undertaken throughout the Study in order to produce the Classes and Resource Quality Objectives for the Usutu to Mhlathuze Catchments. Each Task carried out produced a detailed Technical Report which should be reviewed for more detail on the specific aspects. This Main Report presents an overview of the important information extracted from each of the Technical Reports.

APPROACH TO STUDY

The approach to carry out the study is presented in **Figure 1**. This is in line with the DWS Guidelines on the stepwise procedure to follow when undertaking Classification and setting RQOs.

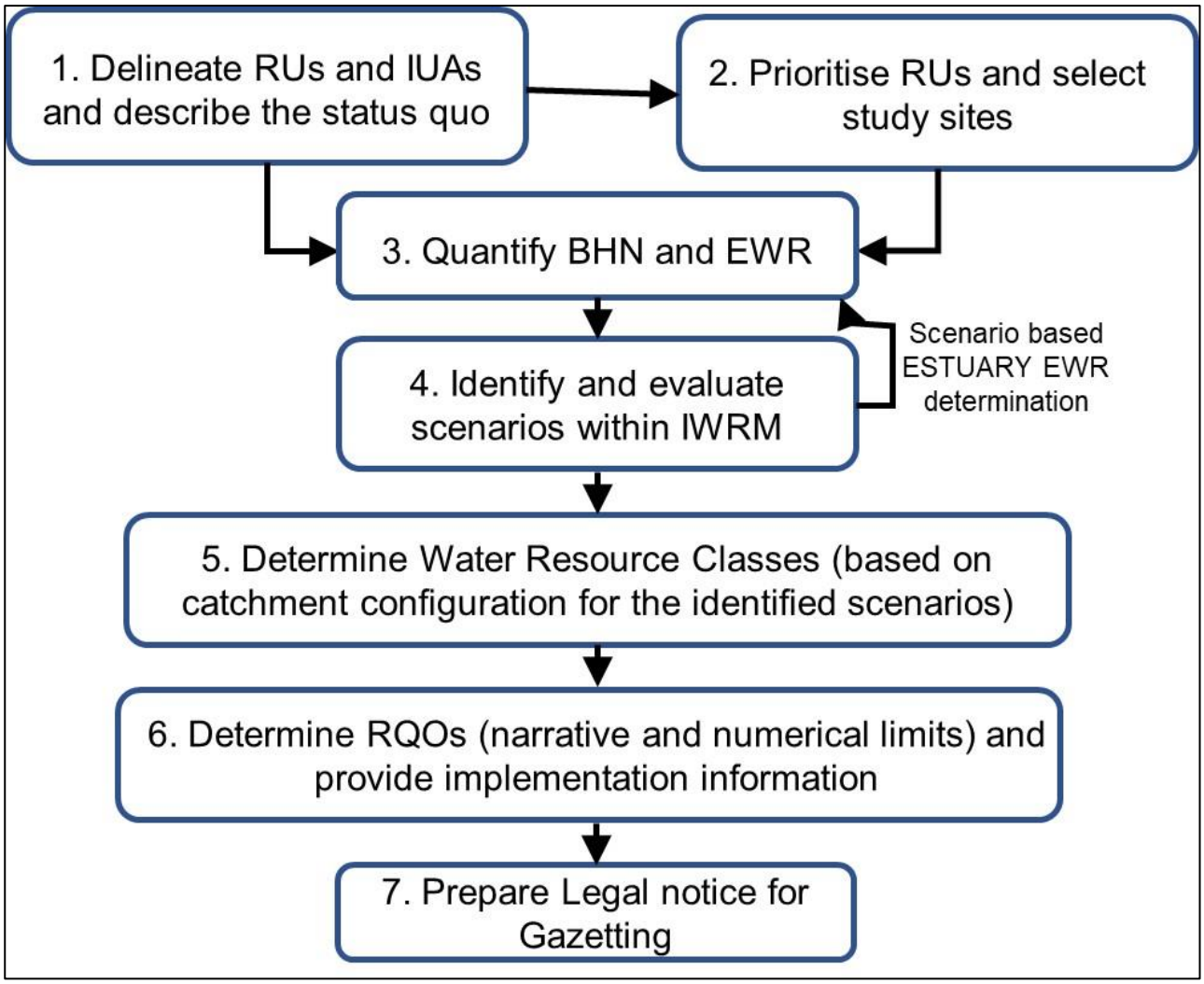

Figure 1: Overall study approach

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TERMINOLOGY AND ACRONYMS

AIPs	Alien Invasive Plants
CMA	Catchment Management Agency
CMF	Catchment Management Forum
CMS	Catchment Management Strategy
CD: WEM	Chief Directorate: Water Ecosystems Management
DSS	Decision Support System
DALRRD	Department of Agriculture, Land Reform and Rural Development
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DMRE	Department of Mineral Resources and Energy
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
D: RQIS	Directorate: Resource Quality Information Services
D: SDS	Directorate: Sources Directed Studies
DO	Dissolved Oxygen
EC	Ecological Category
EcoSpec	Ecological Specification
EDTEA	KZN Department of Economic Development, Tourism and Environmental Affairs
EFZ	Estuarine Functional Zone
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
EMP	Estuarine Management Plan
ES	Ecological Sensitivity
EWR	Ecological Water Requirement
EWRM	Ecological Water Resources Monitoring
e-WULAAS	Electronic Water Use Licence Application and Authorisation System
FRAI	Fish Response Assessment Index
FEPA	Freshwater Ecosystem Priority Area
GA	General Authorisation
GRU	Groundwater Resource Unit
HGM	Hydrogeomorphic
IPMC	Implementation Plan Management Committee
IUCMA	Inkomati-Usuthu Catchment Management Agency
ICMA	Integrated Coastal Management Act
IRIS	Integrated Regulatory Information System
IUA	Integrated Unit of Analysis
IWRM	Integrated Water Resources Management
LB	Left Bank
MIRAI	Macro Invertebrate Response Assessment Index
MPA	Marine Protected Area
MTPA	Mpumalanga Parks and Tourism Association
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NBA	National Biodiversity Assessment

NCMP	National Chemical Monitoring Programme
NCIMS	National Compliance Information Management System
NEMA	National Environmental Management Act
NEMP	National Estuarine Management Protocol
NMMP	National Microbial Monitoring Programme
NWA	National Water Act
NWRS3	National Water Resource Strategy Volume 3
NWMP	National Wetland Monitoring Programme
NRM	Natural Resource Management
PES	Present Ecological State
PES/EIS	Present Ecological State, Ecological Importance and Ecological Sensitivity
Quat	quaternary catchment
RHAM	Rapid Habitat Assessment Method
RHP	River Health Programme
REC	Recommended Ecological Category
RC	Reference Condition
RQO	Resource Quality Objective
RU	Resource Unit
RB	Right Bank
REMP	River EcoStatus Monitoring Programme
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System version 5
SFR	Stream Flow Reduction
SQ	Sub-quaternary
TEC	Target Ecological Category
TPC	Threshold of Potential Concern
TP	Total Phosphorous
VEGRAI	Vegetation Response Assessment Index
WARMS	The Water use Authorization & Registration Management System
WWTW	Waste Water Treatment Works
WMS	Water Management System
WQ	Water Quality
WRCS	Water Resource Classification System

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

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.
Ecological Specifications (EcoSpecs)	EcoSpecs are biological specifications that are numerical values or narrative statements that define a desired biological condition (EC). They indicate the level of habitat integrity that is required to attain a specific biological condition for the river and therefore provides the ecological detail that characterises the EC.
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 Units 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 (SQ) reaches	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.
Threshold of Potential Concern (TPC)	TPCs indicate the numerical values around the EcoSpecs that, if approached, would initiate more detailed investigations or even management actions. TPCs are therefore upper and lower levels along a continuum of change in selected environmental indicators and represent early warning indicators of potential change from a particular Ecological Category to another Ecological Category (warning bell).
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 the 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 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 several 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 include the World Heritage Site and the St Lucia/iMfolozi Estuarine Lake Complex. 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 which 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.

The locality map of the study area is shown in **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.

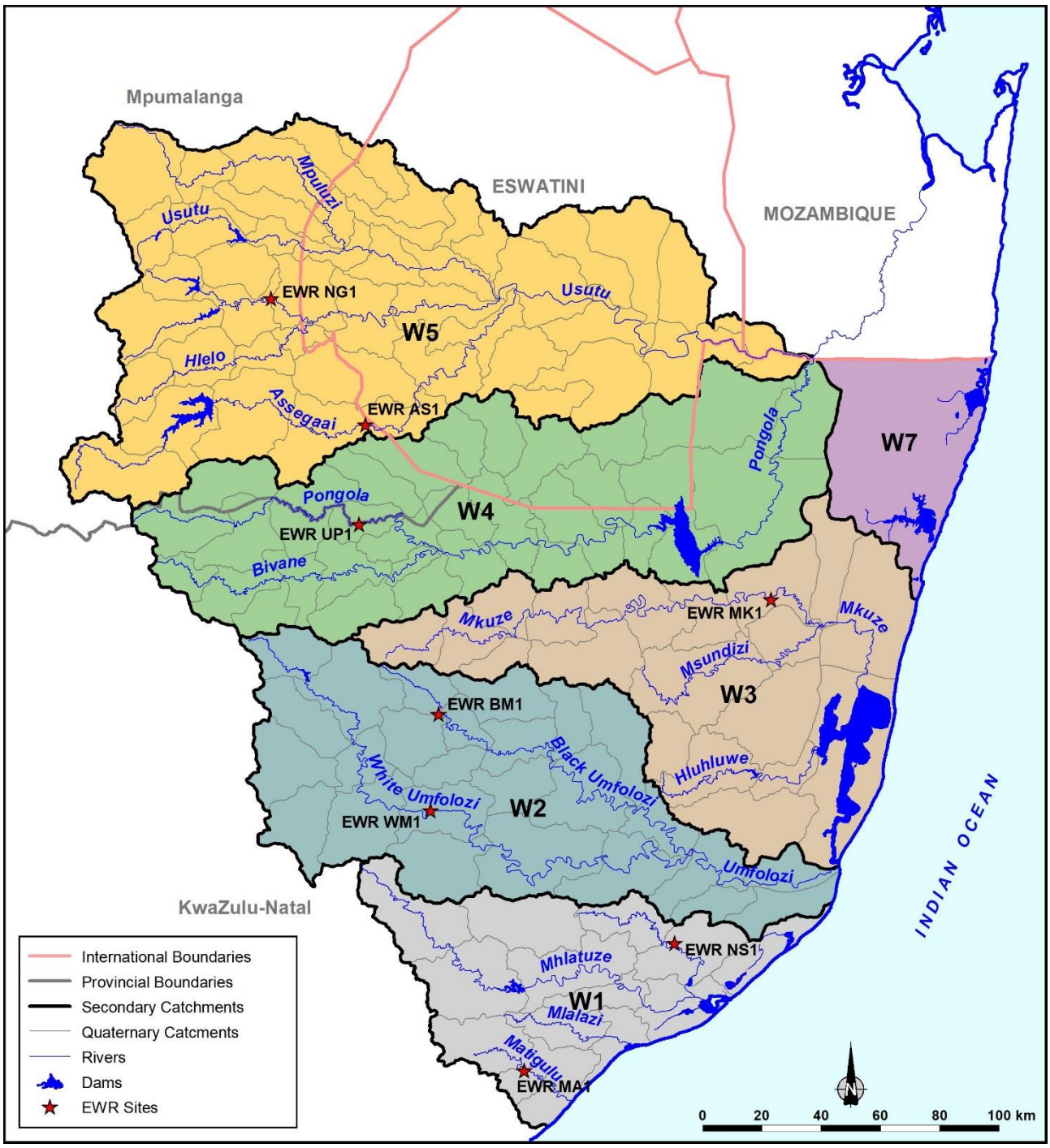


Figure 1-1: Locality Map of the Study Area

1.3 PURPOSE OF THIS REPORT

The purpose of this report is to provide a consolidated summary of all the work that has been undertaken throughout the Study in order to produce the Classes and Resource Quality Objectives for the Usutu to Mhlathuze Catchments. Each Task carried out produced a detailed Technical Report which should be reviewed for more detail on the specific aspects. This Main Report presents an overview of the important information extracted from each of the Technical reports. The 7-step project plan used throughout the Study is presented in **Figure 1-2.**

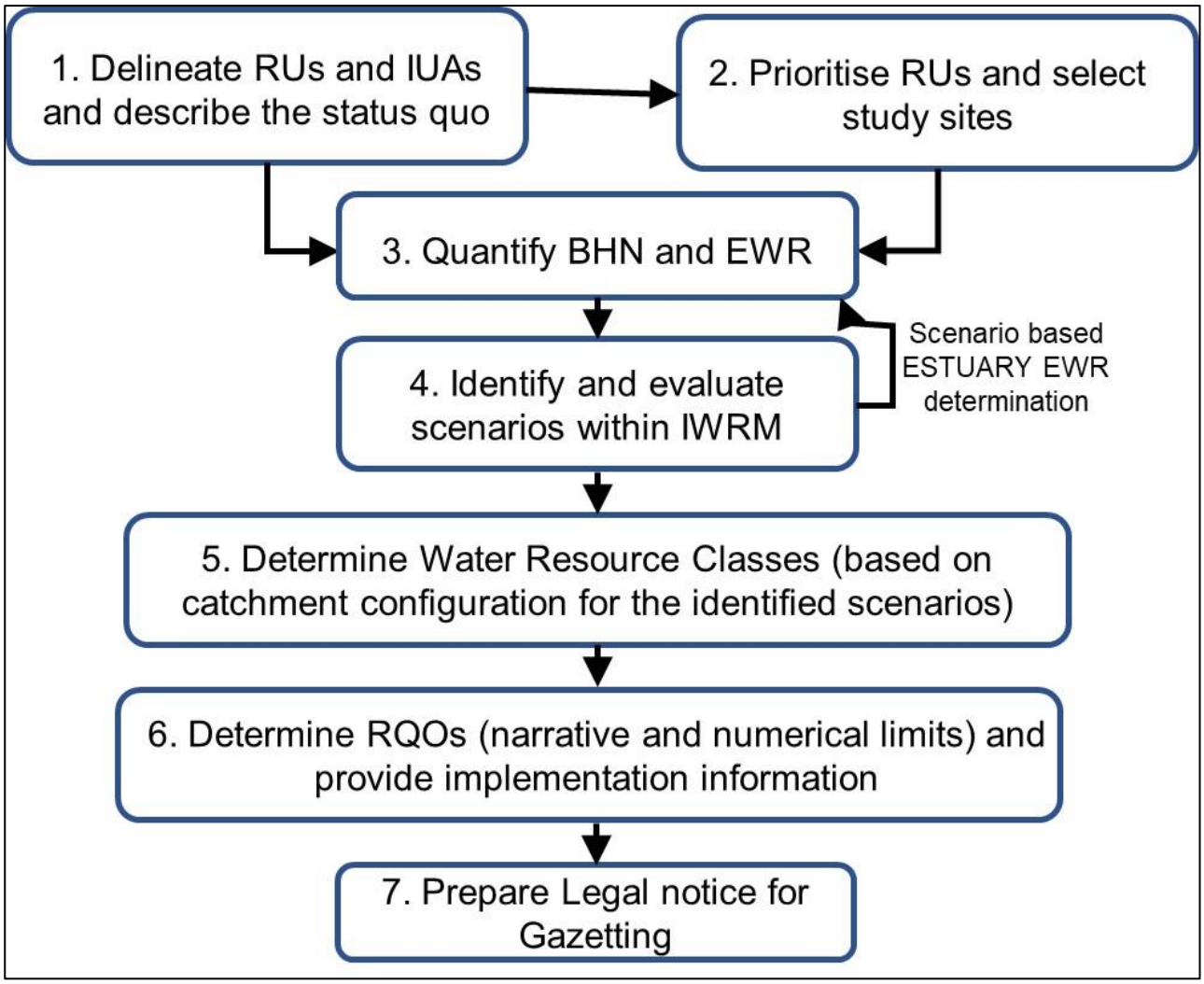


Figure 1-2: Project Plan for the Usutu-Mhlathuze Classification Study

1.4 REPORT OUTLINE

The report broadly follows the timeline of Technical reports as delivered throughout the study and is laid out as follows:

- **Chapter 1** provides general background information on the study area and the Project Plan.
- **Chapter 2** discusses the status quo of the study area at the start of the study (2022) and presents the delineation of Integrated Units of Analyses that were used in the Study.
- **Chapter 3** presents the delineation of Resource Units and describes the prioritization outcomes.
- **Chapter 4** presents the surface water resources used as a basis for flows in the study.
- **Chapter 5** presents the groundwater overview.
- **Chapter 6** presents the basic human needs determined as part of the study.
- **Chapter 7** provides an overview of the wetlands.
- **Chapter 8** presents the river Environmental Requirements set for both the detailed EWR sites and the Desktop biophysical nodes.
- **Chapter 9** is an overview of the Estuaries included in the study area
- **Chapter 10** presents the scenarios that were assessed for both the river EWR sites and estuaries. The consequences of the scenarios are also presented in this chapter.
- **Chapter 11** provides the water resources classes for the IUAs.

- **Chapter 12** presents a summary of the resource quality objectives, the details thereof are provided in **Appendix D**.
- **Chapter 13** presents a summary of other aspects that were covered as part of the study
- **Chapter 14** presents details of the reports references throughout the report.
- **Appendix A** presents the figures.
- **Appendix B** provides an overview of the Training that took place.
- **Appendix C** presents a summary of the River EWR site visit. The estuaries site visit is covered in Chapter 9.

2 STATUS QUO AND IUA DELINEATION

The purpose of this chapter is to describe the status quo of the water resources in the Usutu to Mhlathuze Catchment in terms of the water resource system. The chapter documents the results of Task 1: Delineate Integrated Units of Analysis (IUAs) and Resource Units (RU) and describe the status quo of the Usutu to Mhlathuze Catchment. The objective of this task is to define IUAs, and to provide a status quo description of each IUA.

2.1 STATUS QUO

2.1.1 Surface Water Resources

The Study Area includes six secondary catchments, for which the status quo has been outlined as part of this report. The significant surface water resources of the catchments and the main users are summarised in **Table 2-1**.

Table 2-1: Significant surface water resources of the catchments and the main users

Secondary catchment	Area (km^2)	MAR (million m^3/a)	Dam capacity (million m^3)	Main impoundments	Domestic & Industrial use (million m^3/annum)	Affore station area (ha)	Irrigation use (million m^3/annum)	Transfers in	Transfers out
W1	5 661	816	314	Goedertrouw Dam, Lake Nsezi, Lake Mzingazi, Lake Nhlabane, Lake Cubhu	107	64 072	140	From Thukela From Umfolozi (Thukela: current capacity: 38 million m^3/a, future to be doubled, Umfolozi: 8 million m^3/a)	-
W2	10 008	825	35	Vuna Dam, Vokwena Dam, Klipfontein Dam	30	57 846	53	-	To Mhlathuze (8 million m^3/a)
W3	9 545	578	48	Hluhluwe Dam	4	38 042	85	From Pongola (20 million m^3/a)	-
W4	11 714	1104	2571	Pongolapoort Dam	26	75 610	275	-	To Mkuze (20 million m^3/a)
W5*	7 627	949	695	Westoe Dam, Jericho Dam, Morgenstond Dam, Heyshope Dam,	11	226 510	12	-	To Vaal & Olifants (from Jericho: 74 million m^3/annum, from Heyshope, 135 million m^3/annum.
W7	2 589	143	0	Lake St Lucia	3	24 591	0	-	-

*Note: All figures include RSA portion only.

2.1.2 Groundwater

Groundwater recharge is 2998 Mm^3/a, of which 1836 Mm^3/a is aquifer recharge. Baseflow is 2319 Mm^3/a. Groundwater use is less than 20 Mm^3/a.

Groundwater is of Class 0 (<70 mS/m) over most of the study area. Poor quality groundwater is associated with the upper Karoo Letaba and Jozini Formations, and in the Cretaceous sediments. Elevated nitrates are found in isolated localities. This can be attributed to the removal of vegetation and possibly sanitation practices. Elevated fluoride is found in the upper Karoo volcanics, and in some the some intrusive and extrusive granitoids, volcanics and metamorphics.

W1 Catchment: Recharge declines from over 200 mm/a on the Northern Zululand Coastal Plain to 50 - 60 mm/a inland. Aquifer recharge is 100 - 150 mm/a on the coastal plain and only 20 - 40 mm/a inland. Groundwater is minimally used and the stress index is below 0.05. Baseflow generation decreases inland from 135 mm/a to 40 mm/a. On the middleveld and lowveld, 30-40% of baseflow is from groundwater. The percentage declines towards the coast and in the more rugged Kwazulu-Natal Coastal Foreland.

W2 Catchment: Recharge declines from over 200 mm/a on the Northern Zululand Coastal Plain to 30 - 40 mm/a inland on the Lowveld and Middleveld. Aquifer recharge is over 150 mm/a on the coastal plain. It declines rapidly to less than 40 mm/a inland and is only 10 - 20 mm/a over the Middleveld and Lowveld. Groundwater is minimally used and the stress index is below 0.2. Baseflow generation decreases inland from 80 mm/a to 10 mm/a. Groundwater baseflow increases proportionally from 20% to over 40% of baseflow towards the coast.

W3 Catchment: Recharge declines from 150 - 200 mm/a on the Northern Zululand Coastal Plain to 20 - 30 mm/a inland on the Lowveld and Middleveld. Aquifer recharge is 100 - 190 mm/a on the sandy coastal plain where interflow is minor and decreases from 40 mm/a to 10 mm/a inland. Groundwater is minimally used and the stress index is below 0.05.
Baseflow generation decreases inland from 60 mm/a to 6 mm/a. With the broadening of the flat coastal plain northwards, interflow becomes less significant and over 60% of baseflow is from groundwater in the Lowveld and coastal plain. In the Middleveld it is less than 30%.

W4 Catchment: Recharge is only 10 - 20 mm/a on the drier Lowveld west of the Lebombo range. The highest recharge is on the escarpment of the North-western Highveld, where it reaches 100 - 150 mm/a. Aquifer recharge is over 40 mm/a on the Northern Zululand Coastal Plain, but only 10 - 15 mm/a in the Lowveld. It is 15 - 30 mm/a in the North-eastern and North-western Middlevelds. Groundwater is minimally used and the stress index is below 0.05. Baseflow generation decreases to the east from 125 mm/a on the escarpment to 6 mm/a in the Lowveld. The proportion of groundwater baseflow increases from 10% to 70% towards the east.

W5 Catchment: Recharge in the South African portion of the catchment ranges from 50 - 100 mm/a increasing eastward. Aquifer recharge is only 15 - 30 mm/a. Due to hilly nature of the catchment, much of the recharge is lost as interflow. Groundwater is minimally used and the stress index is below 0.2. Baseflow generation increases to the east from 20 mm/a on the Highveld to 100 mm/a at the border in the Middleveld escarpment to 6 mm/a in the Lowveld. Groundwater baseflow is 10 - 30% of total baseflow.

W7 Catchment: Recharge to Q70A is 133 mm/a. Aquifer recharge is 132 mm/a. Due to the flat sandy nature of the catchment, interflow does not occur and all recharge percolates to the regional aquifer as aquifer recharge. Groundwater is minimally used and the stress index is below 0.05. Baseflow in the catchment is 25 mm/a. The majority of baseflow is not to rivers, but as through flow to coastal lakes where they cut into the Uloa Formation. 97% of baseflow is from groundwater baseflow.

2.1.3 Economics

The economic analysis consists of the status quo of the current economic activities that is directly and indirectly water dependant. The water users in the primary sector that is directly dependant involves irrigation agriculture and commercial forestry. They are divided into the main crops and tree species that are produced in the Usutu to Mhlathuze Catchment. Sugar cane irrigation and gum trees are the prominent water users that initiate secondary and tertiary sector economic activities. These water users produce different products that keep the sugar and sawmills operational. Several ecotourism facilities are also operating in the Study Area. They are not necessary water large water users, but if water sources in the catchment are reduced, it can affect production.

The description of the economic activities is provided below according to secondary catchment:

- **W1 Catchment:** It is a busy economic catchment. Land use comprises of irrigated sugar cane, citrus, vegetables and commercial forests. Industries include a paper mill, sugar mill, shipping and port activities in Richards Bay and Empangeni.
- **W2 Catchment:** This sub-catchment consists of various economic activities. Cultivation of irrigated maize, vegetables and sugar cane occurs in the area. Thirty percent of the total commercial forestry takes place here as well as saw- and sugar mill activities at Mtubatuba. Ecotourism is at St Lucia Lake and the iMfolozi and Hluhluwe Game Reserves. In December 1999, the iSimangaliso Wetland Park was declared a UNESCO World Heritage Site. The park covers areas in both W2 and W3 secondary catchments.
- **W3 Catchment:** Cultivation in this sub-catchment consists of Queen pineapples, winter vegetables, sugar cane and commercial forestry. Ecotourism features the uMkuze Game Reserve.
- **W4 Catchment:** Consists of the largest sugar cane irrigation land use in the total catchments and includes a sugar mill situated at Pongola town.
- **W5 Catchment:** Mostly irrigated maize and winter vegetables are produced in the catchment. Close to 40% of commercial forestry of the total catchment is produced in W5. Production of paper products takes place at a paper mill in Piet Retief.
- **W7 Catchment:** Economic activities are limited to a small share of commercial forestry production compared to the rest of the catchment. The area is rather renowned for its ecotourism activities with the main attractions at the Kosi Estuary and Lake Sibaya.

2.1.4 Water Quality

The study catchments are still largely rural, with the impacts of coal mining (present and past) and mine decant still present in certain areas. Water quality issues appear to be localised due to problems such as non-compliant Waste Water Treatment Works (WWTW), failing sewage infrastructure and industrial complexes, although non-point sources of pollution such as increasing salinity levels are widespread and difficult to manage.

The drivers of water quality state in aquatic systems in the study area are largely the following:

- Coal mining operations and associated consequences, particularly in the northern and north-western region and particularly where the mines have been closed (DWS, 2020). The Richards Bay Coal Terminal is the centre of operations for SA's aluminium industry, making SA the second-largest exporter of steam coal in the world (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- The growth of the Richards Bay urban/industrial complex; both in terms of water demand and waste discharge (DWS, 2020).
- Irrigation return-flows and rising salinity levels. The sugarcane plantations along the coastal belt are critical to the Gross Domestic Product (GDP) of the area, together with the sub-tropical fruit grown in the area. Farmers inland concentrate on vegetable, dairy and stock farming (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- Areas of poor land management have resulted in high sedimentation levels in river systems.
- Extensive forestry in the areas around Vryheid, Eshowe, Richmond, Harding and Ngome (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- Cholera and other diseases have been reported in some rural areas due to poor sanitation and using run-of-river for domestic use (DWS, 2020).
- Most of the municipal WWTW are only partially functional and therefore contribute to some form of pollution within the river catchments. Some of the challenges observed include, but are not limited to, the following (K Naidoo, DWS KZN, *pers. comm*.):
  - Burst pipes/manhole overflows.
  - Pump station failure.
  - Non-functional components of the WWTW.
  - Inadequate disinfection leading to discharge of poor-quality effluent.
  - Nutrient enrichment downstream of WWTW discharges and irrigation schemes. Toxic algal blooms and game fatalities have been reported in the upper reaches of Pongolapoort Dam. Filamentous algal growth has been seen in the Assegaai River downstream of Piet Retief, and algal blooms in the Klipfontein Dam near Vryheid on the upper Umfolozi River (DWS, 2020).

The identification of water quality priority areas (shown as tables per secondary catchment) are based on a water quality impact rating (0 - 5) assigned to priority areas, i.e. from 3 (Large) to Critical (5). Estuaries with a High or Very High Pollution Pressure status have been included in water quality priority tables.

2.1.5 Ecosystem Services

The Usutu-Mhlathuze Water Management Area, because of the nature of the communities that it intersects, plays an important role in maintaining important Ecological Goods, Services and Attributes (EGSA) on-site as well as other users. An EGSA is a product that emerges from processes or features within largely natural environments, which enhances human wellbeing and is directly used by people. In terms of generating data for this report the most important step was to provide an integrated assessment of the current population of all three areas. Analysis was undertaken using primary tools. These were:

- Geographic Information System (GIS) overlays of quaternary catchments
- Cross check of GIS data with available mapping to determine livelihood profiles.

In terms of EGSA the most critical aspects per Catchment are the following:

- The Mhlathuze Catchment includes a diverse set of settlement types as well as land and economic uses. In terms of provisioning aspects of the ecosystem services the rivers and their

associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust.

- As with the Mhlathuze, the Mfolozi Catchment includes a diverse set of settlement types as well as land and economic uses. The Hluhluwe iMfolozi Game Park is of considerable importance as a nature reserve. The river and its integrity are crucial to the functioning of the Park. In terms of provisioning aspects of the ecosystem services the rivers and their associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust. The Ulundi areas are of interest in this regard, The area is associated with the central Zulu Kingdom and the ritual and historical aspects are also of importance.
- The Mkuze area is made up of subsistence farming (Ingonyama Trust) commercial farming, extensive game and nature reserves including state or private concerns. Again, in terms of provisioning aspects of the ecosystem services the rivers and their associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust. The DukuDuku area is prominent with respect to the importance of provisioning services. The northern Zulu Kingdom historical aspects are of importance.
- The Pongola Catchment includes a mixture of land use and types of economic activity. Downstream of Jozini Dam the area is given over to Tribal Trust land that includes the Makhathini Flats. People in this area are closely reliant on provisioning services provided by the river and its floodplains.
- The Usutu area includes a series of catchments west of eSwatini. The Assegai River and tributaries upstream of Driefontein are mostly given over to commercial farming. The Usutu as it exits Swaziland is mostly Ngonyama Trust and the Ndumo Game Reserve and this is important in terms of EGSA considerations.
- The W7 catchment (Kosi Bay and Sibaya Lake) includes systems that feed into Kosi Bay as well as Lake Sibaya. The water bodies function as key providers of provisioning services for subsistence communities.

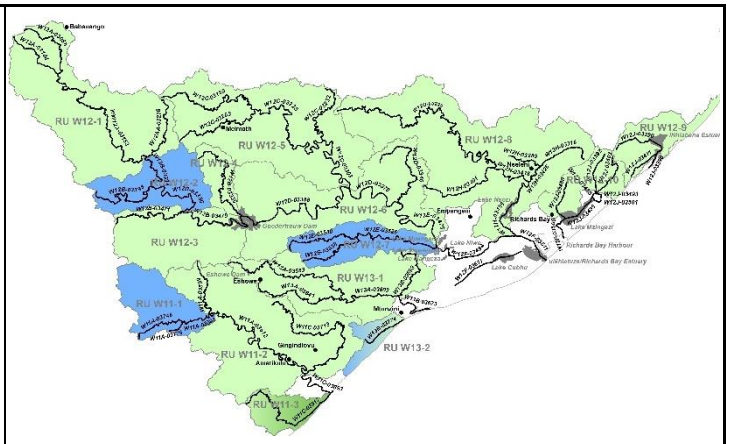
2.1.6 Ecological River State

Determination of the Present Ecological State (PES), which represents the ecological status quo of the rivers, is undertaken as part of the EcoClassification process. Data from a countrywide desktop assessment, referred to as the PES/EI/ES or PESEIS project, was used as the baseline for the status quo assessment. The status quo assessment consists of a table and short summary for each tertiary catchment. The PES is provided as an integrated state, the EcoStatus. Different processes are followed for each component to assign an Ecological Category (EC) from A to F (where A is natural, and F is critically modified). Colours in the figures are as follows: A (light blue), B (dark blue), C (light green), D (dark green), E (yellow), F (red). Half categories indicate shades of the relevant category for example; B/C EC would be dark blue and light green.

Table 2-2: Ecological status quo of rivers

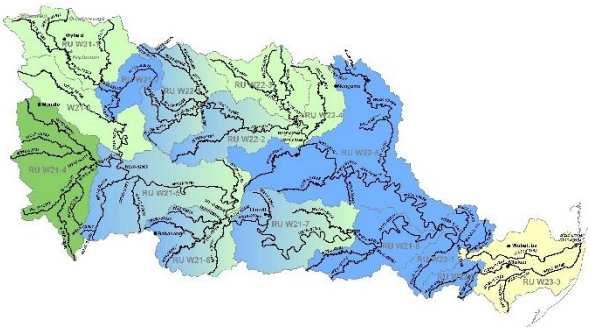
Status Quo Description	RU PES ECs
W1 Catchment (Main River: Mhlathuze)	
▪ W11: Mostly non-flow related activities – extensive agriculture, vegetation clearing, alien vegetation. Mostly in a C (moderately modified) condition. ▪ W12: Upstream of Goedertrouw Dam – roads, extensive overgrazing, sand mining, alien vegetation, forestry, small dams. – mostly in C condition.	

- W12: Downstream of Goedertrouw Dam. Mostly in C EC. Tributaries dominated by rural settlements, forestry, dry land cultivation, dams and towns. The Mhlathuze River has changed in character (alluvial to a rapid pool system) and is canalised and highly modified in lower sections.
- W13: Mlalazi River – parts associated with Umlalazi Nature Reserve and in a B/C EC.



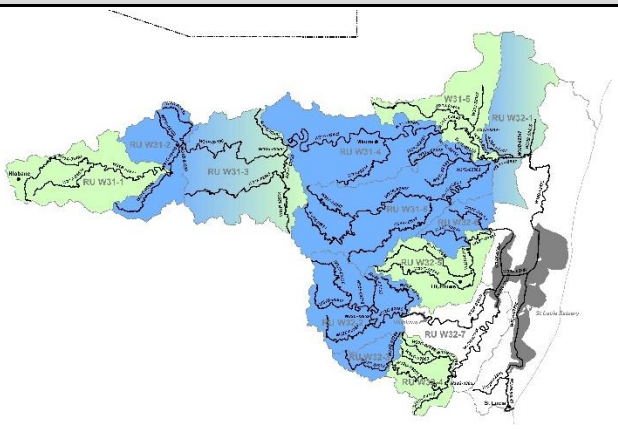
W2 Catchment (Main River Umfolozi)

- W21 & 22 White & Black Umfolozi and tributaries outside the Hluhluwe iMfolozi Game Reserve - forestry, dams, irrigation, erosion, sedimentation, coal mining around Vryheid. Mostly in a C EC.
- W21 & 22 White & Black Umfolozi and tributaries bordering or in Hluhluwe iMfolozi Game Reserve mostly in a B EC.
- W23 Umfolozi in and downstream of the Hluhluwe iMfolozi Game Reserve in a B EC. Further downstream it falls to an E EC due to extensive forestry, irrigated sugar cane and canalisation.



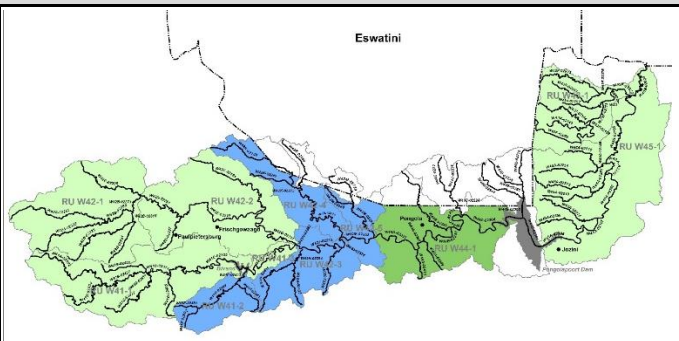
W3 Catchment (Main River Mkuze)

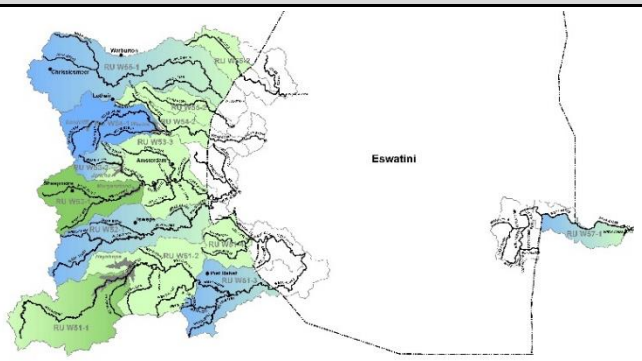
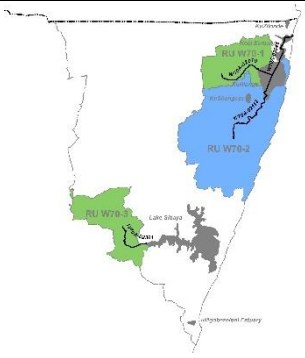
- W31 (Mkuze River) varies from C to B. Impacts are forestry, coal mining, dams, rural areas, irrigated crops, alien vegetation, instream dams, erosion and sedimentation. B section in or bordering uMkuze Game Reserve.
- W32 (Hluhluwe River) B in or bordering Hluhluwe iMfolozi Game Reserve. Tributaries in a C EC (overgrazing, sand mining, subsistence farming, erosion, sugarcane, urban, dams and levees).



W4 Catchment (Main River Pongola)

- W41 (Bivane River) in a C EC. Upstream from Bivane Dam – forestry, agriculture.
- W42 (Pongola River and tributaries) varies from a C and B (Ithala Game Reserve) EC. Impacts are extensive forestry, agriculture, dams, urban areas, alien vegetation, overgrazing, erosion, sand mining.
- W44 (Pongola River) D EC. Impala Irrigation Board canal system, Grootdraai Weir, extensive flow changes, sugar cane farming.
- W45 (Pongola River, Floodplain and Tributaries downstream of Pongola Dam) C EC. Significant changes in flow regime.
- W43 (Ngavuma River) in C EC – subsistence farming, overgrazing, forestry, sedimentation, alteration of drainage lines.



W5 Catchment (Main River Usutu)	
▪ W51 (Assegaai River). Upstream of Heyshope Dam in C/D EC – forestry, irrigation. Downstream of dam in largely in C EC due to flow changes. ▪ W52 (Hlelo River) B/C EC. Forestry, dams, mining, overgrazing. ▪ W53 (Ngwempisi River) largely D and C EC. Instream dams, extensive forestry, alien vegetation, wetland draining, flow changes. ▪ W54 (Usutu River). B EC upstream of Westoe Dam, C EC downstream of dam (flow regime changes, forestry, urban areas). ▪ W55 (Mpuluzi & Lusushwana Rivers). Forestry, dams, sedimentation, erosion. ▪ W57 (lower Usutu River) B/C EC. Borders Ndumo Game Reserve.	
W7 Catchment (Kosi and Sibaya Lakes)	
▪ River feeding into Sibaya is in a D EC (water quality issues from townships). ▪ Rivers feeding into Kos in a B EC (within iSimangaliso Wetland Park) and a C EC (urban areas, forestry, WWTW).	

2.1.7 Wetlands

According to the latest national wetland map (National biodiversity assessment; van Deventer *et al.*, 2018) there are almost 371 603 Ha of wetlands (excluding estuaries) in the study. This includes five RAMSAR sites, the St Lucia System, Lake Sibaya, Kosi Bay, Ndumo Game Reserve and the Turtle Beaches / Coral Reefs of Tongaland. A detailed breakdown of wetland distribution and extent within each of the secondary catchments is shown in the table below. The Pongola (W4) secondary catchment is the highest representing 30% of wetland hectarage, and the Mhlathuze (W1) and Mkuze (W3) the lowest. The study area is also diverse in terms of wetland types and while riverine wetlands dominate with 104038 Ha (excluding estuaries), all other HGMs are well represented.

Table 2-3: HGM wetland area (Ha) within each secondary catchment excluding estuaries (analysis from NWM5, 2018 data)

Secondary Catchment	Main River	Channeled Valley Bottom	Unchanneled Valley Bottom	Depression	Floodplain	Riverine	Seep	Total (Ha)	Total (%) of Wetlands in the Study Area
W1	Mhlathuze	851	3078	949	6705	3882	4490	19953	5
W2	Umfolozi	1399	1764	672	3897	32299	26072	66103	18
W3	Mkuze	706	2722	9484	11844	3501	4689	32947	9
W4	Pongola	20759	3842	433	17660	61752	8626	113072	30
W5	Usutu	33081	3404	11266	12934	2605	16814	80104	22

W7	Sibaya and Kosi	184	2878	33191	21991		1181	59425	16
Total		**56980**	**17688**	**55995**	**75030**	**104038**	**61873**	**371603**	**100**

An estimation of wetland condition and the ecological condition of inland wetlands modelled from ancillary data (using mainly land use within variously defined buffer zones around wetlands) is shown in the figure below using the updated 2018 metadata (van Deventer *et al.*, 2018), where the dominant condition (A/B, C or D/E/F) is indicated. The majority of the wetlands within the study area have a condition status of D/E/F.

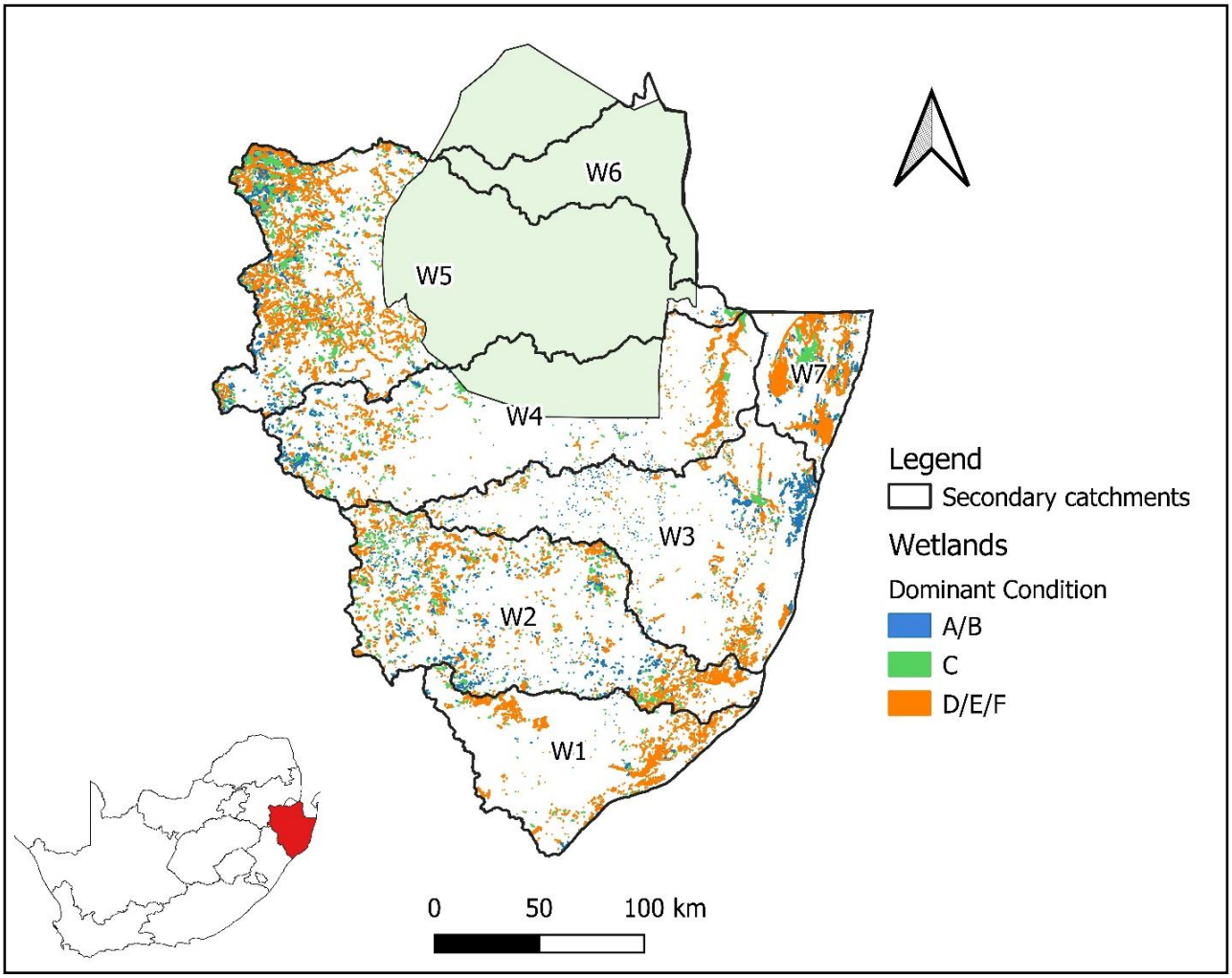


Figure 2-1: Dominant wetland condition within the study area (2018 updated wetland map 5; van Deventer *et al.*, 2018)

2.1.8 Ecological Estuary State

Nine estuaries occur in the study areas, with the uMhlathuze estuarine lake system subdivided to create an estuarine bay (Richards Bay) and a Predominantly open system (uMhlathuze Sanctuary) to accommodate a port development in the 1970s. Most of the systems in the study area are in a degraded state (D to E Category), under high to very high pollution, habitat loss and fishing pressure (see table below). Most estuaries are not under high flow modification pressure with the exception of iSiyaya and Richards Bay. Only four estuaries are in a near-natural state (A/B to B Category), namely aMatigulu/iNyoni, uMlalazi, uMgobezeleni and Kosi.

Table 2-4: The condition and degree of pressure on estuaries in study area

	Estuary Name	PES	Pressure							
			Cumulative	Flow	Pollution	Habitat loss	Fishing Effort	Invasive alien plants	Alien Fish	Artificial Breaching
W11	aMatigulu/ iNyoni	B	L	L	L	L	H		N	Y
W13	iSiyaya	E	VH	VH	VH	VH	M		N	
W13	uMlalazi	B	L	M	L	M	H	M	H	Y
W12	uMhlathuze	D	H	L	VH	VH	VH		H	
W12	Richards Bay	D/E	H	H	H	VH	VH		N	
W12	iNhlabane	E	VH	M	H	VH	H		N	Y
W2	iMfolozi /uMsunduze	D	H	L	VH	VH	VH	H	N	Y
W3	St Lucia	D/E	H	L	M	M	VH	M	N	Y
W7	uMgobezeleni	B	L	L	L	L	H		N	Y
W7	Kosi	A/B	L	L	L	L	VH	L	N	

*VH=Very high, H=High, M=Medium, L=Low, Y=Yes, N=No

2.2 IUA AND RU DELINEATION

Integrated Units of Analysis (IUAs) are ***homogenous catchments*** or linear river reaches that can be managed as an entity. SQRs are nested within RUs which are nested within an IUA which represents a larger catchment and can include various rivers. Water resource use, economics, ecosystem services and ecological status information has been collated and all this information is used to identify catchments that are similar in terms of these specific components. The IUAs delineated as part of this study are included in Figures A2 - A7 of **Appendix A**.

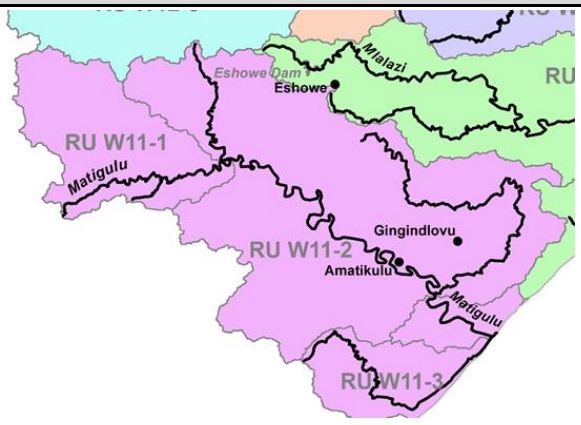
Resource Units (RUs) are the delineation of a river used for an Ecological Water Requirement (EWR) determination and for the setting of Resource Quality Objectives (RQOs). The RUs represent homogenous sections of a river/s. The starting point for RU delineation is the SQR (Sub-Quaternary Reach - which represents a single stretch of river defined by inflows of tributaries). The status of each SQR is known, as well as land cover, and water resource management and operation. SQRs are therefore nested within RUs and using the available information, were grouped into RUs. The table below provides the IUAs per secondary catchment.

Table 2-5: Integrated Unit of Analysis per secondary catchment

Secondary Catchment	IUA No	IUA Descriptive Name	RU (& SQRs where relevant)
W1	W11	Matigulu	W11-1, W11-2, W11-3, SQR W11C-03893, Estuary
	W12-a	Upper Mhlathuze	W12-1, W12-2 W12-3, W12-4
	W12-b	Mfule, Mhlatuzane, Nseleni Tributary systems	W12-5, W12-7, W12-8
	W12-c	Lower Mhlathuze	W12-6, W12F-03494, W12F-03511, W12F-03611 (Lake Cubhu) Mhlathuze Estuary
	W12-d	Lake Nhlabane	W12-9, W12J-03390, Lake Nhlabane and Estuary

Secondary Catchment	IUA No	IUA Descriptive Name	RU (& SQRs where relevant)
	W12-e	Lake Msingazi	W12-10, W12J-03501, W12J-03493, W12J-03485,W12F-03509, (Lake Msingazi and Mhlathuze Estuary connection)
	W13	Mlalazi	W13-1, W13-2, SQR W13B-03673, Estuary
W2	W21	Upper and Middle White Umfolozi	W21-1, W21-2, W21-3, W21-4, W21-5, W21-6, W21-7
	W22	Upper Black Umfolozi	W22-1, W22-2, W22-3, W22-4
	W23	Umfolozi Hluhluwe Game Reserve	Nyalazi and Mzinene Tributaries
W3	W31-a	Upper Mkuze	W31-1, W31-2, W31-2
	W31-b	Lower Mkuze	W31-4, W31-5, W31-6, W32-1
	W32-a	Upper Hluhluwe	W32-2
	W32-b	Nyalazi and Mzinene Tributaries	W32-3, W32-4, W32-5, W32-6
W4	W41	Bivane River	W41-1, W41-2
	W42-a	Upper Pongola	W42-1, W42-2
	W42-b	Middle Pongola (Ithala)	W41-3, W42-3, W42-4, W42-5
	W44	Middle Pongola (Grootdraai)	W44-1
	W45	Lower Pongola (Floodplain)	W43-1, R45-1
W5	W51	W5 Upstream major dams	W51-1, W53-1, W53-2, W54-1
	W52	W5 Downstream major dams & Hlelo River	W51-2, W51-3, W51-4, W52-1, W53-3, W54-2
	W55	Mpuluzi & Lusushwana River systems	W55-1, W55-2
	W57	Lower Usutu River	W57-1
W7	W70-a	Kosi Bay	W70-1, W70-2
	W70-b	Sibaya	W70-3
W2 & W3	IUA St Lucia	St Lucia	W23-3, W32H-02998, W32H-03048, W32H-02854, W32F-02835, W32B-02535

Table 2-6: Status quo of each IUA

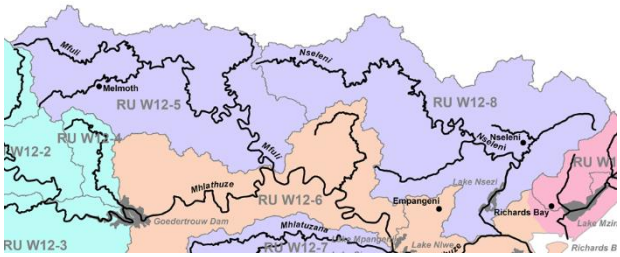
IUA Status Quo	IUA map
W1 Catchment (Main River: Mhlathuze)	
IUA W11 Matigulu ▪ Farm dams and river runoff. No major dams. ▪ Groundwater Stress index: < 0.05. ▪ Large area of subsistence agriculture. ▪ Low water quality impact. ▪ Tribal Trust land and Entumeni Nature Reserve. ▪ River PES largely C and C/D EC. Roads, extensive agriculture, vegetation clearing, alien vegetation, small dams. ▪ Most wetlands in a D to F condition. ▪ Matigulu estuary in a B.	

IUA W12-a Upper Mhlathuze

- Farm dams and river runoff. Transfers from Thukela catchment.
- Groundwater Stress index: < 0.05.
- Subsistence agriculture & forestry.
- Low water quality impacts.
- Heart of Shaka and Zulu Kingdom.
- River PES largely C EC. Roads, extensive agriculture, sand mining, alien vegetation, forestry.
- Most wetlands in a C condition.

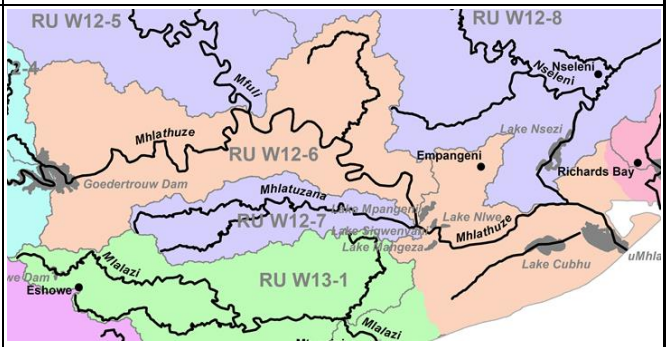
IUA W12-b Mfule, Mhlatuzane, Nseleni Tributaries

- Farm dams and river runoff. Lake Nsezi supplying Mhlathuze Water.
- Groundwater Stress index: < 0.05.
- Tribal subsistence farming.
- High water quality impact (WWTW discharges and mining).
- Lower section is Melmoth area and Ingonyama Trust.
- River PES largely C and B EC. Rural settlements, forestry, dams in tributaries, alien vegetation, dams & WWTW.
- Most wetlands in a D-F condition. Notable wetland is Nsezi.



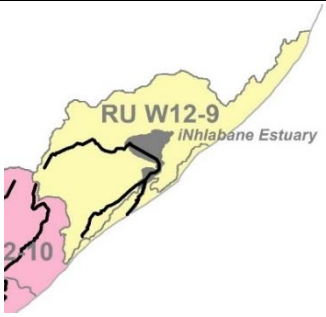
IUA W12-c Lower Mhlathuze

- Releases from Goedtrouw Dam, Lake Cubhu supplying Eikhaweni.
- Groundwater Stress index :< 0.05.
- Extensive irrigated sugar cane, fruit and vegetable production, forestry, industrial (paper mill, Richards Bay Port.).
- Water quality impacts (high sedimentation, turbidity, settlements, and industrial impacts).
- Nkwaleni valley (commercial farms and land reform) and Ingonyama Trust.
- River PES highly modified due to Goedertrouw releases, extensive irrigated cultivation, alien vegetation, sand mining – lower section canalised.
- Most wetlands in a D-F condition. Notable wetlands are Mhlatuze swamp system and floodplain, Cubhu, Thulazihleka.
- Estuary in a D/E EC (cumulative pressure, port development, habitat destruction, pollution, overfishing.



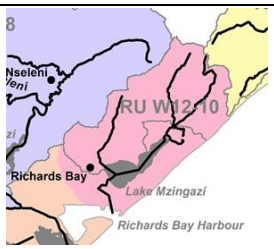
IUA W12-d Nhlabane

- Lake Nhlabae supplying Richard Bay Minerals.
- Groundwater Stress index: < 0.05
- Minor tourism activity.
- Moderate water quality impacts.
- Highly contested area and heavily populated.
- River PES largely C due to extensive forestry.
- Most wetlands in a D-F condition. Notable wetland is Mzingazi.
- Estuary in an E EC (cumulative pressure, weir cutting off lake, mining, habitat destruction, pollution, overfishing.



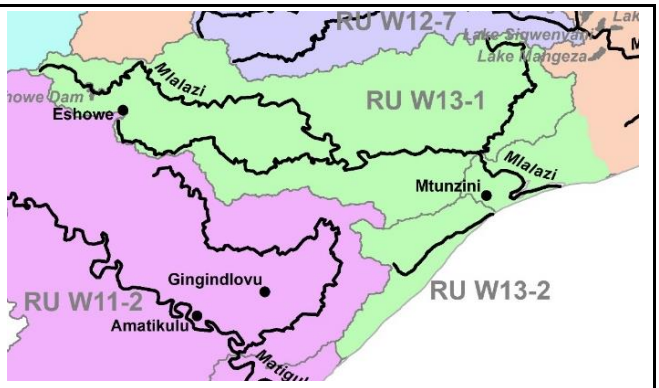
IUA W12-e Msingazi

- Lake Mzingazi supplying Richard Bay.
- Groundwater Stress index: < 0.05.
- Minor tourism activity.
- Water quality impacts from RBM smelter impacts.
- Highly contested area and heavily populated.
- River PES largely C (extensive forestry, storm water runoff, RMB smelter, urban areas).



IUA W13 Mlalazi

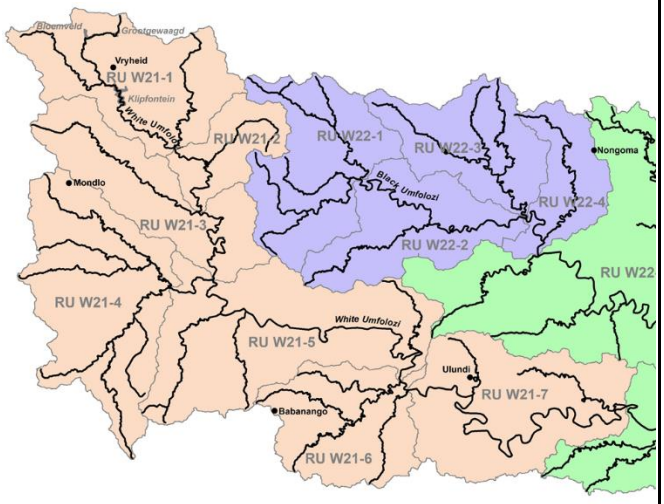
- Farm dams and river runoff. Eshowe and Rutledge Dam provide water to Eshowe town.
- Groundwater Stress index: < 0.05.
- Emerging and subsistence agriculture.
- Moderate water quality impacts.
- Ingonyama Trust.
- River PES largely C due to extensive formal agriculture, WWTW, dams, subsistence agriculture.
- Most wetlands in a D-F condition. Notable wetland is Mlalazi.
- Mlalazi Estuary in a B EC. In Umlalazi Nature Reserve.
- Siyaya Estuary in an E EC. High cumulative pressure, flow modification, pollution, habitat destruction.



W2 Catchment (Main River Umfolozi)

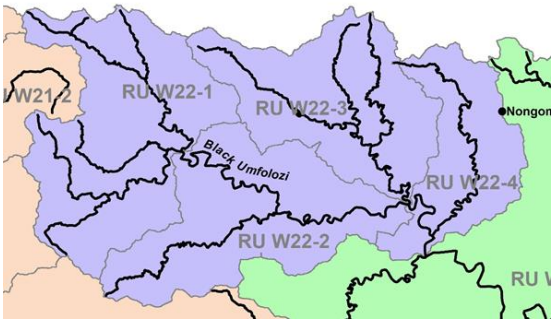
IUA W21 Upper and Middle White Umfolozi

- Klipfontein Dam and smaller dams supplying Vryheid and Ulundi.
- Groundwater Stress index :< 0.01-0.11.
- Commercial and subsistence farming. Forestry Hluhluwe iMfolozi Game Reserve.
- High water quality impact, nine priority areas, impacts from coal mine pollution, dysfunctional WWTW, urban impacts, gully erosion and sedimentation.
- South western portion Ingonyama Trust. Rural settlements.
- River PES largely C (Upper White Umfolozi – forestry, dams, agriculture, rural developments, irrigation, erosion, sedimentation, mine dumps). Nondweni largely in a D (overgrazing erosion, sedimentation, urban areas, WWTW). Middle Umfolozi in a B/C and B within the Hluhluwe iMfolozi Game Reserve.
- Most wetlands in a D to F condition. Notable wetlands: Stilwater Vlei, Blomveld Vlei, Lenjani Vlei, Grootgewaagd Vlei.



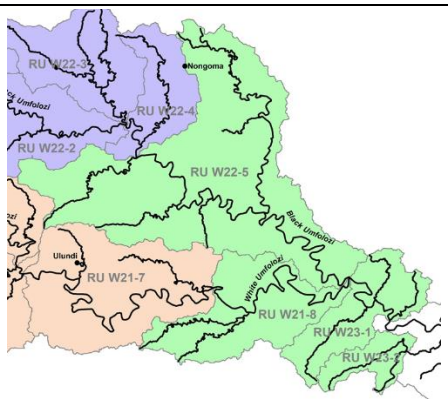
IUA W22 Upper Black Umfolozi

- Vuna and Vokwena Dams supplying Nongoma
- Groundwater Stress index: < 0.01-0.12.
- Subsistence farming. Forestry.
- Moderate water quality impacts.Acid mine drainage impacts.
- Scattered rural homesteads, land claim farms, closer rural settlements and dense settlement proximate to Nongoma.
- River PES upstream of Hluhluwe iMfolozi Game Reserve in a B/C and a B within or bordering the Park.
- Most wetlands in a D to F condition. Notable wetland: Aloeboom Vlei.



IUA W23 Upper Umfolozi

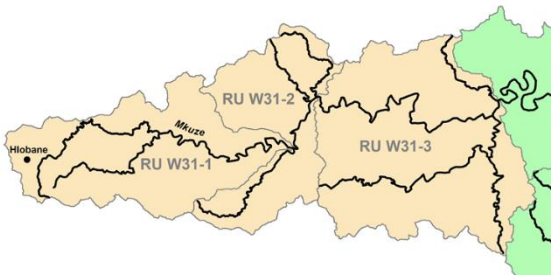
- Farm dams and river runoff
- Groundwater Stress index: < 0.05.
- Coal mining, sugar cane, saw mill, tourism, forestry.
- High water quality impacts. Mining operations, dysfunctional WWTW, irrigation return flows.
- River PES a B EC within or bordering the Park.
- Most wetlands in a D to F condition. Notable wetlands: Fuyeni Reedbed, Mvamazi Pan, Umfolozi riverine floodplain.



W3 Catchment (Main River Mkuze)

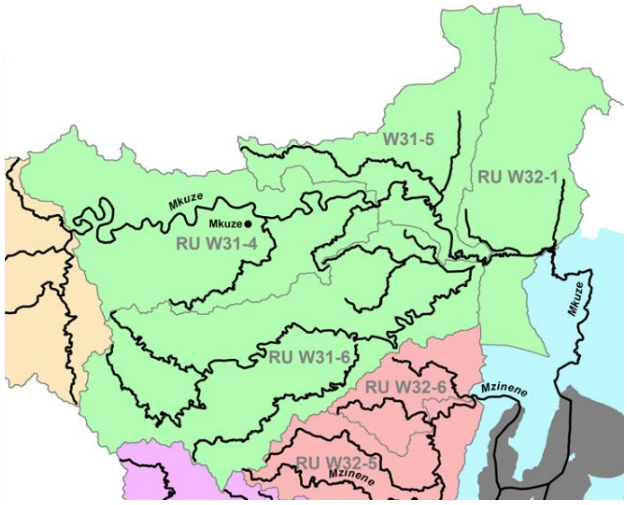
IUA W31-a Upper Mkuze

- Vaalbank Dam, Boulder Dam and smaller dams.
- Groundwater Stress index: < 0.05.
- Subsistence agriculture
- Low to moderate water quality impacts. Impacts from the Mfolozi into upper Mkhuze (mine-water decant).
- Ingonyama Trust.
- River PES ranges from C to B EC. Forestry, coal mining, instream dams, rural areas, irrigated crops, alien vegetation, erosion, sedimentation.
- Most wetlands in a D to F condition.



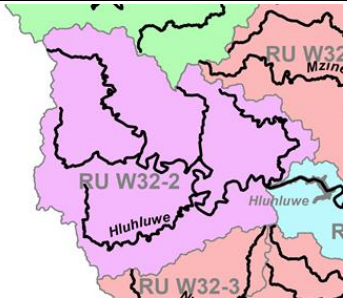
IUA W31-b Lower Mkuze

- Blackie Dam receives water from Pongolapoort Dam for irrigation and communities.
- Groundwater Stress index: < 0.05.
- Irrigated sugar cane, vegetable, cotton, citrus, maize and some tourism.
- Variable water quality impacts with one dysfunctional WWTW.
- Ingonyama Trust. Closer settlements bordering private farms and game parks.
- River PES ranges from C (outside Mkhuze Game Park – town, irrigation, subsistence farming, erosion, canals to B EC (Mkhuze Game Park).
- Most wetlands in an A to B condition. Notable wetlands: Nhlonhlela Pan, Hlonhlela, Mkuze Gr Airstrip Pans, Nsumu Pan, Muzi (South), Neshe, Yengweni, St Lucia – Manzibomvu, Mdlaze Pan, Mpanze Pan, Tshanetshe



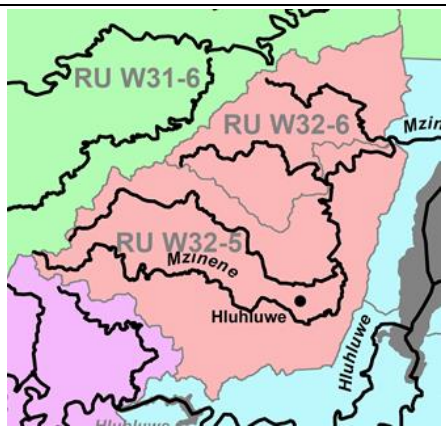
IUA W32-a Upper Hluhluwe

- Hluhluwe Dam at outlet.
- Groundwater Stress index: < 0.05.
- Tourism.
- Low water quality impacts.
- Denser rural settlement in vicinity of Sangonya.
- River PES ranges largely in a B EC (Hluhluwe iMfolozi Game Reserve).
- Most wetlands in a D to F condition. Notable wetland: Enseleni.



IUA W32-b Nyalazi and Mzinene

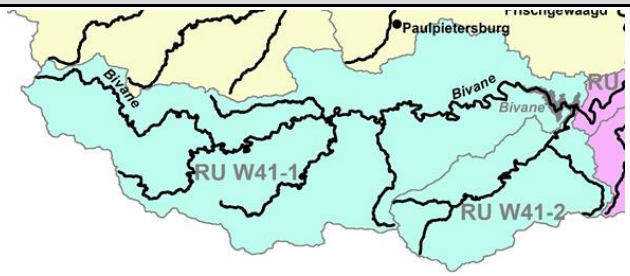
- Farm dams and river runoff.
- Groundwater Stress index: < 0.01-0.11
- Large commercial farming
- Low water quality impacts with one dysfunctional WWTW.
- Southern portion: Denser rural settlement in vicinity of KwaSithole and Ensolweni and dense rural and closer settlement, virtually all within the Ingonyama areas, Shikishela. Northern portion includes Ingonyama Trust.
- River PES largely C EC. Sand mining, overgrazing, subsistence farming, erosion, sugarcane, urban, instream dams and levees.
- Notable wetland: Hluhluwe Floodplain.



W4 Catchment (Main River Pongola)

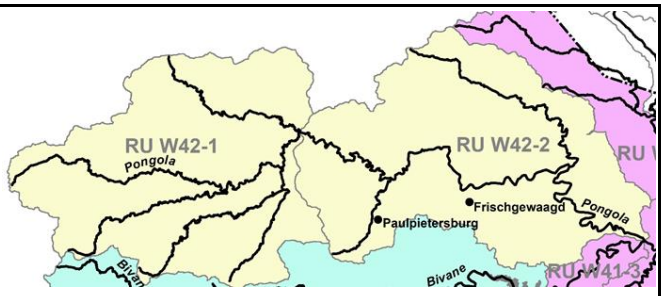
IUA W41 Bivane

- Bivane Dam at outlet (releases for commercial irrigation).
- Groundwater Stress index :< 0.05.
- Forestry, commercial and subsistence farming.
- Low water quality impacts.
- Ingonyama Trust.
- River PES C EC. Forestry, agriculture.
- Most wetlands in a D to F condition.



IUA W42-a Upper Pongola

- Edumbe Dam (Paul Pietersburg). River abstraction for Frischgewaagd communities.
- Groundwater Stress index: < 0.05.
- Forestry.
- Moderate water quality impacts.
- Some tribal trustland associated with Ntombe tributary. Downstream of Frischgewaard is tribal trustland.
- River PES largely C EC. Forestry, agriculture, Paul Pietersburg water quality issues.
- Most wetlands in a D to F condition. Also large portion in A to B condition.

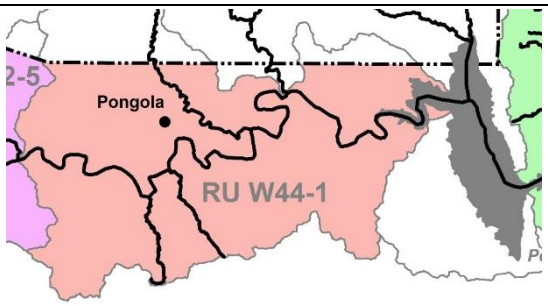


IUA W42-b Middle Pongola (Ithala)

- Smaller tributaries supply Sidlangentsha Central communities.
- Groundwater Stress index: < 0.05.
- Sugar cane, maize and summer vegetable production.
- Low water quality impacts.
- Mostly Ingonyama Trust and Tribal Trust areas. Dense settlement in lower part of catchment.
- River PES in C EC (tributaries with instream dams, forestry, agriculture, alien vegetation, overgrazing, sand mining). Pongola and Mozana River in a B EC (borders and within Ithala Game Reserve).
- Most wetlands in a C condition.

IUA W44 Middle Pongola

- Canal diversion for irrigation, Pongola Town and communities. Pongolapoort Dam situated at outlet.
- Groundwater Stress index: < 0.05.
- Sugar cane and some maize.
- High water quality impacts (extensive irrigated agriculture, dysfunctional WWTW and urban impacts).
- River PES D EC. Impacts associated with Impala Irrigation Board canal system and Grootdraai Weir – extensive flow regulation.



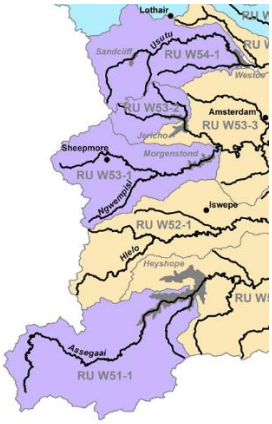
IUA W42-a Lower Pongola (Floodplain)

- Releases from Pongalapoort Dam to supply downstream communities and new Shemula WWTW.
- Groundwater Stress index: < 0.05.
- Irrigated and dryland cotton production.
- Moderate to high water quality impacts. Dysfunctional WWTWs, extensive irrigated agriculture and dense settlements.
- Tribal trust areas.
- River PES largely C EC. Changes in flow regime, subsistence agriculture, forestry, sedimentation. Short section bordering Ndumo Game Reserve.
- Most wetlands in a D to F condition. Notable wetlands: Mtoti Pan, Pongolo Floodplain, Msenyeni Pan, Balamhlanga, Mandlankunzi Pan, Ndumo Game Reserve, Bumbe Pan, Khanganzeni Pan, Nhlole Pan, Shalala Pans, Tete Pan

W5 Catchment (Main River Usutu)

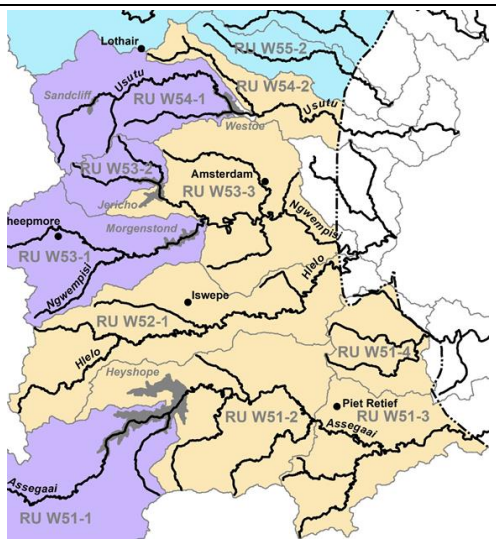
IUA W51 W5 upstream major dams

- Major Dams (Westoe, Jericho, Morgenstond, Heyshope). Transfers from these dams to Vaal and Olifants power stations.
- Groundwater Stress index 0 - 0.13.
- Maize and winter vegetables, commercial forestry.
- Low water quality impacts.
- Some denser settlements.
- River PES ranges from C to D EC (forestry, alien vegetation, agriculture).
- Most wetlands in a D - F condition. Notable wetlands: Langfontein Pan 3, Liefgekozen.



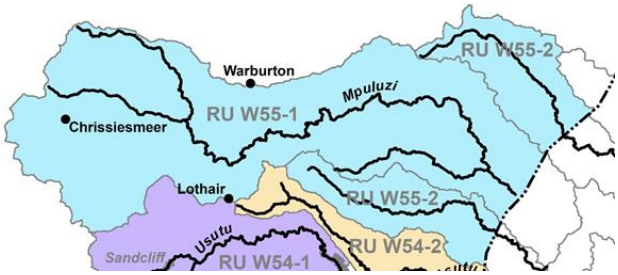
IUA W52 W5 downstream major dams & Hlelo

- Farm dams and river runoff
- Groundwater Stress index :< 0.05.
- Maize and winter vegetables, commercial forestry.
- Variable water quality state. Dysfunctional WWTW and urban impacts from Piet Retief and surrounds.
- Some scattered rural tribal trust areas in upper areas.
- River PES largely C (upstream dams and flow changes, forestry, alien vegetation, agriculture, mining).
- Most wetlands in a D - F condition.



IUA W55 Mpuluzi & Lusushwana

- Farm dams and river runoff.
- Groundwater Stress index: <0.05.
- Commercial agriculture.
- Moderate water quality impacts. Priority area in lower reaches due to dysfunctional WWTW and extensive settlements.
- Dense tribal trust areas on border of Eswatini.
- River PES in Mpuluzi B/C (small dams, forestry) and in Lusushwana C EC (forestry, dams, subsistence farming.
- Most wetlands in a D - F condition. Many notable wetlands which includes Lake Chrissie.



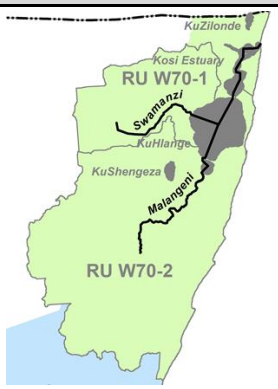
IUA W57 Lower Usutu

- Groundwater Stress index: <0.05.
- Subsistence agriculture.
- Low water quality impacts.
- River PES B/C EC (borders Ndumo Game Reserve).
- Most wetlands in a C condition. Notable wetlands: Shokwe Pan and Banzi Pan in Ndumo.

W7 Catchment (Kosi and Sibaya Lakes)

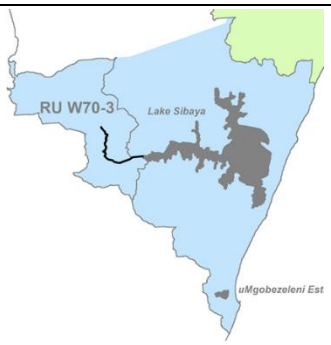
IUA W70-a Kosi

- Small streams and Lake Shengesa supplying surrounding communities.
- Groundwater Stress index: 0 - 0.1.
- Forestry, tourism.
- Moderate water quality impacts (urban impacts and a dysfunctional WWTW).
- Dense rural area.
- River PES B in iSimangaliso Wetland Park and C EC outside (urban areas, WWTW, forestry).
- Most wetlands in a D to F condition. Many notable wetlands including the Kosi Lakes.
- Estuary in A/B PES.



IUA W70-b Sibaya

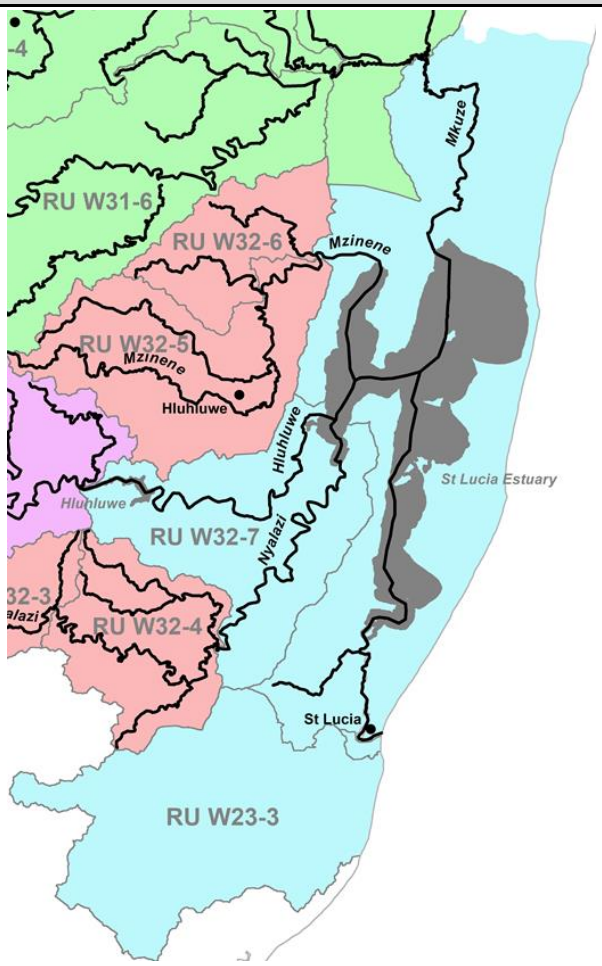
- Lake Sibaya supplying Mseleni and Mbaswane.
- Groundwater Stress index: 0 - 0.1.
- Forestry, tourism.
- Moderate water quality impacts (extensive settlements and elevated nutrients).
- River PES D EC (water quality impacts from township and hospital).
- Most wetlands in a D to F condition. Many notable wetlands including Sibaya Lake.
- uMgobezeleni Estuary in B PES.



W2 & W3

IUA St Lucia

- Transfer from lower Umfolozi to Mhlathuze catchment. Run of river abstraction for Mtubatuba Town and sugar mill.
- Tourism activities.
- River PES for feeder rivers low. Main purpose is to ensure that the management objectives of St Lucia are achieved.
- Notable wetlands: Notable wetlands: Teza, Lake Teza, Umfolozi Swamp, Mavuya Pan, Lake Mfuthululu, Mfuthululu, Collin's Lake, St Lucia – Mbazwana, Mfula Pan, Siphudwini, Mhlazi Pan, St Lucia – Manzibomvu, Mdlaze Pan, Mpanze Pan, Mkuze Floodplain, Mkuze Swamp System, Ntshangwe Lake, Ku Ndlebeni, Tshanetshe.
- Estuary: D to D/E PES. Flow reduction, extensive mouth manipulation, formal & subsistence agriculture, pollution, overfishing, invasive alien vegetation. Lake St Lucia is threatened by rising salinity levels during drought cycles.



3 RESOURCE UNIT DELINEATION AND PRIORITISATION

The purpose of this chapter is to document the results of Task 2: Prioritise Resource Units (RUs) and select study sites. The objective of this task is to identify high priority Resource Units, as these are the areas where more detailed work for the rest of the steps would be the focus.

3.1 WATER RESOURCE USE IMPORTANCE

The importance of a Resource Unit from the perspective of water resource use is determined by assessing the volume of use for the various user sectors (domestic and industrial, irrigation, afforestation). The use is compared relatively between Resource Units, and the Resource Units with high use (irrelevant of sector) score as higher priorities, and those with little to no use score as low priorities. Consideration is also given to future development of water resources if such is planned for a specific area. Furthermore, importance scoring related to water quality is also included with Resource Units with potentially higher water quality problems scoring as higher priorities than those with no water quality problems.

Combining all the water resources use importance scores resulted in the following:

- Five of fifteen RUs in W1 (Mhlathuze) have a WRUI rating of Very High. (Water quality and surface water use).
- Two of sixteen RUs in W2 (Umfolozi) have a WRUI rating of High to Very High. (Water quality, surface water use).
- Nine of thirteen RUs in W3 (Mkuze) have a WRUI rating of High to Very High. (Future development, surface water use and groundwater contribution to baseflow/lakes).
- Five of eleven RUs in W4 (Pongola) have a WRUI rating of High to Very High. (Water quality and groundwater contribution to baseflow/lakes).
- Seven of thirteen RUs in W5 (Usutu) have a WRUI rating of High to Very High. (Surface water use and groundwater contribution to baseflow/lakes).
- All three RUs in W7 (Kosi Bay and Sibaya Lake) have a WRUI rating of Very High. (Groundwater contribution to baseflow/lakes)

3.2 SOCIO-CULTURAL IMPORTANCE

The Socio-cultural Importance (SCI) was generated by scoring each Resource Unit for the following metrics:

- Ritual Use. This was scored between 0 – 5. The question that was asked was “How much ritual use of the river takes place?” Typically, this would be for ceremonial purposes or for spiritual/religious activities. Both intensity and significance of use are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to make use of the river for ritual use and significance relates to the degree to which the river is of critical importance to people.
- Aesthetic Value. This was scored between 0 – 5. The question that was asked was “How important is the aesthetic value to people? Does the river stretch add value to people’s life as an object of natural beauty? Would changing flows detract from this value?”
- Resource Dependence. This was scored between 0 – 5. This refers to the goods and services delivered by the river system and peoples’ dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. It should be noted that commercial or “for financial gain” usage of resources is excluded from consideration in this instance.

- Recreational Use. This was scored between 0 – 5. The question that was asked was "Does the river stretch provide recreational facilities to people and would this be affected by changing flows?"
- Historical/Cultural Value. This was scored between 0 – 5. The question that was asked was "Does the river have a strong cultural or historical value?"

The results are summarised as follows:

- Four of fifteen RUs in W1 (Mhlathuze) have a SCI rating of High. (Recreation and aesthetic value, historical importance of the high dependence on resource associated with poor and vulnerable communities).
- Four of sixteen RUs in W2 (Umfolozi) have a of SCI rating of High. (Recreation and aesthetic value, historical importance of the high dependence on resource associated with poor and vulnerable communities).
- Three of thirteen RUs in W3 (Mkuze) have a of SCI rating of High. (Recreation and aesthetic value, historical importance of the high dependence on resource associated with poor and vulnerable communities).
- Two of eleven RUs in W4 (Pongola) have a SCI rating of High. (Recreation and aesthetic value, historical importance of the high dependence on resource associated with poor and vulnerable communities).
- Two of three RUs in W7 (Kosi Bay and Sibaya Lake) have a SCI rating of High. (Recreation and aesthetic value, historical importance of the high dependence on resource associated with poor and vulnerable communities).

3.3 RIVER ECOLOGICAL IMPORTANCE AND SENSITIVITY

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Resh *et al.*, 1988; Milner, 1994). The Ecological Importance and Sensitivity (EIS) information was used as provided in the 2014 PES/EIS study (DWS, 2014b).

Freshwater Ecosystem Priority Areas (FEPAs) for Sub-quaternary reaches (SQRs) were indicated in the master spreadsheet. The verification of the NFEPAs was essential prior to the NFEPA status being used to influence decision-making within the National Water Resource Classification System (NWRCS). The following filtering process was followed to verify the current NFEPA status:

- All FEPAs were identified from the shapefiles (Nel *et al.*, 2011) as well as correlating it with the data provided in the front end PESEIS models (DWS, 2014).
- If the PES results from the PESEIS project (DWS, 2014 and 2022 update) indicated that the SQR was not in a B or higher PES, it was not further considered as a FEPA (Category B/C was considered to be marginal and hence included within the acceptable limit).
- The presence of the important fish species (that the NFEPA was based on) in the SQR were verified using the information from the PESEIS study (DWS, 2014).

Using the PES/EIS study (DWS, 2014b), and verifying the information with the NFEPA output, the results were as follows:

- Thirteen of fifteen RUs in W1 (Mhlathuze) have an EIS rating of High.
- Fourteen of sixteen RUs in W2 (Umfolozi) have an EIS rating of High.
- Twelve of thirteen RUs in W3 (Mkuze) have an EIS rating of High.

- Eight of eleven RUs in W4 (Pongola) have an EIS rating of High.
- Six of thirteen RUs in W5 (Usutu) have an EIS rating of High.
- One of three RUs in W7 (Kosi Bay and Sibaya Lake) have an EIS rating of High

3.4 RIVER RU PRIORITISATION

The steps used to identify the priority areas (hotspots) were:

- Reviewed desktop EcoClassification which included the determination of the EIS, SCI and PES was used as the basis.
- Determination of the Integrated Environmental Importance (IEI) by integrating the EIS, SCI and the PES.
- Determining the Water Resource Use Importance (WRUI).
- Identification of the areas which were priority hotspots because of high IEI and/or WRUI and require more detailed studies.
- Provide recommendations for the locality of detailed EWR sites.

Integrated Environmental Importance: The Ecological and Socio-Cultural Importance were assessed separately and were then integrated with the PES to determine the Integrated Environmental Importance. The PES forms part of the IEI as rivers (or wetlands) in good condition are scarce, and therefore important in their own right. A river that is in very good condition, but of low EIS, and/or SCI; might still be important from an ecological perspective, as it could be one of a limited number of that type of river that is in good condition.

The High and Very High IEI results were as follows:

- W1: Four RUs in the Matigulu, Mhlathuze and Manzamnyama rivers.
- W2: Ten RUs in the White Umfolozi, Black Umfolozi, Mfolozi and the Msunduzi rivers.
- W3: Eight RUs in the Mkuze, Msunduze, Hluhluwe, Nyalazi and Munywana rivers.
- W4: Four RUs in the Manzana, Pongola and Mozana rivers.
- W5: Four RUs in the Assegaai, Hlelo, Mpuluzi and lower uSutu rivers.
- W7: One RU in the Malangeni River.

RU prioritisation: High Priority RUs (hotspots) are identified by comparing (or overlaying) IEI with WRUI. RU importance for groundwater is addressed as part of the WRUI (**Section 2.6** - **2.7**) and water quality importance is discussed in **Section 2.5**. The results are summarised below:

- The rivers in W1 with a Very High priority importance are the Mhlathuze, Nseleni, Kondweni and those associated with Lake Msingaze. This is due to the high WRUI around current and future water use.
- The rivers in W2 are dominated by a Moderate priority.
- The rivers in W3 are dominated by High and Very High priority mostly associated with the Mkuze River. The High IEI and a Moderate WRUI are the driving force for this evaluation.
- The rivers in W4 are dominated with a High priority with the IEI the driving force. W45-1 is the only RU with a Very High priority and this is due to the WRUI.
- The rivers in W5 have mostly Very High and High priority and it is driven largely by the high WRUI.
- The three rivers in W7 have a Very High and High priority driven by the groundwater WRUI.

3.5 WETLAND ECOLOGICAL IMPORTANCE AND PRIORITISATION

According to the latest national wetland map (National biodiversity assessment; van Deventer *et al.*, 2018) there are almost 1.5 million Ha of wetlands in the study area if estuaries are included in the

analysis and 371 603 Ha if they are excluded. This includes five RAMSAR sites, the St Lucia System, Lake Sibaya, Kosi Bay, Ndumo Game Reserve and the Turtle Beaches / Coral Reefs of Tongaland. One of the fundamental concepts of the Ramsar convention is Wise Use, which is defined as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development". Ramsar sites are therefore automatically designated as high priority wetlands in this study, and for this section, only includes those that are freshwater wetlands i.e. Ndumo Game Reserve and Lake Sibaya.

The objective of this report was to identify high priority wetlands or wetland groups. These high priority areas were selected based on ecological, socio-cultural and water resource use importance and are often areas of high ecological importance where water resources are stressed or may be stressed in future. A simple 7-step process was followed, using best available data

- Step 1: Determine wetland PES at SQ catchment scale.
- Step 2: Determine wetland ecological importance (EI) at the same scale as above.
- Step 3: Determine wetland sensitivity (ES) at the same scale as above.
- Step 4: Determine the wetland importance score (IS) by integration of EI, ES and SCI.
- Step 5: Determine integrated environmental importance of wetland/s (IEI) by integration of IS and PES.
- Step 6: Determine wetland priority by integration of IEI and WRUI.
- Step 7: Contribute to determination of High Priority Areas by integration with other components.

Estuaries were excluded in the process of wetland prioritisation and where values within the same SQ are assigned, they refer to wetlands surrounding / associated with the respective estuary.

The extensive wetland assessment work conducted in the study area by Begg (1989) and DWS (DWS, 2014) was additionally integrated into this assessment and used to adjust moderate or low scores of wetlands that were previously highlighted as priority wetlands. Begg (1989) identified 24 priority wetlands within the entire KwaZulu Natal region and these included several known “Vleis” in the headwater regions of major rivers, and some large “swamps” in the lower reaches of the catchments. Out of these 24 priority wetlands, 8 systems fall within this study area:

- Pongola floodplain.
- Muzi swamps;
- Greater Mkuze Swamp system;
- Mfolozi swamps;
- Aloeboom Vlei;
- Mvamanzi Pan;
- Stilwater Vlei; and
- Greater Mhlatuze Wetland system which includes:
    - Richards Bay Sanctuary;
    - Lake Nsese;
    - Lake Mzingazi; and
    - Lake Chubu.

Priority RUs were identified by integrating Integrated Environmental Importance and Water Resource Use Importance. RUs with Very High priority are summarised as follows:

- W1 (Mhlathuze Catchment)
    - W12-3 (Nyawushane and Mhlathuze), W12-6 (Mhlathuze and Mtambanana, including the Mhlathuze swamp system), W12-8 (mostly lower reaches of Nseleni, including

Nsezi and portions of the Mhlathuze floodplain), W12-9 (Nhlabane and Mzingwenya including lake Cubhu) and W12-10 (mainly Mzingazi).

- W2 (Umfolozi)
  - W21-5 (mainly the White Mfolozi).
- W3 (Mkuze)
  - W31-1 (Mkuze), W31-4 (Mkuze including Nhlnhlela Pan), W31-5 (Mkuze), W31-6 (Nsumu), W32-1 (Mkuze), W33-7 (Hluhluwe, Nyalazi and Mpate, including Nyalazi, Bushlands Pan and Hluhluwe River Vlei) and the St Lucia RU.
- W4 (Pongola)
  - W41-1 (Bivane) and W43-1 (Ngwavuma).
- W5 (Usutu)
  - W51-2 (Boesmanspruit and Assegaai), W51-3 (Swartwater and Mhkondvo), W53-1 (Sandspruit and Ngwempisi), W54-1 (uSuthu, inckusing Coalbank and Liefgekozen, and Seganagana) and W55-1 (Mpumalanga pan district around Chrissiesmeer, Majosie se Vlei and Mpuluzi) and W57-1 (uSuthu, Banzi Pan Ndumo, Shokwe Pan).
- W7 (Kosi Estuary and Lake Sibaya)
  - W70-1 (Swamanzi) and W70-3 (Lake Sibaya, Muzi swamps).

3.6 ESTUARY IMPORTANCE

The steps used to identify the priority estuaries were:

- Desktop EcoClassification which included the determination of the **Ecological and Biodiversity/Conservation, Ecosystem Services Importance** and **PES**.
- Determination of the **Integrated Environmental Importance (IEI)** by integrating the Ecological, Biodiversity/Conservation, and Ecosystem Services Importance and the PES.

Ecological and Biodiversity/Conservation Importance: The ecological importance of an estuary is an expression of its importance to the maintenance of biological diversity and ecological functioning on a regional, national or global scale. All estuaries within the study area, with the exception of iNhlabane, are also conservation priorities, being either in formally protected areas (i.e. provincial park, iSimangaliso Wetland Park and UNESCO World Heritage Site) or desired protected areas. In addition, three systems are also Ramsar sites and five systems are Important Bird Areas.

Combining the Ecological and Biodiversity/Conservation Importance of the estuaries in the study area showed that all the systems had either High or Very High ratings:

- W1: Six estuaries (aMatigulu/iNyoni, iSiyaya, uMlalazi, uMhlathuze, Richards Bayand iNhlabane).
- W2: One estuary (iMfolozi/uMsunduze – part of St Lucia Estuarine Lakes complex).
- W3: One estuary (St Lucia – part of St Lucia Estuarine Lakes complex).
- W7: Two estuaries (uMgobezeleni, and Kosi).

Ecosystem Services were evaluated for each estuary based on its carbon sequestration and nursery function value. 'Blue carbon' is associated with three estuary biotic habitats (mangroves, seagrasses, and salt marshes) that sequester carbon from the atmosphere and lock it into the soil. More than half of South Africa's estuarine-associated fish species are utilised in fisheries (subsistence, recreational and commercial). At least 60% of these species are considered entirely or partially dependent on estuaries. Thus, one of the most important values of estuaries to various fisheries species relates to the provision of sheltered nursery environments.

The evaluation of key Ecosystems Services indicated that most of the estuaries in the study area also rated High to Very High from this perspective:

- W1: Five estuaries (aMatigulu/iNyoni, uMlalazi, uMhlathuze, Richards Bay and iNhlabane).
- W2: One estuary (iMfolozi/uMsunduze – part of St Lucia Estuarine Lakes complex).
- W3: One estuary (St Lucia– part of St Lucia Estuarine Lakes complex).
- W7: One estuary (Kosi).

Ecological/Conservation Importance and Ecosystem Service Importance were assessed separately and then integrated with the PES to determine the **IEI**. The PES forms part of the IEI because estuaries in good condition are important in their own right as they assist in achieving national biodiversity targets.

The IEI for the estuaries in the study area showed that all the systems had either High or Very High ratings:

3.7 RIVER BIOPHYSICAL NODES

Each RU is represented by biophysical nodes which are either desktop nodes, or EWR sites. These nodes and sites are those where an EWR assessment of appropriate level has been provided. The selected nodes and EWR sites are summarised as follows:

- W1: Seven desktop nodes. Two desktop nodes with hydraulics (i.e. higher confidence). Two active EWR sites in the Matigulu and Nseleni Rivers where EWRs will be reviewed. One historical EWR site in the Mhlathuze River where the existing gazetted results for compulsory licensing will be reviewed to ensure an acceptable monthly distribution.
- W2: Seven desktop nodes. Four desktop nodes which will be extrapolated from active EWR sites. One active EWR site in the White Umfolozi where EWRs will be reviewed. Three active EWR sites in the Black Umfolozi and EWRs will be reviewed at one or two of the sites.
- W3: Seven desktop nodes. Three desktop nodes which will be extrapolated from an active EWR site. One active EWR site in the Mkuze River where the EWRs will be reviewed.
- W4: Seven desktop nodes. One desktop node which will be extrapolated from an active EWR site. One active EWR site in the Pongola River where the EWRs will be reviewed.
- W5: Ten desktop nodes. One desktop node with hydraulics available from a historical EWR site (i.e. higher confidence). One desktop node which will be extrapolated from an active EWR site. One active EWR site in the Assegaai River where the EWRs will be reviewed.

4 SURFACE WATER HYDROLOGY

The Purpose of this chapter is to describe the hydrology and water resources model configurations used for water resources analyses throughout this Study. No new hydrology data has been prepared as part of this study, all hydrology data has been sourced from other studies as detailed in the hydrology technical report. This chapter summarises the hydrology as well as presents the natural and present day flows as the various required biophysical nodes and EWR sites.

4.1 HYDROLOGY SOURCES AND MODELS

Monthly hydrological flows for the catchments have been sourced from four studies, namely:

- The Mhlathuze Water Availability Assessment Study (DWAF, 2009) and updates as part of the Reconciliation Strategy Study (DWS, 2021a)
- The Pongola to Umfolozi Reconciliation Strategy Study (DWS, 2022).
- The Usutu Water Availability Assessment Study (IUCMA, 2016).
- Joint Maputo River Basin Water Resources Study (TPTC, 2008)

Part of this Task involved gathering the water resources model data sets. The biophysical nodes and EWR sites have been configured into the models at representative points throughout the systems. The models were used to simulate present day flows.

4.2 SIMULATED NATURAL AND PRESENT DAY FLOWS

Results from the models in the form of time series of monthly flows at the biophysical nodes and EWR sites presented (**Figure A1** of **Appendix A**) (for two scenarios, namely Natural, and present day) are further assessed with the Desktop Model.

Present Day flows are extracted from simulated model results with the models set in present day mode. This means that all landuse areas and point abstraction volumes are set at the current (year 2020) size for the entire historical simulation period. The following Tables provide a summary of the results.

Table 4-1: Natural and present day flows: W1

Node	Natural MAR (million m^3/a)	Present day MAR (million m^3/a)	Difference	Comment
11_1	22.78	13.07	9.72	-
EWR_MA1	72.69	37.00	35.70	-
EWR5_UM	32.14	23.32	8.82	-
12_2	95.13	28.48	66.65	-
12_3	125.08	162.13	-37.05	Pres Day greater due to Thukela Transfer inflows
12_4	12.86	9.88	2.98	-
EWR8_LM	50.80	37.84	12.95	-
12_7	23.13	21.76	1.37	-
EWR6_NS1	31.23	31.56	-0.33	Pres Day greater due to return flows from Heatonville scheme entering W12H
13_1	107.19	97.34	9.85	-

13_2	42.56	3.72	38.84	-

Table 4-2: Natural and present day flows: W2

Node	Natural MAR (million m^3/a)	Present day MAR (million m^3/a)	Difference
21_1	53.4	33.38	20.03
21_2	63.5	41.60	21.95
21_3	103.3	79.16	24.12
21_4	66.0	60.51	5.49
EWR_WM1	222.5	191.80	30.71
21_6	301.4	62.79	238.65
21_7	377.0	137.24	239.79
21_8	424.8	185.03	239.82
EWR_BM1	34.7	28.08	6.61
EWR_BM2	71.6	59.38	12.20
22_3	69.1	60.58	8.51
MB_EWR	166.7	144.13	22.59
22_5	346.8	320.03	26.81
23_1	809.0	533.97	275.01
23_2	19.4	16.49	2.89

Table 4-3: Natural and present day flows: W3

Node	Natural MAR (million m^3/a)	Present day MAR (million m^3/a)	Difference
31_1	56.2	48.86	7.31
31_2	99.7	89.19	10.48
31_3	138.3	101.38	36.89
EWR_MK1	158.8	106.13	52.62
31_5	166.5	113.73	52.78
31_6	20.2	19.28	0.88
32_1	202.8	149.02	53.80
32_2	23.9	23.67	0.23
32_3	11.8	11.78	0.00
32_4	25.9	25.92	0.00
32_5	20.8	16.82	3.98
32_6	3.7	3.67	0.04

Table 4-4: Natural and present day flows: W4

Node	Natural MAR (million m^3/a)	Present day MAR (million m^3/a)	Difference
41_1	221.5	190.28	31.25
41_2	45.1	43.56	1.53
42_1	264.4	237.40	26.98

EWR_UP1	356.8	299.39	57.45
42_3	791.0	682.85	108.15
42_4	52.7	46.50	6.20
42_5	902.0	784.53	117.46
43_1	27.0	26.86	0.09
44_1	942.0	654.62	287.42

Table 4-5: Natural and present day flows: W5

Node	Natural MAR (million m^3/a)	Present day MAR (million m^3/a)	Difference
51_1	99.62	89.91	9.71
51_2	255.77	115.53	140.25
EWR_AS1	328.61	164.10	164.51
51_4	43.36	40.50	2.86
52_1	97.06	78.34	18.72
53_1	38.66	28.14	10.52
53_2	5.05	4.00	1.06
53_3	181.14	100.52	80.62
54_1	32.77	24.22	8.55
54_2	79.46	32.29	47.17
55_1	128.96	110.42	18.53
EWR_Lush	39.48	36.19	3.30
57_1	2289.46	1434.03	855.43

5 GROUNDWATER

The purpose of this chapter is to summarise the results of the groundwater analysis as a key component of the Usutu-Mhlathuze Classification study. The objective of this task is to calculate the Groundwater Component of the Reserve and the Groundwater Classification.

5.1 METHODOLOGY

The Groundwater Component of the Reserve and Groundwater Classification is undertaken by calculating the Stress Index (SI) for each quaternary catchment based on abstraction (sourced from Registered use in the Water Allocation Registration Management System (WARMS) and the Schedule 1 water use for domestic and livestock based on StatsSA household survey) and revised figures for baseflow and recharge calibrated using Water Resources Simulation Model (WRSM Pitman - Pitman *et al*., 2006). Groundwater baseflow and the Basic Human Needs (BHN) component from groundwater are utilised to determine the Groundwater contribution to the Ecological Reserve.

5.2 OUTPUTS

A series of integrated maps of the basin or sub catchments which combine various spatial data sets and highlight crucial aspects of the groundwater systems (aquifers) in the project area were produced. Included are basin wide simplified geological and structural maps, aquifer distribution and type, borehole yield, recharge, stress index, baseflow and aquifer sustainable yield (productivity) maps, groundwater quality maps and recharge distribution maps. Tables are provided on groundwater resources, yield, and classification per catchment.

5.2.1 W1 Mhlathuze

Groundwater is minimally used and the stress index is below 0.05. Quaternary catchment classification is shown below.

Table 5-1: Groundwater Summary: W1

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer Recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W11A	445.15	43.65	12.80	3.12	34.40	0.269	0.021
W11B	126.82	12.27	3.73	1.28	5.30	0.061	0.016
W11C	383.02	40.52	10.68	3.82	8.60	0.232	0.022
W12A	623.31	35.08	18.91	4.64	21.29	0.158	0.008
W12B	656.33	42.43	18.81	4.96	34.38/	0.122	0.006
W12C	570.07	32.70	17.82	4.22	10.52	0.102	0.006
W12D	568.94	29.36	13.32	3.77	27.30	0.092	0.007
W12E	248.59	21.38	6.71	1.95	7.02	0.043	0.006
W12F	387.31	82.04	45.38	20.70	84.99	0.419	0.009
W12G	326.36	18.99	10.01	3.19	4.33	0.064	0.006
W12H	484.57	44.68	13.02	15.46	37.23	0.365	0.028
W12J	332.85	71.07	42.57	25.19	117.31	0.093	0.002
W13A	275.84	30.77	6.47	2.04	12.16	0.216	0.033
W13B	222.76	32.26	4.75	3.30	10.42	0.046	0.010

1 Basic Human Needs

5.2.2 W2 Umfolozi

Groundwater is minimally used and the stress index is below 0.12. Quaternary catchment classification is shown below.

Table 5-2: Groundwater Summary: W2

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	GRAII Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W21A	340.14	25.97	6.18	1.63	6.89	5.72	0.073	0.012
W21B	580.39	19.71	8.21	3.79	8.55	9.03	0.186	0.023
W21C	369.64	18.85	4.96	1.60	3.54	5.93	0.067	0.014
W21D	468.70	23.65	6.22	2.01	5.07	8.57	0.136	0.022
W21E	415.98	20.67	5.44	1.65	4.45	7.54	0.620	0.114
W21F	242.75	11.31	2.98	1.10	2.50	4.87	0.044	0.015
W21G	562.85	22.16	6.65	2.32	7.38	13.53	0.225	0.034
W21H	432.82	18.59	5.58	1.69	6.01	10.65	0.065	0.012
W21J	530.05	25.34	7.60	1.98	7.25	18.92	0.085	0.011
W21K	797.46	34.40	10.32	4.17	8.14	43.71	0.097	0.009
W21L	532.82	25.43	9.25	3.83	6.56	11.75	0.077	0.008
W22A	238.71	15.81	5.69	0.62	4.10	3.89	0.041	0.007
W22B	331.69	18.60	6.69	1.04	3.60	4.55	0.056	0.008
W22C	185.61	11.61	4.18	0.56	3.13	2.69	0.033	0.008
W22D	197.48	10.27	3.69	0.70	2.43	2.69	0.030	0.008
W22E	385.42	30.60	11.02	0.72	9.10	5.78	0.073	0.007
W22F	312.04	17.05	6.14	1.15	3.25	4.71	0.056	0.009
W22G	249.36	12.03	4.01	1.68	2.20	3.39	0.077	0.019
W22H	306.12	13.80	4.60	1.82	3.28	4.17	0.577	0.126
W22J	604.95	26.11	8.71	4.01	4.53	8.23	0.120	0.014
W22K	475.54	21.92	7.31	3.35	4.24	6.47	1.321	0.181
W22L	279.30	13.01	4.73	2.04	2.71	3.80	0.066	0.014
W23A	413.72	24.97	15.37	4.33	5.36	5.54	0.541	0.035
W23B	192.79	13.72	8.44	4.42	3.89	13.87	0.393	0.047
W23C	312.69	71.29	68.84	31.52	15.70	103.71	0.221	0.003
W23D	247.88	51.54	49.76	22.80	9.21	42.07	0.566	0.011

5.2.3 W3 Mkuze

Groundwater is minimally used and the stress index is below 0.05. Quaternary catchment classification is shown below.

Table 5-3: Groundwater Summary: W3

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	GRAII Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W31A	369.72	17.59	5.86	1.21	5.41	5.92	0.066	0.011
W31B	304.28	14.19	4.73	0.85	3.85	4.21	0.054	0.011
W31C	171.56	9.56	3.19	0.44	2.90	2.33	0.065	0.020
W31D	294.57	13.49	4.50	0.91	3.57	4.00	0.048	0.011
W31E	334.19	7.83	3.91	1.09	2.98	4.14	0.048	0.012
W31F	583.35	12.89	6.44	3.52	5.65	7.93	0.147	0.023

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	GRAII Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W31G	519.77	11.42	6.52	4.17	5.45	6.90	0.176	0.027
W31H	322.59	5.30	3.79	2.63	3.21	4.62	0.060	0.016
W31J	552.60	19.71	18.40	9.95	4.65	60.48	0.116	0.006
W31K	855.31	13.66	9.76	7.46	8.98	11.35	0.258	0.026
W31L	321.38	12.38	11.55	12.33	3.11	19.25	0.058	0.005
W32A	417.40	44.80	43.20	28.30	7.88	80.69	0.096	0.002
W32B	934.44	148.95	143.81	91.98	42.39	234.12	0.206	0.001
W32C	728.23	30.65	25.54	25.39	8.76	27.64	0.127	0.005
W32D	267.22	7.47	4.08	2.42	3.51	3.63	0.115	0.028
W32E	455.92	12.63	6.89	4.61	6.68	6.11	0.090	0.013
W32F	187.34	9.78	8.15	10.07	3.46	10.68	0.052	0.006
W32G	647.50	37.04	30.87	25.64	13.15	25.39	0.220	0.007
W32H	1276.01	230.48	222.54	109.80	40.97	252.66	0.648	0.003

5.2.4 W4 Pongola

Groundwater is minimally used and the stress index is below 0.05. Quaternary catchment classification is shown below.

Table 5-4: Groundwater Summary: W4

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	GRAII Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W41A	187.61	18.88	2.60	1.17	7.39	3.16	0.018	0.007
W41B	305.61	28.14	3.88	1.93	10.72	5.41	0.043	0.011
W41C	217.31	19.75	2.72	1.40	7.44	3.84	0.026	0.010
W41D	238.02	20.33	2.80	1.52	7.09	6.68	0.033	0.012
W41E	303.17	21.14	2.97	2.01	9.16	4.84	0.066	0.022
W41F	343.46	22.27	3.13	1.85	7.95	4.76	0.055	0.018
W41G	95.80	5.64	0.80	0.35	1.53	1.07	0.015	0.018
W42A	397.37	40.45	5.58	2.91	17.68	9.87	0.039	0.007
W42B	416.55	37.00	5.10	3.02	14.50	12.28	0.061	0.012
W42C	376.56	36.53	5.04	3.32	15.71	11.05	0.056	0.011
W42D	489.41	40.57	5.59	3.74	15.55	18.68	0.093	0.017
W42E	231.74	17.69	2.44	1.66	6.52	5.73	0.042	0.017
W42F	305.53	23.29	3.21	2.12	8.21	8.76	0.125	0.039
W42G	248.17	15.74	2.22	1.22	5.42	2.78	0.037	0.017
W42H	272.90	16.14	2.27	1.06	4.50	3.37	0.045	0.020
W42J	290.46	14.67	2.07	1.09	4.54	4.11	0.040	0.019
W42K	415.98	30.26	4.17	2.22	5.85	6.70	0.217	0.052
W42L	250.66	13.55	1.91	0.90	3.78	2.81	0.031	0.016
W42M	391.57	19.25	2.72	1.39	4.71	8.77	0.036	0.013
W43A	248.21	21.22	7.07	2.61	0.00	6.21	0	0
W43B	331.71	28.86	9.62	3.29	0.00	8.29	0	0
W43C	395.08	30.34	10.11	3.76	0.09	9.88	0.001	0.000
W43D	261.66	5.29	3.78	2.35	0.00	6.54	0	0
W43E	264.55	4.67	3.33	2.17	0.02	6.61		0.000
W43F	631.45	12.84	9.17	11.74	5.83	28.76	0.080	0.009
W44A	254.71	5.85	3.15	1.49	2.38	4.07	0.037	0.012

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	GRAII Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W44B	486.09	10.31	5.56	3.51	3.55	7.98	0.482	0.087
W44C	314.30	6.07	3.27	2.82	0.70	5.16	0.008	0.002
W44D	236.43	3.05	1.94	1.76	2.08	2.73	0.029	0.015
W44E	711.45	9.80	6.24	5.68	3.52	10.52	0.046	0.007
W45A	1289.09	73.16	69.49	34.51	7.84	84.62	0.289	0.004
W45B	508.13	29.23	27.77	16.64	6.77	74.18	0.120	0.004

5.2.5 W5 Usutu

Groundwater is minimally used and the stress index is below 0.13. Quaternary catchment classification is shown below.

Table 5-5: Groundwater Summary: W5

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	GRAII Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W51A	624.64	41.11	10.39	6.81	15.25	13.53	0.224	0.022
W51B	496.45	31.29	8.50	6.91	12.11	10.63	1.114	0.131
W51C	677.71	47.70	12.53	9.38	18.11	22.89	0.470	0.037
W51D	527.43	36.12	8.89	6.67	13.86	8.31	0.164	0.018
W51E	274.28	23.59	6.11	1.66	0.67	3.07	0.084	0.014
W51F	589.36	52.08	12.65	2.64	9.59	18.23	0.168	0.013
W51G	420.10	40.95	11.91	0.00	0.00	12.60	0.000	0.000
W51H	286.45	26.67	8.25	0.00	0.00	8.59	0.000	0.000
W52A	289.44	17.79	5.03	3.80	5.81	6.03	0.124	0.025
W52B	336.19	20.60	6.27	4.16	7.20	12.53	0.208	0.033
W52C	177.84	10.71	3.35	2.33	3.86	6.71	0.066	0.020
W52D	119.29	10.12	2.38	0.59	2.32	1.34	0.015	0.006
W53A	547.48	34.42	10.25	7.87	11.47	17.25	0.452	0.044
W53B	218.54	15.48	4.09	3.51	5.26	5.67	0.020	0.005
W53C	315.62	24.97	5.82	5.09	8.91	7.55	0.089	0.015
W53D	314.71	21.45	5.86	4.54	7.83	6.38	0.056	0.010
W53E	421.87	39.11	8.96	2.39	5.53	9.29	0.047	0.005
W53F	447.34	42.11	10.48	2.76	0.03	11.18	0.000	0.000
W53G	382.31	41.42	11.92	0.00	0.00	9.56	0.000	0.000
W54A	251.08	15.73	3.99	4.01	5.26	5.47	0.065	0.016
W54B	281.94	19.73	4.38	4.53	6.78	4.70	0.026	0.006
W54C	107.45	7.72	1.85	1.58	2.53	4.55	0.010	0.005
W54D	138.75	12.42	2.71	0.69	4.01	5.63	0.054	0.020
W54E	194.12	19.97	3.68	1.39	0.72	8.54	0.005	0.001
W54F	268.30	29.76	5.46	0.00	0.00	12.07	0.000	0.000
W54G	265.33	27.29	5.55	0.00	0.00	11.94	0.000	0.000
W55A	688.70	39.75	11.10	12.04	15.62	15.16	0.068	0.006
W55B	217.83	14.66	3.44	3.10	4.87	7.21	0.021	0.006
W55C	532.20	49.55	15.02	2.51	14.29	21.41	0.138	0.009
W55D	270.86	25.09	7.70	1.38	6.04	11.92	0.018	0.002
W55E	161.23	15.73	4.50	1.19	0.11	7.09	0.000	0.000
W56A	359.72	67.58	13.91	2.08	13.33	15.83	0.013	0.001
W56B	224.66	45.86	10.55	1.80	2.62	9.89	0.002	0.000

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	GRAII Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W56C	252.69	62.81	13.93	0.00	0.00	11.37	0.000	0.000
W56D	165.69	36.52	9.45	0.00	0.00	7.46	0.000	0.000
W56E	185.68	44.61	10.43	0.00	0.00	8.36	0.000	0.000
W56F	199.26	21.29	9.29	0.00	0.00	8.97	0.000	0.000
W57A	593.11	52.86	18.58	0.00	0.00	17.79	0.000	0.000
W57B	433.96	12.25	6.33	0.00	0.00	13.02	0.000	0.000
W57C	574.49	15.20	8.24	0.00	0.00	17.23	0.000	0.000
W57D	366.35	37.91	14.88	0.00	0.00	10.99	0.000	0.000
W57E	403.01	8.02	5.59	0.00	0.00	12.09	0.000	0.000
W57F	223.41	19.31	9.04	0.00	0.00	6.70	0.000	0.000
W57G	623.17	10.43	7.84	0.00	0.00	18.70	0.000	0.000
W57H	804.68	25.25	13.79	0.00	0.00	28.16	0.000	0.000
W57J	519.42	12.87	6.29	6.01	0.91	18.46	0.011	0.002
W57K	137.42	2.42	1.71	4.24	0.92	10.64	0.017	0.010

5.2.6 W7 Kosi Estuary and Lake Sibaya

The stress index calculated from the total present use and aquifer recharge is 0.01. Groundwater is minimally used. Quaternary catchment classification is shown below.

Table 5-6: Groundwater Summary: W7

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exploitation Potential (Mm^3/a)	GRAII Exploitation Potential (Mm^3/a)	Harvest Potential (Mm^3/a)	Use (Mm^3/a)	Stress Index
W70A	2577.95	342.37	340.15	216.18	97.08	649.41	5.189	0.013

6 BASIC HUMAN NEEDS

The purpose of this chapter is to summarise the quantification the Basic Human Needs Reserve (BHNR) as a key component of the Usutu-Mhlathuze Classification study. The National Water Act (Act No. 36 of 1998) ensures that everyone has access to sufficient water by setting aside a certain amount of water to meet everyone's basic needs, i.e. the BHNR. The BHNR is based upon the current and projected population of those either living within the catchment and directly dependant on the catchment or, critically, not being supplied with water from a recognised formal source. This report therefore documents the basic human needs requirements for the population currently and in the reasonably near future, whom would be relying upon, taking water from or being supplied from the water resource for their essential needs of drinking water, food preparation and personal hygiene.

6.1 APPROACH

Communities likely to be reliant on direct abstraction from run of river and surface water were identified in the study area using Geographic Information System (GIS) mapping and the 2016 population Census. A series of steps were undertaken to determine the population within each quaternary catchment dependant on the water resource. The method follows the approach revised by DWS (DWA, 2008a), with additional steps to improve projections. In this method, the BHNR only applies to the areas in which informal water sources are the means by which communities obtain water. The method adopted is summarized below:

- Quaternary catchments falling within the Usutu to Mhlathuze Catchment were determined, and the area of each catchment was calculated based on GIS information.
- Data from the 2016 Statistics South Africa Community Survey (Stats SA, 2016) was used to determine the number of people within Local Municipalities that fall either entirely or partially within the Usutu to Mhlathuze Catchment. Some quaternary catchments fall within more than one Local Municipality. Local Municipality data is provided with a statistical analysis of level of service with respect to provision and access to water resources.
- The 2016 Statistics South Africa Community Survey (Stats SA, 2016) is the most recent comprehensive national data set. The 2011 Census is out of date as a reliable source of water service information and the current Census (2022) is unavailable.
- The number of people within the Local Municipality was apportioned to the quaternary catchment based on the size of the quaternary relative to the total Municipal Population.
- Based on level of service provided by the Local Municipality, the number of people estimated to be directly dependant on the various water sources were calculated per quaternary catchment. Areas falling completely or partially in each quaternary catchment were used in order to determine households with access to formal and informal water supplies. The former included all households with access to piped water in any configuration, while the latter covers all households without access to piped water and therefore would be reliant on other informal sources such as run of river, springs, dams, lakes, vendors and tankers. It should be noted that in the 2016 Statistics South Africa Community Survey (Stats SA, 2016) water supply was determined by household and therefore the method needed adjustment to account for individuals. Average individuals per household were determined via the analysis of 2016 Statistics South Africa Community Survey (Stats SA, 2016). Total qualifying households multiplied by the average number of individuals was used to determine the total population qualifying under the BHNR. Those who receive water from formal schemes and mechanised groundwater extraction were excluded (see the DWS directive (DWA, 2008a) relating to formal

scheme exclusion). Those who use buckets to collect from wells are included. According to the results of the 2016 Statistics South Africa Community Survey, approximately 77% of the overall Water Management Area (WMA) population has access to formal water supply schemes or abstract groundwater via boreholes.

- Having calculated the qualifying population per quaternary catchment the next step in determining the BHNR is to project the population to a target date. The average growth for the applicable Local Municipalities between 2011 Census and 2016 Community survey of 1.7% per annum was used.

6.2 RESULTS

The summarised population projections per catchment area up to 2030 are provided in **Table 6-1**.

Table 6-1: Summary of catchment area population and population dependant on BHNR

Secondary catchment Area	Total population	Population BHNR Dependent (excluding boreholes and formal schemes)		
		2022	2030	2040
W1	842 052	111 687	127 811	153 851
W2	758 735	212 514	243 194	292 742
W3	612 763	202 600	231 850	279 086
W4	438 168	116 746	133 601	160 821
W5	425 388	38 000	43 486	52 346
W7	107 693	18 427	21 087	25 384
Total	**3 184 799**	**699 974**	**801031**	**964 229**

To calculate the quantum of water for the BHNR, the daily normative allowance of 60 litres per person per day was used for eligible individuals in the population, according to guidelines set out in DWAF (1999; 2007 and 2008a;b). **Table 6-2** sets out the figure expressed in million cubic metres of water per annum for the current date (2022) as well as for 2025 and 2030. Projecting beyond 2030 was not done as the number is dependant on trajectories of service delivery and these cannot be predicted with certainty.

Table 6-2: Basic Human Needs (BHN) per catchment area expressed in million m^3 per annum

Secondary catchment Area	Population BHNR Dependent 2022 (excl. boreholes and formal schemes)	BHN as Million m^3 per annum @ 60 L/day		
		2022	2025	2030
W1	111 687	2.446	2.617	2.847
W2	212 514	4.654	4.979	5.416
W3	202 600	4.437	4.746	5.164
W4	116 746	2.557	2.735	2.976
W5	38 000	0.832	0.890	0.969
W7	18 427	0.404	0.432	0.470
Total	**699 974**	**15.329**	**16.399**	**17.841**

Table 6-3 sets out the figures for 100 l per day expressed in million cubic metres of water per annum for the current date (2022) as well as for 2025 and 2030. This is for illustrative purposes.

Table 6-3: Basic Human Needs (BHN) per catchment area expressed in million m^3 per annum

Secondary catchment Area	Population BHNR Dependent 2022 (excl. boreholes and formal schemes)	BHN as Million m^3 per annum @ 100 L/day		
		2022	2025	2030
W1	111 687	4.077	4.361	4.744
W2	212 514	7.757	8.298	9.027
W3	202 600	7.395	7.911	8.606
W4	116 746	4.261	4.558	4.959
W5	38 000	1.387	1.484	1.614
W7	18 427	0.673	0.719	0.783
Total	**699 974**	**25.549**	**27.331**	**29.735**

Table 6-4 sets out the figures expressed as cubic metres per day.

Table 6-4: Basic Human Needs per catchment area expressed in m^3 per day

Secondary catchment Area	Population BHNR Dependent (excl. boreholes and formal schemes)	BHN as m^3 per day @ 60 L/ day		
		2022	2025	2030
W1	111 687	6 701	6 931	9 231
W2	212 514	12 751	13 188	17 565
W3	202 600	12 156	12 573	16 745
W4	116 746	7 005	7 245	9 649
W5	38 000	2 280	2 358	3 141
W7	18 427	1 106	1 144	1 523
Total	**699 974**	**41 998**	**43 439**	**57 854**

7 WETLANDS

The purpose of this chapter is to provide a summary of the desktop assessment of the EcoClassification for very high priority wetlands, and establish EWRs for very high priority wetlands as a key component of the Usutu-Mhlathuze Classification study. The distribution of different wetland types (HGMs – hydro-geomorphic units, Level 4 classification from Ollis *et al.*, 2013) is shown in **Figure 7-1**. This includes five RAMSAR sites, the St Lucia System, Lake Sibaya, Kosi Bay, Ndumo Game Reserve and the Turtle Beaches / Coral Reefs of Tongaland.

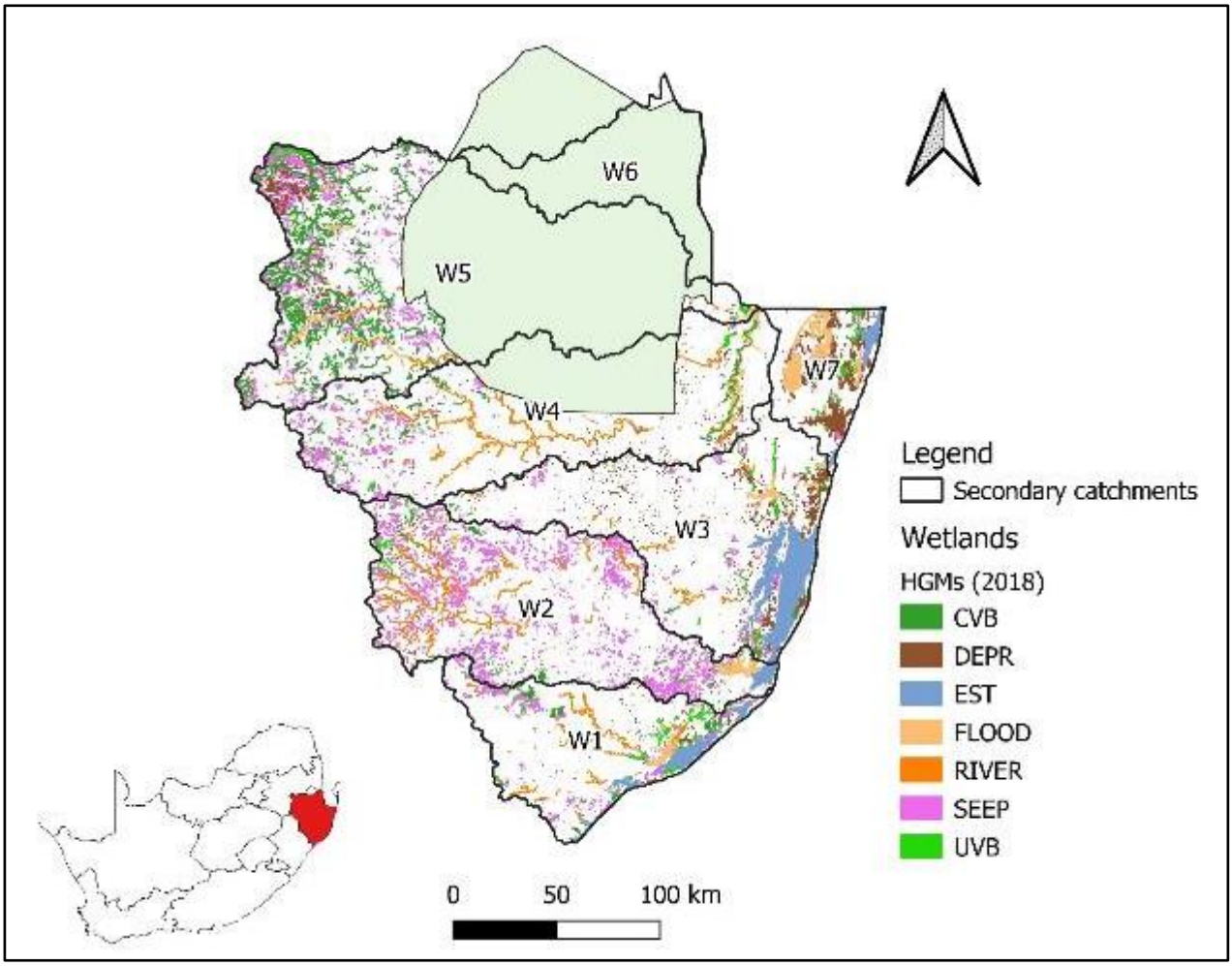


Figure 7-1: Wetlands within the study area showing distribution of different HGMs (2018 updated wetland map 5; van Deventer *et al.*, 2018) and secondary catchments

The outcomes of the prioritisation process resulted in smaller subsets of wetlands with very high or high priority, within each secondary catchment, that were again assessed for PES at a more detailed level, using additional and more current / updated data. The resultant PES scores / categories and dominant impacts are summarised as follows:

1) W1 (Mhlathuze) – Four groups of wetlands including riverine wetlands along the Mhlathuze River leading into the Mhlathuze swamp system, lower reaches of Nseleni, including Nsezi and portions of the Mhlathuze floodplain, Nundwane, mainly Mzingazi, extensive channelled valley bottom wetlands leading into Richard's Bay Estuary, and depressions and seeps near the Nlabane estuary.
2) W2 (Umfolozi) – Four groups of wetlands including riparian wetlands along the White Mfolozi River, Aloeboom vlei, Mvamanzi pan and the Mfolozi swamp.

3) W3 (Mkuze) – Five groups of wetlands including Mkuze and Nhlonhlela rivers including Nhlonhlela Pan, Hluhluwe, Nyalazi and Mpate, including Nyalazi, and the Mkuze River with swamps and floodplain before entering the estuary.
4) W4 (Pongola) – Two groups of wetlands including riparian wetlands along the Bivane River and the Pongola floodplain.
5) W5 (Usutu) – Six groups of wetlands including Boesmanspruit and Assegaai River, Sandspruit and Seganagana, Mpumalanga pan district around Chrissiesmeer, lower Usutu River including Banzi Pan and Ndumo.
6) W7 (Kosi & Sibaya) – Two groups of wetlands including Lake Sibaya and the Muzi swamps.

Besides Lake Sibaya and the Pongola floodplain which have quantitative flow requirements expressed as Lake levels and dam releases respectively (DWS, 2015a,b), the Ecological Water Requirement (EWR) of very high priority floodplains, channelled and unchannelled valley-bottom, and seep wetlands is expressed through ecological specifications that protect the habitat. To provide these specifications, the EWRs are expressed in terms of a Recommended Ecological Category (REC), which is dependent on the Present Ecological State (PES) and the ecological importance, which denotes whether the REC is the same as the PES or an improvement, if at all possible. Where the REC is an improvement of the PES, this will involve management of land use. The most common method to achieve the REC where it is higher than the PES is to remove alien vegetation, reduce agricultural / forestry encroachment of wetlands and manage (usually reduce) grazing pressures which can promote erosion. A summary of high priority wetlands is shown in **Table 7-1** with some indication of a proposed REC and strategies to achieve said.

Table 7-1: Validated PES, trajectory and REC for wetlands with High or Very High priority

Name	Includes SQs	Size (Ha)	PES	Trajectory	REC	How to achieve the REC
W1 Mhlatuze						
Mhlathuze Riverine Wetlands	W12E-03475	N/A	C	N/A	C	Maintain PES.
Mhlathuze Floodplain	W12H-03459	4809.0	E	↓	D	Reduce / control sugarcane cultivation.
Nlabane Wetlands	W12J-03411	546.9	D	↓	C/D	Reduce / control forestry.
Mzingazi	W12J-03392 W12J-03403 W12J-03450	1689.0	B/C	→	B/C	Control expansion of forestry and residential development.
W2 Umfolozi						
White Mfolozi Riverine Wetlands	W21G-02885 W21H-02897 W21H-03004	N/A	B	N/A	B	Maintain PES.
Aloeboom Vlei	W22A-02586 W22A-02591 W22A-02596	343.8	C	↓	B/C	Reduce / control forestry, control formal residential expansion.
Mvamanzi Pan	W23A-03160	485.1	B/C	→	B/C	Control expansion of subsistence / small-scale crops and formal residential areas.
Mfolozi Swamps	W23C-03180 W23D-03108	11911.1	D	→	D	Reduce / control sugarcane cultivation.
W3 Mkuze						

Name	Includes SQs	Size (Ha)	PES	Trajectory	REC	How to achieve the REC
Nhlonhlela Pan	W31J-02469 W31J-02501	8.2	A	→	A	Preventative conservation: prevent expansion of surrounding forestry.
Hluhluwe Floodplain	W32F-02835	2310.1	C/D	↓	C	Reduce / control cultivation of commercial and emerging farmer sugarcane.
Nyalazi Pan	W32H-02854	43.2	C	→	C	Control existing forestry extent
Mpate Wetlands	W32H-02998	236.9	A	→	A	Preventative conservation: prevent expansion of forestry and small-scale subsistence farming.
Mkuze Floodplain	W32B-02535	11222.9	B	→	B	Control extent of subsistence / small-scale annual crops.
W4 Pongola						
Bivane Riverine Wetlands	W41B-02431	N/A	B	N/A	B	Maintain PES
Pongola Floodplain	W45A-02216 W45A-02245 W45A-02246 W45A-02256 W45A-02275 W45A-02282 W45A-02285 W45A-02310 W45A-02316 W45A-02356 W45A-02367 W45A-02368 W45B-02029 W45B-02105	11802.6	D	↓	C	Reduce / control subsistence and small-scale annual crops, continued implementation of EWR determined in 2015 (DWS, 2015b).
W5 Usutu						
Assegaai Floodplain	W51C-01981 W51C-02011 W51C-02022 W51C-02067 W51C-02074 W51C-02109 W51D-02044 W51D-02151 W51D-02160 W51D-02171 W51D-02177 W51D-02193	886.4	C	→	C	Control expansion of forestry and informal farming.
Sandspruit Wetlands	W53A-01757 W53A-01804 W53A-01853	1676.8	C	→	C	Control expansion of commercial annual crops and dry-land agriculture.
Upper Usutu Wetlands	W54A-01534 W54A-01630	767.2	B/C	→	B/C	Control expansion of commercial annual crops and dry-land agriculture.
Seganagana Wetlands	W54B-01569	1264.7	A	→	A	

Name	Includes SQs	Size (Ha)	PES	Trajectory	REC	How to achieve the REC
	W54B-01623					Preventative conservation: Control expansion of forestry and dry-land agriculture.
Pans District	W55A-01375 W55A-01423 W55C-01395	21348.2	**A/B**	→	**A/B**	Preventative conservation: Control expansion of forestry and commercial annual crops, rain-fed.
Lower Usutu (Ndumo)	W57J-01923 W57K-01929 W57K-02025	1310.0	**A**	→	**A**	Preventative conservation: prevent expansion of nearby slash and burn agricultural activities.
W7 Kosi & Sibaya						
Lake Sibaya	W70A-02278 W70A-02301 W70A-02381	10168.0	**B**	→	**B**	Prevent expansion of surrounding forestry, residence and dry-land agriculture. Continued implementation of EWR determined in 2015 (DWS, 2015a).
Muzi Swamps	None	25409.9	**C**	↓	**C**	Control forestry and subsistence and small-scale annual crops, address erosion.

8 RIVER EWRS FOR DESKTOP BIOPHYSICAL NODES AND SITES

The purpose of this chapter is to document the results of a component of Task 3: Quantify Basic Human Needs (BHN) and Ecological Water Requirements (EWR). The first part of the chapter deals with is the determination of EWRs at those biophysical nodes for which a desktop estimation model was used. The second part outlines the EcoClassification and EWR results of the eight river EWR sites in the Usutu to Mhlathuze Catchment.

8.1 RESOURCE UNITS: ECOCLASSIFICATION

EcoClassification consists of three basic steps as follows (Kleynhans and Louw, 2007):

- Determination of Present Ecological State (PES) (DWS, 2022).
- Determination of Ecological Importance and Sensitivity (EIS) (DWS, 2022).
- Deriving the Recommended Ecological Category (REC).

Biophysical nodes for which EWR assessments have been undertaken have been selected and are summarised in **Table 8-1**. (See **Figure A1** of **Appendix A** for locations)

Table 8-1: Biophysical nodes per secondary catchment

Secondary catchment	Number of Integrated Unit of Analysis (IUAs)	Number of nodes representing Resource Units	Desktop EWR	Existing EWR sites as key nodes	Extrapolated from EWR sites
W1	7 (W11, W12-a, W12-b, W12-c, W12-d, W12-e, W13)	12	9	3	0
W2	3 (W21, W22, W23)	15	7	4	4
W3	4 (W31-a, W31-b, W32-a, W32-b)	12	8	1	3
W4	5 (W41, W42-a, W42-b, W44, W45)	9	7	1	1
W5	4 (W51, W52, W55, W57)	13	11	1	1
W7	2 (W70-a, W70b)	0	0	0	0
W2&W3	1 (IUA St Lucia)	0	0	0	0
TOTAL	**26**	**61**	**42**	**10**	**9**

For the 42 nodes requiring a desktop assessment of the EWR, the PES and EIS are used to derive the REC according to established rules. Information based on the sources and causes of the problems (whether flow-related or non-flow related) are utilised to derive the Ecological Category for which a desktop model will be applied to estimate the EWRs.

Eighteen of the 42 nodes require the PES to be improved (i.e. the REC is a higher Ecological Category than the PES) based on a High or Very High importance. Of these 18 nodes, seven nodes require this improvement to be achieved by improvement in flow. This may be a partial improvement (i.e. a half Ecological Category improvement where the other half is achieved by mitigating non-flow related activities) or a full category improvement.

8.2 RESULTS: DESKTOP BIOPHYSICAL NODES

The estimation of EWRs in this study applies Version 2 of the Revised Desktop Reserve Model (RDRMv2). The RDRM is a Desktop application of the Habitat-Flow Stressor-Response Ecological Water Requirement Methodology. The RDRM explicitly includes the links and relationships between hydrology, hydraulics and hydraulic-habitat, and ecological response. The RDRMv2 runs within the Spatial and Time Series Information Modelling (SPATSIM) software.

Generally, the ranges of recommended EWRs expressed as percentages of the Naturalised Mean Annual Runoffs (MARs) range from, for B, B/C, C and D ECs: 30.2 to 46.0, 38.7 to 49.9, 29.6 to 46.1, and 29.7 to 33.1. While there is a general overall reduction in proportion of MAR with reducing EC, there is no clear / simple relationship, since EWRs are also a function of the links/relationships between *inter alia* hydrological, hydraulic, and ecological characteristics as well as Present Day (PD) flows (when constrained), which vary for the different biophysical nodes. The RDRMv2 is developed to explicitly account for these links/relationships at the Desktop level of assessment.

The EWR results are provided (as part of e-data provided as a deliverable for this study) in the following formats as text files named according to the biophysical node:

- RDRMv2 generated reports.
- Assurance rules for EWR low flows and total flows (in 10^6 m^3).
- Time-series of monthly EWR low and total flows (in 10^6 m^3)[2].

A summary of low and high flow EWR long-term requirements (which are computed from the monthly EWR time-series), naturalised and PD Mean Annual Runoff (MAR), and other supporting information, is provided in **Table 3.1**. For the seven nodes where an improvement of the PES is recommended, the Flow-Duration Curve (FDC) is not constrained based on PD hydrology.

Several nodes are located in wetland-type environments with no well-defined low flow channel, for which the RDRM was not explicitly developed. For these nodes, the full length of the river channel was assessed within the SQ to obtain an indication of channel widths along reaches where low flows appear to be contained within a defined channel. An example of such a node is W31-6, which for B REC has an EWR of 11.96 10^6 m^3 (59.3% naturalised MAR). Since this is notably higher relative to the results for other nodes assessed (refer to **Table 8-2**), a range of alternative, but reasonable, parameter values were also assessed to check result sensitivity. Also, the sensitivity analysis available in the RDRMv2 was also used. The EWR results, however, did not change substantially; given this, a more detailed analysis based on field data is recommended to increase the certainty of this Desktop assessment, if required.

Hydraulic information from previous EWR assessments was available for biophysical nodes on the upper Mhlathuze (W12-1), lower Mfule (W55-2) and Lusushwana (W55-2). The RDRMv2 was applied without (i.e., Desktop hydraulics) and with surveyed and modelled hydraulic information. This resulted in an absolute average change in the total EWR requirement by 2.3% (max. of 3.9%); while this is only for these three sites, the small change is reassuring.

Excluding the above two nodes, the ranges of recommended EWRs expressed as percentages of the Naturalised MARs range from, for B, B/C, C and D ECs: 30.2 to 46.0, 38.7 to 49.9, 29.6 to 46.1, and 29.7 to 33.1. While there is a general overall reduction in proportion of MAR with reducing EC,

[2] Note, total flow time-series are not constrained to PD for any of the biophysical nodes, whereas FDCs are.

there is no clear / simple relationship, since EWRs are also a function of the links / relationships between *inter alia* hydrological, hydraulic, and ecological characteristics as well as PD flows (when constrained), which vary for the different biophysical nodes. The RDRMv2 is developed to explicitly account for these links/relationships at the Desktop level of assessment.

Table 8-2: Summary of Desktop EWRs for desktop biophysical nodes in the Usutu to Mhlathuze River secondary catchments W1 to W5

Node	Sub-quaternary	River	Catchment area (km^2)	MAR			PES	REC	Constrain FDC[3]	EWR long-term requirements			
				10^6 m^3		PD (% Nat)				MAR low flows		MAR total flows	
				Nat	PD					10^6 m^3	% Nat	10^6 m^3	% Nat
Secondary catchment W1													
W11-1	W11A-03597	Matigulu	183.8	22.78	13.06	57.3	B	B	PD	4.68	20.6	7.16	31.4
W12-1	W12A-03153	Mhlatuze	309.5	32.15	23.32	72.5	B	B	PD	8.21	25.5	12.79	39.8
W12-2	W12B-03356	Mhlatuze	840.8	95.13	28.48	29.9	B	B	PD	22.83	24.0	37.90	39.8[4]
W12-3	W12B-03479	Mhlatuze	1055.0	125.08	162.13	139.6	C	C	PD	35.66	28.5	51.63	41.3
W12-4	W12B-03336	KwaMazula	92.0	12.87	9.89	76.8	C	B/C	Nat	4.40	34.2	6.12	47.6
W12-5	W12C-03303	Mfule	571.0	50.80	37.84	74.5	C	C	PD	16.12	31.7	20.54	40.4
W12-7	W12E-03526	Mhtatuzana	172.0	23.13	21.76	94.1	B	B	PD	6.86	29.6	8.76	37.9
W13-1	W13A-03609	Mlalazi	400.7	107.19	97.34	90.8	C	C	PD	31.46	29.4	41.20	38.4
W13-2	W13B-03774	Manzamnyama	162.5	42.57	3.72	8.7	B/C	B/C	PD	3.70	8.7	8.02	18.8[4]
Secondary catchment W2													
W21-1	W21B-02546	White Mfolozi	670.6	53.41	33.38	62.5	C	B/C	Nat	17.74	33.2	25.01	46.8
W21-2	W21B-02670	White Mfolozi	920.0	63.55	41.59	65.4	B	B	PD	17.88	28.1	29.52	46.4
W21-3	W21F-02727	White Mfolozi	1492.7	103.29	79.16	76.6	C	C	PD	24.47	23.7	40.80	39.5
W21-4	W21D-02815	Mvunyane	885.0	66.00	60.51	91.7	D	D	PD	10.85	16.4	19.85	30.1
W22-3	W22F-02726	Sikwebezi	475.9	69.08	60.58	87.7	C	C	PD	15.61	22.6	26.18	37.9
W23-1	W23A-03113	Mfolozi	9165.2	808.98	533.98	66.0	B	B	PD	219.47	27.1	353.70	43.7
W23-2	W23B-03250	Ntobozi	142.8	19.38	16.49	85.1	B	B	PD	6.12	31.6	8.36	43.2
Secondary catchment W3													
W31-1	W31B-02477	Mkuze	674.0	56.17	48.87	87.0	C	B/C	Nat	14.69	26.1	23.31	41.5
W31-2	W31D-02500	Mkuze	1135.1	99.66	89.19	89.5	B	B	PD	27.99	28.1	44.51	44.7

[3] Discharge constrained to not exceed Nat or PD on the FDC.
[4] > PD, since total flows are NOT constrained to PD in the long-term time-series; FDCs are, however, constrained.

Node	Sub-quaternary	River	Catchment area (km^2)	MAR			PES	REC	Constrain FDC[3]	EWR long-term requirements			
				10^6 m^3		PD (% Nat)				MAR low flows		MAR total flows	
				Nat	PD					10^6 m^3	% Nat	10^6 m^3	% Nat
W31-6	W31L-02569	Msunduzi	1176.0	20.16	19.28	95.6	B	B	PD	8.64	42.9	11.96	59.3[5]
W32-2	W32E-02865	Hluhluwe	405.8	23.90	23.67	99.0	B	B	PD	3.69	15.5	7.21	30.2
W32-3	W32G-02973	Nyalazi	162.0	11.80	11.78	99.9	B	B	PD	2.40	20.3	3.89	32.9
W32-4	W32G-03055	Nyalazi	356.4	25.92	25.92	100.0	C	C	PD	3.83	14.8	7.68	29.6
W32-5	W32C-02671	Mzinene	611.5	20.80	16.82	80.9	C	C	PD	3.82	18.4	7.23	34.8
W32-6	W32C-02612	Munywana	109.2	3.72	3.67	98.9	B	B	PD	0.92	24.6	1.64	44.1
Secondary catchment W4													
W41-1	W41E-02359	Bivane	1182.3	221.53	190.28	85.9	C	B/C	Nat	55.34	25.0	85.73	38.7
W41-2	W41F-02433	Manzana	343.0	45.09	43.56	96.6	B	B	PD	10.57	23.4	16.68	37.0
W42-1	W42B-02271	Phongolo	1191.0	264.38	237.40	89.8	C	B/C	Nat	52.03	19.7	102.96	38.9
W42-4	W42K-02272	Mozana	416.0	52.70	46.50	88.2	B	B	PD	14.40	27.3	22.37	42.4
W42-5	W42M-02352	Phongolo	5739.8	901.99	784.54	87.0	B	B	PD	180.04	20.0	335.16	37.2
W43-1	W43F-02072	Ngwavuma	632.0	26.95	26.86	99.7	C	C	PD	3.74	13.9	9.00	33.4
W44-1	W44D-02304	Phongolo	6966.2	942.03	654.62	69.5	D	D	PD	124.76	13.2	251.62	26.7
Secondary catchment W5													
W51-1	W51A-02082	Assegaai	633.9	99.61	89.91	90.3	C/D	C	Nat	27.31	27.4	40.96	41.1
W51-4	W51F-01986	Blesbokspruit	312.5	43.36	40.50	93.4	C	C	PD	12.59	29.0	17.98	41.5
W52-1	W52D-01862	Hlelo	874.4	97.06	78.34	80.7	B/C	B/C	PD	26.96	27.8	42.77	44.1
W53-1	W53A-01804	Ngwempisi	463.6	38.66	28.14	72.8	D	D	PD	8.03	20.8	12.80	33.1
W53-2	W53B-01694		48.8	5.05	4.00	79.1	B/C	B/C	PD	1.53	30.3	2.14	42.4
W53-3	W53E-01790	Ngwempisi	1575.9	181.14	100.52	55.5	C	C	PD	39.32	21.7	66.00	36.4
W54-1	W54B-01569	uSuthu	403.3	32.77	24.22	73.9	B	B	PD	9.05	27.6	15.07	46.0
W54-2	W54D-01593	uSuthu	779.0	79.46	32.29	40.6	C	C	PD	17.82	22.4	27.84	35.0
W55-1	W55E-01477	Mpuluzi	1130.0	128.96	110.43	85.6	B/C	B/C	PD	48.05	37.3	64.37	49.9
W55-2	W56A-01372	Lusushwana	234.8	39.48	36.19	91.7	C	C	PD	14.09	35.7	18.19	46.1

[5] Refer to discussion in text.

Node	Sub-quaternary	River	Catchment area (km^2)	MAR			PES	REC	Constrain FDC[3]	EWR long-term requirements			
				10^6 m^3		PD (% Nat)				MAR low flows		MAR total flows	
				Nat	PD					10^6 m^3	% Nat	10^6 m^3	% Nat
W55-7	W57K-01929	uSuthu	16388.0	2289.46	1434.03	62.6	B/C	B	Nat	487.89	21.3	922.46	40.3

MAR = Mean Annual Runoff (in million cubic metres, i.e., 10^6 m^3); Nat = Natural; PD = Present Day; PES = Present Ecological State; REC = Recommended Ecological Category; FDC = Flow-Duration Curve; Long-term requirements derived from monthly time-series (high flows are NOT CONSTRAINED in the RDRMv2 though the total FDCs are).

8.3 RESULTS: EWR SITES

A summary of the EcoClassification results and EWR per site is provided in the Tables that follow.

Table 8-3: EWR MA1: 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
PRESENT ECOLOGICAL STATE: PES								
I IHI[5]	**R IHI[6]**	**PC[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%)**
ECOLOGICAL IMPORTANCE AND SENSITIVITY								
MODERATE								
RECOMMENDED ECOLOGICAL CATEGORY (REC) = PES								
REC = B/C for ECOSTATUS								
ECOLOGICAL WATER REQUIREMENTS (EWR)								
Natural MAR: 55.17 MCM[11]					Present day MAR: 41.85 MCM			
Low flow EWR					**Total flow EWR**			
MCM		% of nMAR[12]			MCM		% of nMAR	
13.04		23.6			18.75		34	

Table 8-4: 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
PRESENT ECOLOGICAL STATE: PES								
I IHI	**R IHI**	**PC**	**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%)**
ECOLOGICAL IMPORTANCE AND SENSITIVITY								
MODERATE								
RECOMMENDED ECOLOGICAL CATEGORY (REC) = PES								
REC = C for ECOSTATUS								

ECOLOGICAL WATER REQUIREMENTS (EWR)			
Natural MAR: 31.23 MCM		Present day MAR: 31.56 MCM	
Low flow EWR		**Total flow EWR**	
MCM	% of nMAR	MCM	% of nMAR
4.76	15.2	6.85	21.9

Table 8-5: 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
PRESENT ECOLOGICAL STATE: PES								
I IHI	**R IHI**	**PC**	**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 (77.08**	**B/C (79.2%)**
ECOLOGICAL IMPORTANCE AND SENSITIVITY								
MODERATE								
RECOMMENDED ECOLOGICAL CATEGORY (REC) = PES								
REC = B/C for ECOSTATUS								

ECOLOGICAL WATER REQUIREMENTS (EWR)			
Natural MAR: 222.51 MCM		Present Day MAR: 191.8 MCM	
Low flow EWR		**Total flow EWR**	
MCM	% of nMAR	MCM	% of nMAR
54.74	24.6	89.31	40.1

Table 8-6: 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
PRESENT ECOLOGICAL STATE: PES								
I IHI	**R IHI**	**PC**	**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%)**
ECOLOGICAL IMPORTANCE AND SENSITIVITY								
MODERATE								
RECOMMENDED ECOLOGICAL CATEGORY (REC) = PES								

REC = C for ECOSTATUS			
ECOLOGICAL WATER REQUIREMENTS (EWR)			
Natural MAR: 166.72 MCM		Present Day MAR: 144.13 MCM	
Low flow EWR		**Total flow EWR**	
MCM	% of nMAR	MCM	% of nMAR
18.38	11	43.58	26.1

Table 8-7: EWR MK1: Mkuze River

EWR MK1: Mkuze River								
							Coordinates	S27.59210 E32.21800
							SQ code	W31J-02480
							RU	RU W31-5
							IUA	IUA W31-b
							Level 2 EcoRegion	3.08
							Geomorph Zone	Lowland
PRESENT ECOLOGICAL STATE: PES								
I IHI	**R IHI**	**PC**	**Geom**	**Rip Veg**	**Fish**	**Inverts**	**Instream**	**EcoStatus**
C (66.3%)	**C (72.1%)**	**C/D (58.3%)**	**B (82.26%)**	**C (73%)**	**C (75.4%)**	**C (77.7%)**	**C (76.6%)**	**C (74.8%)**
ECOLOGICAL IMPORTANCE AND SENSITIVITY								
HIGH								
RECOMMENDED ECOLOGICAL CATEGORY (REC) = PES								
REC = B for ECOSTATUS (Impacts non-flow related and flows will be set for a C EC)								
ECOLOGICAL WATER REQUIREMENTS (EWR)								
Natural MAR: 158.75 MCM				Present Day MAR: 106.13 MCM				
Low flow EWR				**Total flow EWR**				
MCM	% of nMAR			MCM			% of nMAR	
34.74	21.9			58.87			37.1	

Table 8-8: EWR UP1: Pongola 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
PRESENT ECOLOGICAL STATE: PES								
I IHI	**R IHI**	**PC**	**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%)**
ECOLOGICAL IMPORTANCE AND SENSITIVITY								

MODERATE			
RECOMMENDED ECOLOGICAL CATEGORY (REC) = PES			
REC = C for ECOSTATUS			
ECOLOGICAL WATER REQUIREMENTS (EWR)			
Natural MAR: 356.84 MCM		Present Day MAR: 299.39 MCM	
Low flow EWR		**Total flow EWR**	
MCM	% of nMAR	MCM	% of nMAR
54.84	15.4	97.31	27.3

Table 8-9: 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
PRESENT ECOLOGICAL STATE: PES								
I IHI	**R IHI**	**PC**	**Geom**	**Rip Veg**	**Fish**	**Inverts**	**Instream**	**EcoStatus**
C/D (59.1%)	**C/D (58.7%)**	**B/C (80.6%)**	**C (70.84%)**	**C (69.9)%**	**C (69.2%)**	**B/C (78.6%)**	**C (77.8%)**	**C (74.16%)**
ECOLOGICAL IMPORTANCE AND SENSITIVITY								
MODERATE								
RECOMMENDED ECOLOGICAL CATEGORY (REC) = PES								
REC = C for ECOSTATUS								
ECOLOGICAL WATER REQUIREMENTS (EWR)								
Natural MAR: 328.61 MCM				Present Day MAR: 164.11 MCM				
Low flow EWR				**Total flow EWR**				
MCM	% of nMAR			MCM			% of nMAR	
40.06	12.2			70.85			21.6	

Table 8-10: 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

PRESENT ECOLOGICAL STATE: PES								
I IHI	**R IHI**	**PC**	**Geom**	**Rip Veg**	**Fish**	**Inverts**	**Instream**	**EcoStatus**
C (64.3%)	**C/D (61.8%)**	**B (85.5)**	**B (83.3.%)**	**B/C (77.4%)**	**C (72.8%)**	**B (87.3%)**	**B/C (80.36%)**	**B/C (79.8%)**
ECOLOGICAL IMPORTANCE AND SENSITIVITY								
MODERATE								
RECOMMENDED ECOLOGICAL CATEGORY (REC) = PES								
REC = B/C for ECOSTATUS								

ECOLOGICAL WATER REQUIREMENTS (EWR)			
Natural MAR: 156.33 MCM		Present Day MAR: 79.15 MCM	
Low flow EWR		**Total flow EWR**	
MCM	% of nMAR	MCM	% of nMAR
30.46	19.5	50.82	32.5

1 Sub-quaternary reach.
2 Resource Unit.
3 Integrated Unit of Analysis
4 Geomorphic Zone
5 Instream component of Index of Habitat Integrity.
6 Riparian component of Index of Habitat Integrity.
7 Physico-Chemical
8 Geomorphology'
9 Riparian Vegetation
10 Macro-invertebrates
11 Million Cubic Meters
12 Natural Mean Annual Runoff

9 ESTUARIES

The purpose of this chapter is to provide an overview of the estuaries included in the study. These estuaries were visited as part of a site visit to gather information in October 2022.

9.1 KOSI ESTUARY

9.1.1 Water Quality and Microalgae

The Kosi system consists of a series of four interconnected lakes about 10 km in length that run parallel to the Indian Ocean. A salinity gradient was apparent in September 2022 from Lake 4 to the estuary with salinity of 0.63 reported for Lake 4, 5.55 - Lake 3, 11.2 - Lake 2 and 15.6 for Lake 1 surface waters and 27 for bottom waters. The salinity in the estuary ranged from 22 to 27. The edges of Lake 3 were supersaturated with oxygen values of 120 – 130%.

9.1.2 Macrophytes

The estuarine lake system is of considerable botanical importance because the salinity gradient that characterises the transition from the lakes to the sea supports nationally important areas of submerged macrophytes, swamp forest and mangrove habitat. Kosi is a unique estuary with characteristics of a tropical system as indicated by the seagrass *Halodule universis* that only occurs here as well as the mangrove species *Lumnitzera racemosa, Ceriops tagal* and *Xylocarpus granatum.*

The same transects sampled in 2016 were revisited to check the distribution of submerged and emergent macrophytes along a water depth and elevation gradient. Only sites 19 and 22 were not checked in detail in 2022 due to hippos blocking access. On 29 September the west bank of Lake 3 and Lake 4 and Sihadhla River / Channel were visited to check macrophyte distribution. Since the field work in 2016 the vegetation (reeds and sedges) had grown further downstream in the channel towards Lake 4. On 30 September Lakes 1, 2 and east bank of Lake 3 was visited. Thick pondweed and filamentous green macroalgae filled the water column up to a depth of 2 m parallel to the steep east banks characterizing Lake 3. The estuary / mouth area was visited on 1 October 2022. The mangrove area was very disturbed due to harvesting activities but was fringed by healthy *Juncus kraussi* marshes. We walked along the water's edge to the estuary mouth. Two seagrass species were present *Halodule universis* and *Zostera capensis*. There has been an increase in macroalgal cover in all lakes and the estuary; possible indication of nutrient enrichment. Although extensively harvested the stands of mangroves were regenerating as indicated by a range of size classes. We walked through the water channel and past the fish traps to the mangroves adjacent to the steep east banks. Here there were some signs of harvesting; overall the mangroves are extensive and healthy (**Figure 5.1 - 5.7**).

9.1.3 Sediment Sampling

Sediment samples were collected from three sites at the Kosi Estuary (See **Appendix A**). Site 1 was located within the tidal estuary (26.89879°S; 32.86250°E), Site 2 was located on the southern bank of Lake Makhawulani (26.93263°S; 32.85558°E), and Site 3 was located within the Mthando Channel (26.94530°S; 32.84606°E) between Lake kuMpungwini and Lake kuNhlange. Sites 2 and 3 were sampled on Saturday, 30 September 2022, and Site 1 was sampled on Sunday, 1 October 2022. At Site 1, four cores each were sampled from mixed mangrove (*Rhizophora mucronata*, *Bruguiera gymnorrhiza*, and *Avicennia marina*), reeds and sedges (*Phragmites australis*), and salt

marsh (*Juncus kraussii*). There was evidence of cattle trampling in the salt marsh. The sediment ranged from being muddy in mangroves, to sandy mud and sand in the reeds and sedges and salt marsh respectively. At Site 2, four cores each were sampled from mixed mangrove (*Lumnitzera racemosa*, and *Ceriops tagal*), as well as from reeds and sedges (mosaic of *Phragmites australis* and *Cyperus crassipes*). There was a very narrow band of salt marsh (*Sporobolus virginicus*) parallel to the water's edge that was not sampled as it was traversed by a footpath. This site had evidence of disturbance from mangrove harvesting, as well as trampling. The sediment appeared predominantly sandy mud to sand, with an organic layer at ~ 20 cm depth. At Site 3, four cores were sampled each from mangrove (*Lumnitzera racemosa*) and reeds and sedges (*Phragmites australis*). There was evidence of disturbance at the site, with lots of wood debris (dead wood). The cores were predominantly muddy sand, to mud, with up to 10 cm of compaction. Some sections of the cores were lost during extraction due to high volume of water down to 20 cm depth.

9.1.4 Invertebrates

All samples are yet to be analysed but the impression was of a system that has an increasing salinity profile in the upper reaches. This was also evidenced by for e.g., the sand prawn (*Kraussillichirus kraussi)* which was historically prolific in Lakes Mpungwini and Makhawulani, but this survey found evidence of increased distribution into Lake Nhlange (Lake 3, sites NHL1, NHL3 and NHL4; **Figure 5.9**). Also notable was the spread of the invasive gastropod *Tarebia granifera* further into Lake Nhlange where it seems to have spread from the boat launch area initially. The giant mangrove whelk, *Terebralia palustris* (**Figure 5.10**) was fairly common at waypoint 221 and the shells of which were used by an as yet unknown species of hermit crab. The whelk has all but disappeared from every other mangrove system to the south. Invertebrate bycatch from fish seines were retained for identification.

9.1.5 Fish

In all, 25 species of fish were caught and at least another 10 seen whilst sampling and using mask and snorkel. Harrison recorded a total of 18 species in this estuary. Local fisherman indicated that the high abundance of macroalgal growth in the fish traps has not happened before in living history. See **Appendix C** for a summary of fish species caught during the trip. A high number of Illegal gillnets were found in 4th Lake, never observed before (new pressure).

9.1.6 Summary

- Mouth open.
- Lake water levels higher than in 2016.
- System shows signs of drought recovery.
- Despite being a very Important Estuarine Lake in a formally protected area there are significant signs of further decline in condition – system now likely to be B Category.
- Significant increase in clearing of natural vegetation (land use change), increase harvesting pressure on mangroves, more fish traps (first time fish traps observed in 3de Lake), and gill nets observed for the first time in 4th Lake.
- Significant submerged macrophyte and macroalgal growth observed in 3rd lake.
- Local fisherman indicated that this has not happened before in living history, e.g., macroalgal growth in fish traps. Indicating nutrient enrichment but will need to confirm source.
- In all, 25 species of fish were caught and at least another 10 seen whilst sampling or using a mask and snorkel.

9.2 UMGOBEZELENI ESTUARY

9.2.1 Water Quality and Microalgae

On Monday 3 October 2022 the mouth of the estuary was open to the sea. The estuary was perched and freshwater flowed to the sea. The lower (Site 1) and middle (Site 2) reaches of the estuary were characterised by fresh (salinity < 1) surface waters, with brackish (>5) and hypoxic (< 2 mg l^{-1}) bottom-waters. The upper reaches (Site 3) were fresh and hypoxic. The mouth area is a boat launching site for Sodwana Bay fishing and diving and is severely disturbed by the high intensity of vehicle activity (**Table 6.1**).

9.2.2 Macrophytes

Grassy banks characterized the lower reaches with fringing swamp forest. Surviving mangroves occurred adjacent to the road on the west bank. There were seedlings, saplings and adults of the black mangrove *Bruguiera gymnnorhiza*. Across from this site were dead trunks of black mangrove growing amongst the mangrove fern and adjacent to reeds and sedges closer to the water column and swamp forest (*Hibiscus tiliaceus*) closer to land. Mangroves died in the estuary in the 1970s when he road bridge was built across the estuary. There was another dieback in 2007 when there was mouth closure and high water level (Taylor, 2016). Mangrove fern *Acrostichum* occurred in the area of dead trees with dense surrounding reeds. Reeds and sedges were abundant colonizing most of the lower estuary reaches. The surviving mangroves require protection; there were signs of bark harvesting and disturbance from road and recent fence construction.

9.2.3 Sediment Sampling

Sediment samples were collected from two sites at the uMgobezeleni Estuary (See **Appendix A**). Site 1 was located just beyond the bridge, on the northern bank of the estuary channel (27.54182°S; 32.67612°E) and Site 2 was located slightly further upstream on the southern bank (27.54250°S; 32.67623°E). Site 2 was accessed from the road as the swamp forest vegetation prevented access from the estuary channel.

At Site 1, four cores were sampled each from swamp forest (*Hibiscus tiliaceus*) and reeds and sedges (*Phragmites australis*). The site was a mosaic of reeds and sedges and swamp forest. The vegetation was dense. The site was located among tall dead mangrove (*B. gymnorrhiza*). The cores were predominantly sandy mud with compaction ranging from 0 - 6 cm. At Site 2, four cores were sampled from swamp forest only (*Hibiscus tiliaceus*). Reeds and sedges at this site were not accessible for sampling, as they only occurred in areas where the sediment was submerged. Under these conditions the sediment is lost from the corer when it is extracted. There were individual live mangrove trees (*B. gymnorrhiza*) in amongst the swamp forest vegetation.

9.2.4 Invertebrates

All samples are yet to be analysed (**Figure 6.4** for site locations). Samples appeared more depauperate than from similar sediment habitats in Kosi and sediments had much particulate organic decaying matter (POM) which with the low oxygen levels measured would not support an abundant benthic invertebrate community. Invertebrate bycatch from fish seines were retained for identification.

9.2.5 Fish

A total of 18 fish species were sampled which compares well with 14 recorded across all previous studies. Of interest, is the existence of spotted bass *Micropterus punctulatus*, probably descendants of bass introduced in the 1950s to 1970's. The system represents a fully functional estuarine lake system. More important than previously indicated. New recruits of obligate estuarine-dependent fish species were recorded in uMgobezeleni Lake (< 2 weeks old freshwater mullet that was recruited from the sea). See **Appendix C** for a summary of fish species caught during the trip. Illegal gillnets found in the uMgobezeleni Lake.

9.2.6 Summary

- Mouth open.
- Limited salinity penetration in lower reaches.
- System in good condition.
- Fully functional estuarine lake system.
- More important than previously indicated.
- New recruits of fish were recorded in uMgobezeleni Lake (< 2 weeks old freshwater mullet that recruited from the sea).
- New individuals of black mangrove were observed.
- However, urgent action is needed to protect mangroves (e.g., road through mangroves) and fish (high number of illegal gillnets in the lakes).
- A total of 18 fish species were sampled which compares well with 14 recorded across all previous studies.
- Of interest, is the existence of spotted bass *Micropterus punctulatus*, an alien invasive not previously recorded in the system.

9.3 INHLABANE ESTUARY

9.3.1 Water Quality and Microalgae

On Tuesday 4 October 2022 the estuary was accessed at the mouth and then in the upper reaches at the barrage that separates the lake from the estuarine lake. The lower estuary was highly impacted from plastic pollution and water quality deterioration as indicated by the presence of leeches and bilharzia snails. The estuary was closed to the sea (**Figure 7.1**). Freshwater conditions (< 0.6) were present throughout the estuary, with biologically stressful (< 5 mg l^{-1}) and hypoxic (< 2 mg l^{-1}) conditions characterising the surface and bottom waters, respectively (**Table 7.1**). Standing stagnant water near the mouth was surrounded by dense emergent vegetation of bulrush, reeds, sedges and bulrush. Water lilies covered the water surface area and the herb *Centella asiatica* and sedge *Eleocharis* sp. was abundant on the sandy edges (**Figure 7.1 - 7.4**).

9.3.2 Macrophytes

At the barrage / dam wall that separates the iNhlabane Estuary from the dam / previous estuarine lake the aquatic invasive plant *Pistia stratiotes* (water cabbage) was floating on the surface water. Also present was large submerged beds of the invasive aquatic macrophyte *Ceratophyllum demersum* that is associated with slow flowing, freshwater eutrophic habitats. Pondweed *Stuckenia pectinata* was also present as well as the floating invasive *Lemna minor* (duckweed) (**Figure 7.5 - 7.7**).

9.3.3 Sediment Sampling

Sediment samples were collected from one site at the iNhlabane Estuary (See **Appendix A**). Vegetated areas could not be accessed for sampling at the upper reaches site near the bridge. Site 1 was located adjacent to the estuary channel in a flat seepage area (28.65883°S; 32.25862°E). The estuary was closed at the time of sampling on Tuesday 4 October 2022. At Site 1, four cores were sampled from reeds and sedges (*Phragmites australis*, *Typha capensis*). Other species present included *Paspalum vaginatum* and *Centella* sp. The sediment was predominantly sandy and compaction ranged from 0 - 2 cm.

9.3.4 Invertebrates

All samples are yet to be analysed (**Figure 7.8** for site locations). The system is no longer functioning as an estuary, visible invertebrates sampled were all freshwater insects (*Diptera, Zygoptera*). Also noted were gastropods *Physa* and *Biomphalaria* which are the intermediate snail hosts for *Schistosoma,* widespread alien invasive *Tarebia granifera* on the subtidal sediment surface and giant Hirudinea (still to be identified) among the macrophytes of the lower reaches *(***Figure 7.9***).*

9.3.5 Fish

Only three species of fish were sampled, all freshwater taxa tolerant of poor water quality. No estuarine functionality remaining. See **Appendix C** for a summary of fish species caught during the trip.

9.3.6 Summary

- Mouth Closed.
- Significant further decline in condition.
- Very high unnatural sand dune has formed in mouth indicating years of flow depravation.
- No connection to the sea. Mouth has not been open in years.
- EWR cannot have been released in years. System was completely fresh as indicated by leeches, water lilies and tadpoles.
- Extensive loss of open water area due to macrophyte growth.
- Water body infested with bilharzia snail vectors.
- No flow over the weir. Fishway non-functional.
- No estuarine functionality remains in what was once an important estuarine lake in the region due to freshwater flow depravation.
- Only three species of fish were sampled, all freshwater taxa tolerant of poor water quality.
- Extensive infestation by alien invasive *Terebia granifera* snails.
- Other macroinvertebrates sampled seemed only to be various dragonfly larvae supporting no current estuarine function.
- System is now used for livestock watering (evidence around lower estuary margins), further degrading water quality and nutrients allowing proliferation of macrophytes which have closed off the middle reaches (see satellite imagery).

9.4 ISIYAYA ESTUARY

9.4.1 Water Quality and Microalgae

On Wednesday 5 October 2022 the estuary was visited at the mouth. The water trickled fresh between the dunes but was not connected to the sea. Freshwater (salinity < 1) and biologically

stressful dissolved oxygen (< 5 mg l^{-1}) conditions were present throughout the estuary. An isolated shallow pool near the mouth (Site 1) exhibited brackish (salinity *ca.* 2.5) and supersaturated dissolved oxygen (> 11 mg l^{-1}) conditions, as well as extensive benthic microalgal growth (**Table 8.1**).

9.4.2 Macrophytes

Casuarina trees occurred on the east bank and the west bank was steep and colonized by dune vegetation. Grassy banks consisted of *Paspalum vaginatum* with some sharp rush *Juncus kraussii*. Small patches of filamentous green algae occurred in the lower reaches. Just upstream from the mouth (~650 m) dense stands of reeds, sedges and bulrush occurred. Where there were open water lilies were present and other aquatic plants such as *Persicaria decipiens*. The estuary was also accessed via the dunes at a site 1.18 km upstream from the mouth. Here swamp forest was present. Team member's photos from the wood bridge site showed flooded *Barringtonia racemosa* and some die-back possibly due to high water level. Here there was evidence of silt input possibly from upstream mining activities. The estuary has a long history of catchment disturbance that has resulted in sedimentation, shallowing and expansion of reeds, sedges and swamp forest; little open water surface area remains. *Barringtonia racemosa* and *Hibiscus tiliaceus* swamp forest are also encroaching as a result of the shallowing and freshening of the estuary (**Figure 8.3 - 8.7**).

9.4.3 Sediment Sampling

Sediment samples were collected from one site at the iSiyaya Estuary (See **Appendix A**). Vegetated areas could not be accessed for sampling at the upper reaches site near the bridge or along the estuary channel. Site 1 was located adjacent to the estuary channel on the northern bank (28.96444°S; 31.76450°E). The estuary was closed at the time of sampling on Wednesday, 5 October 2022. At Site 1, four cores were sampled from reeds and sedges (*Schoenoplectus brachyceras*, *Juncus kraussi*). Some *Triglochin* sp. was also present. The sediment was predominantly sandy with no compaction occurring on the cores.

9.4.4 Invertebrates

All samples are yet to be analysed (**Figure 8.8** for site locations). Visible fauna included macrocrustaceans *Varuna litterata* (swimming crab) and *Kraussillichirus kraussi* (sand prawn) (**Figure 8.9**) which are remnant estuarine indicative, whereas all other visible aquatic invertebrates were Insecta given the brackish/fresh conditions along the system (salinity 2.39 at the closed mouth). Invertebrate bycatch from fish seines were retained for identification.

9.4.5 Fish

A total of 18 species of fish were sampled in the lower reaches which compares well with the 13 recorded in previous studies. Low species diversity is typical of a predominantly closed estuary. The relatively high species count in the current survey was likely influenced by the fish in the lower reaches being concentrated into small ponds at the mouth, remnants of the larger system which were effectively acting as refugia in very low water level conditions. See **Appendix C** for a summary of fish species caught during the trip.

9.4.6 Birds

Very few waterbirds were present. Access to this estuary for waterbird counting is restricted due to the low water levels. No existing or past waterbird counts exist for this estuary in the Coordinated Waterbird Counts (CWAC) database. The high turbidity due to mine siltation would be highly

negative for visual piscivorous waterbird species and also likely highly negative for invertebrate feeders if the substrate is smothered by this silt. See **Appendix D** for a summary of bird species observed during the trip.

9.4.7 Summary

- Mouth Closed.
- Declining further in condition.
- Very little flow reaches the estuary.
- Only small stagnant pools were observed in the mouth area. Very high turbidity was observed in the middle and upper reaches linked to possible upstream slimes dam input and contamination - to be confirmed with satellite imagery.
- This said, a total of 18 species of fish were sampled and compares well with previous studies.
- The relatively low species count in this and earlier studies are typical of a predominantly closed estuary. Very few waterbirds were present.
- The high turbidity due to mine siltation is highly negative for visual piscivorous waterbird species and also likely highly negative for invertebrate feeders if the substrate is smothered by this silt.

9.5 UMLALAZI ESTUARY

9.5.1 Water Quality and Microalgae

The lower reaches of the estuary were marine and well-oxygenated, while the mid- to upper reaches (Site 2 and 3) were characterised by vertically stratified salinity profiles (i.e., saltier water underlying brackish surface waters) and bottom-water hypoxia (< 2 mg l^{-1}). Several oxygen-deprived zones noted (particularly in mid-lower reaches) in the bottom water column layer (<3% saturation) (**Table 9.1**).

9.5.2 Macrophytes

From the launch site downstream stringy filamentous green algae was abundant possibly indicating nutrient enrichment. This is a perfect site for long term monitoring of mangroves due to lack of pressures such as harvesting and cattle browsing. White mangrove and black mangrove were dominant with recruitment throughout the estuary. Stands of different age structures indicating a regenerating forest was found in the lower, middle and upper reaches of the estuary. Mangroves were most extensive in the middle reaches where intertidal and floodplain habitat occurs. According to Taylor (2020) the mangrove extent is 40 ha. Mangroves did not occur in the estuary prior to the 1930's and artificial mouth breaching created suitable intertidal conditions for mangrove expansion. The estuary also has important salt marsh and reed and sedge habitats (**Figure 9.2 - 9.5**).

9.5.3 Sediment Sampling

Sediment samples were collected from 3 sites at the uMlalazi Estuary (See **Appendix A**). Site 1 was located adjacent to the estuary channel (28.95348°S; 31.77404°E), Site 2 was located within the same area but further within the mangrove forest (28.95434°S; 31.77329°E), and Site 3 was located towards the landward edge where additional vegetation types were present (28.94592°S; 31.77752°E). The estuary was open at the time of sampling. Sites 1 and 2 were sampled on 5 October, and Site 3 was sampled on 06 October. At Site 1, four cores were sampled from mangroves (*Bruguiera gymnorrhiza* and *Avicennia marina*). The sediment was sandy at the surface, but then compact mud / clay along most of the core. No compaction was recorded. At Site 2, four cores were sampled from mangroves (*Bruguiera gymnorrhiza* and *Avicennia marina*). There were bare ground

patches in between the stands of trees where the sediment was compact and cracked at the surface. The sediment was predominantly muddy with no compaction recorded. At Site 3, four cores were sampled each from salt marsh (*Triglochin* sp., *Salicornia tegetaria*, and *Sporobolus virginicus*), and reeds and sedges (*Phragmites australis*, *Schoenoplectus brachyceras*, and *Juncus kraussii*). There was open mudflat between the mangroves (*Avicennia marina*) and the reeds and sedges. The cores were muddy and clay-like with no compaction recorded. Sediment samples were not collected from the mangroves here as the compact sediment in the reeds and sedges damaged the corer, preventing further use for the remainder of the day.

9.5.4 Invertebrates

All samples are yet to be analysed (**Figure 9.4** for site locations). Visible fauna included macrocrustaceans *Scylla serrata* (giant mud swimming crab) (**Figure 9.5**) and *Ashtoret lunaris* (moon crab). Penaeidae prawns, *Penaeus indicus* (Indian white prawn) and *P. monodon* (Giant tiger prawn) are using the system as a nursery area. Notable in the infauna samples thus far is the burrowing ocypodid crab, *Paratylodiplax blephariskios*. This small crab is endemic to the southeast coast of southern Africa where it forms an important component of the muddy estuaries (where it occurs). Twenty years ago, it was prolific in St Lucia but has not been noted there since then. Invertebrate bycatch from fish seines were retained for identification.

9.5.5 Fish

Very high fish species diversity was observed at this estuary, with for example, 46 fish species recorded during our one-day visit. Previous studies recorded a total of 58 species in the estuary. The system represents a very important nursery area in the region. It will be very important to maintain its present baseflows (prevent mouth closure) and water quality (i.e. no low oxygen levels) to ensure functionality and ecosystem services. See **Appendix C** for a summary of fish species caught during the trip. A number of Illegal gillnets were found in system.

9.5.6 Birds

A fairly comprehensive waterbird count was done from the Arc inflatable. Quite high numbers of Palearctic waders, especially Common Sandpiper – reflecting the muddy substrate which this species prefers. A single Eurasian Curlew was also recorded. The count information will be compared with CWAC data for the site. Small roost of Swift Terns at the mouth. See **Appendix D** for a summary of birds species observed during the trip.

9.5.7 Summary

- Mouth open.
- In a good condition, but some concern over water quality.
- Several oxygen-deprived zones noted (particularly in mid-lower reaches) in the bottom water column layer (<3% saturation).
- Upper reaches show increasing livestock influences (cattle/goats) and possible informal sand mining.
- Healthy mangroves and salt marsh habitat.
- Some macroalgal growth in the middle reaches. Very high species diversity, with for example 46 fish species recorded. Very important nursery area in the region.
- High numbers of Palearctic waders, especially Common Sandpiper – reflect the muddy substrate.

9.6 AMATIGULU/INYONI ESTUARY

9.6.1 Water Quality and Microalgae

On Friday 7 October 2022 the aMatikulu Estuary was accessed from the Dokodweni beach site near the mouth. The sea was overtopping into the perched estuary (**Figure 10.1**). Shallow conditions limited phytoplankton and water quality sampling to the confluence (Site 3; **Figure 10.1**) of the aMatigulu and iNyoni systems. The lower and middle reaches were characterised by well-mixed brackish conditions (salinity 12–16), with fresher conditions (salinity *ca*. 3) observed at the confluence (**Table 10.1**).

9.6.2 Macrophytes

The lower reaches were characterized by sandy banks with little vegetation. Large *Casuarina* trees occurred downstream of the launch site and there was some erosion. The same filamentous green algae (*Chaetomorpha*?) as that found in the Mlalazi Estuary was abundant in the lower reaches. Some pondweed (*Stuckenia pectinata*) occurred as patches in the lower and upper reaches. The estuary was shallow up to the first bend with gill nets across the channel. Both the Nyoni and straight channel of the Matikulu to the N2 were chocked up with sediment with no boat access. The confluence of the two systems is approximately 5 km from the mouth. Reeds, sedges and grassy banks characterized the north / east bank. The west / south banks were steep and colonized by the dune species *Scaevoli thunbergii.* Patches of saline grasses *Sporobolus virginicus* and *Paspalum vaginatum* occurred along the banks. The dominant sedge was *Schoenoplectus scirpioides* and reed *Phragmites australis*.

9.6.3 Sediment Sampling

Sediment samples were collected from one site at the aMatigulu/iNyoni Estuary. Site 1 was located adjacent to the estuary channel (29.10299°S; 31.61998°E) on the northern bank. This was the only accessible site for sampling the representative vegetation. The upper reaches could not be accessed by boat due to low water levels and the formation of a sand bank at the confluence point. Closer to the mouth conditions were predominantly sandy with very limited adjacent habitat. The estuary was sampled on 7 October 2022. At Site 1, four cores were sampled from reeds and sedges (*Phragmites australis* and *Schoenoplectus scirpioides*). The site had evidence of disturbance by cattle. The sediment was predominantly sandy, with an organic layer at the surface that had high water content, and then anoxic conditions down the core. No compaction was recorded for the cores.

9.6.4 Invertebrates

All samples are yet to be analysed (**Figure 10.2** for site locations). Visible fauna included an exceptionally high density of alien invasive *Tarebia granifera* snails from the mid-reaches of the system until where boat passage was no longer possible due to the shallow depths (upstream of the confluence of the iNyoni system). The lower estuary subtidal sediments were covered with extensive growth of an unidentified filamentous algae (**Figure 10.3**). Until further laboratory analysis, it is not known how this influences the infauna communities. High densities of *Kraussillichirus kraussi w*ere noted in all sandy, shallow subtidal sediments where algae were absent. Invertebrate bycatch from fish seines were retained for identification.

9.6.5 Fish

Previous studies recorded a total of 54 species in the estuary as opposed to 15 in our 1-day visit. This is possibly a function of low water levels following a recent breaching of the estuary. Sampling was also restricted to the low half of the system with the upper reaches inaccessible due to shallow water and macrophyte growth. See **Appendix C** for a summary of fish species caught during the trip. Several Illegal gillnets were observed in the system.

9.6.6 Birds

Even higher number of Palearctic waders than at uMlalazi, including Bar-tailed Godwit. Large numbers of White-fronted Plovers and Sanderlings reflecting sandy nature of substrate. Large numbers of waterfowl (ducks and geese) in upper reaches, reflecting large expanses of submerged vegetation highly favoured as a food source. Count information will be compared with CWAC data for the site – counts seemed very high on the day. See **Appendix D** for a summary of birds species observed during the trip.

9.6.7 Summary

- System was closed with overwash from the sea at low water levels.
- Estuary in relatively good condition, but a possible decline in condition.
- Housing developments expanding in lower reaches (iNgonyama Trust land), evidence of increased nutrification (lower 3/4 km of sediment surface covered with filamentous algae.
- Observed significant areas of submerged macrophyte and filamentous algae.
- Pending water quality results, but blooms can be developing when water level is low after a mouth breaching event.
- Benthic inverts very high numbers of invasive snail *Terebia granifera*.
- Previous studies recorded a total of 54 fish species in the estuary as opposed to 15 during this field trip.
- High numbers of Palearctic waders, including Bar-tailed Godwit. Large numbers of White-fronted Plovers and Sanderlings reflecting sandy nature of substrate. Large numbers of waterfowl (ducks and geese) in upper reaches, reflecting large expanses of submerged vegetation highly favoured as a food source.

10 SCENARIOS AND CONSEQUENCES

10.1 SCENARIO DESCRIPTIONS

Scenarios were configured and assessed using the water resources models. Inputs to the Classification process require the historical time series of flows under both the natural and present day conditions in order to set the environmental requirements at specific predetermined EWR sites. However, it is acknowledged that present day flows will not necessarily continue into the future as a result of changing conditions (both climatic and man-made) in the catchments. Varying scenarios were therefore simulated with the water resources models in order to assess the potential impacts on the EWR sites.

10.1.1 River Scenarios

The river flow related scenarios that were assessed are summarised in **Table 10-1**.

Table 10-1: River flow scenarios

Site	Reference	Scenario
Amatigulu	MA1_CC	Natural inflow files scaled for climate change scenario
Nseleni	NS1_CC	Natural inflow files scaled for climate change scenario
Black Mfolozi	BM1_CC	Natural inflow files scaled for climate change scenario
White Mfolozi	WM1_CC	Natural inflow files scaled for climate change scenario
	WM1_HFY no ewr	HFY abstracted from upstream dams, no EWR on
	WM1_HFY with ewr	HFY (12.9) abstracted from upstream dams, with EWR on (yield is not affected by EWR)
	WM1_raise klip with ewr	Raised Klipfontein HFY (14.3) abstracted from upstream dams, with EWR on (yield is not effected by EWR)
Mkuze	MK1_CC	Natural inflow files scaled for climate change scenario
	MK1_2040	PD scenario with increased upstream domestic use
	MK1_IRR	PD scenario with increased return flows due to increased irrigation supplied from Pongolapoort Dam
Pongola	UP1_CC	Natural inflow files scaled for climate change scenario
	UP1_2040	PD scenario with increased upstream domestic use (upgraded Fritz WTW)
Assegaai	AS1_CC	Natural inflow files scaled for climate change scenario
	AS1_2040	PD scenario with increased upstream domestic use
	AS1_EWR	PD scenario with EWR as provided included (no impact on yield of Heyshope)
	AS1_noEWR	PD scenario with no EWR
Ngwempisi	NG1_CC	Natural inflow files scaled for climate change scenario
	NG1_2040	PD scenario with increased upstream domestic use
	NG1_EWR	PD scenario with EWR as provided included (Yield of Jericho drops from 58 to 49)

10.1.2 Estuary Scenarios

The estuary flow related scenarios that were assessed are summarised in **Table 10-2**.

Table 10-2: Estuary flow scenarios

Site	Scenario Reference	Description
Amatigulu (north & south)	AMA_10%red	Reduction of present day MAR by 10%
	AMA_20%red	Reduction of present day MAR by 20%
	AMA_30%red	Reduction of present day MAR by 30%
	AMA_15%incr	Increase of present day MAR by 15%
Siyaya	SIY_15%incr	Increase of present day MAR by 15%
	SIY_15%red	Reduction of present day MAR by 15%
Mlalazi	MLA_WWTW	Present day including the upgrade of the Mtunzini WWTW increased to a 1.5 Ml/d plant
	MLA_Scen1	Present day including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million m^3.
	MLA_Scen2	Present day reduced by 10% through abstraction from lower reaches of river
	MLA_Scen3	Present day reduced by 20% through abstraction from lower reaches of river
	MLA_Scen4	Scenario 3 including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 20 million m^3.
Mhlathuze	MHL_15%incr	Increase of present day MAR by 15%
	MHL_10%incr	Increase of present day MAR by 10%
	MHL_2030	2030 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)
	MHL_2040	2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)
Nhlabane	NHL_EWR	Present Day including EWR releases from Lake Nhlabane as obtained from MWAAS (DWAF, 2009)
	NHL_rest	Restoration Scenario to allow for mouth breaching each year. Increase of flows as follows, if natural flow is < 0.25 m^3/s, restoration flow is 0, if 0.25 m^3/s < natural flow < 0.3 m^3/s, restoration flow is 0.1 m^3/s, if 0.3 m^3/s < natural flow < 0.5 m^3/s, restoration flow is 0.3 m^3/s, if natural flow is > 0.5 m^3/s, restoration flow is present day flow

10.2 ECOLOGICAL CONSEQUENSES OF SCENARIOS: RIVERS

A few major operational and development scenarios will impact on rivers and EWR sites, and therefore required further evaluation. Of those identified, Scenario CC was often marginally 'worse' than the other scenarios. All scenarios met the Recommended Ecological Category (REC) and it was therefore recommended that the REC becomes the Target Ecological Category (TEC) and that RQOs are set for the REC.

It must be noted that EWR MK1 (Mkuze River) requires improvement to achieve the REC, but these improvements are NON-FLOW RELATED. A summary of the results showing the scenarios compared to the REC is provided in **Table 10-3** and **Figure 10-1**.

The scenario value refers to the ranking values of the scenarios in terms of a numerical scale with values 0 and 1 (typically, where one (1) indicates that the scenario achieves the REC and a zero (0) representing the situation where the scenario results in a F category).

Table 10-3: Scenario consequences results

	MA1_CC	NS1_CC	BM1_CC	WM1_CC	MK1 (all scenarios)	UP1_CC	AS1_CC	NG1_CC
Sc ranking 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

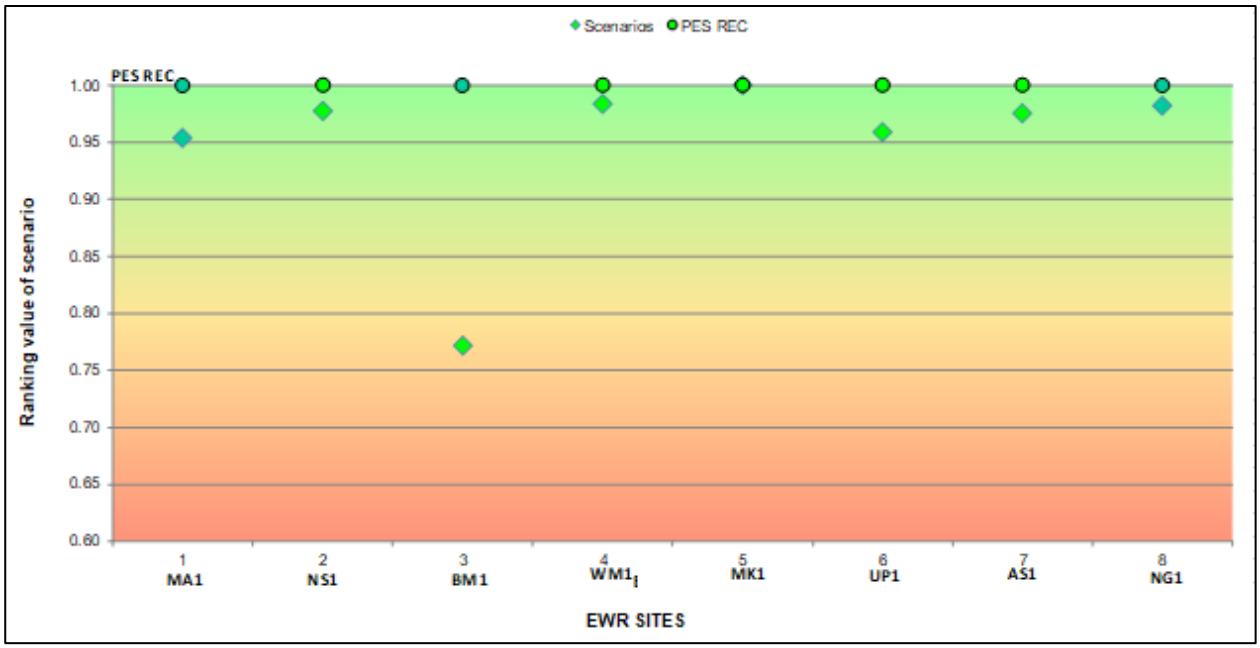


Figure 10-1: Summary traffic diagram of scenario consequences results

10.2.1 EWR MA1 (Matigulu River)

Scenario MA1_CC was evaluated. A summary explanation of the consequences of the scenarios compared to the PES and the REC are provided in **Table 4.1**.

Table 10-4: EWR MA1: Scenario consequences on the driver and response component ECs

Component	PES & REC	Sc MA1_CC	Comment
Physico-chemical (Water quality)	B (84.5%)	B/C (80.6%)	PES is driven by elevated turbidity and salts; with a small increase in nutrient levels. There is expected to be small impact on most variables under the scenario, particularly at low flows.
Geomorphology	B (87.4%)	B (81.6%)	Small increase in catchment erosion and overbank flooding predicted due to climate change. Possible small increase in fines (sand) on bed but strong flows should maintain clean gravel habitat.
Riparian vegetation	B/C (79.4%)	B/C (78.7%)	Stream permanency and seasonality remain unaltered. Flooding regime remains intact, slightly less than PD but more than required by EWR. Base flows mostly lower than PD and the EWR, particularly in the dry season. Differences are small and not likely to result in vegetation shifts but duration of inundation of marginal zone grasses and sedges will be reduced providing less instream habitat to aquatic fauna, and possible reduced density.
Fish	B (86.4%)	B/C (79.4%)	Semi-rheophilic and flow intolerant species will be negatively impacted by slightly reduced availability of fast habitats during the wet season (compared to EWR). Species with preference for substrate may be impacted by slight increase in sedimentation (especially in pools). Vegetative cover should not be impacted notably but reduced duration of inundation of vegetation may

Component	PES & REC	Sc MA1_CC	Comment
			reduce spawning success slightly in some species. Reduced water quality may negatively impact water quality intolerant species and predatory species (increased turbidity).
Macro-invertebrates	B/C (80.9%)	B/C (78.5%)	The reduced availability of fast flowing habitats during the wet season might impact slightly on the abundance of taxa with a preference for moderately fast to very fast flowing water, especially cobble dwellers. The increase in salts and turbidity will influence the abundance and/or frequency of occurrence of taxa with a high requirement for unmodified physico-chemical conditions. However, the better flows during the dry season might alleviate this slight adverse situation.
EcoStatus	B/C (81.3%)	B/C (79.15%)	All components indicate a slight decrease in category due to largely small changes in the drivers (increased turbidity and silt, decrease in velocity during the wet season and possible changes in marginal vegetation.

10.2.2 EWR NS1 (Nseleni River)

compared to the PES and the REC are provided in **Table 5.1**, with the rating of the scenarios shown in **Figure 5.1**.

Specialists identified that there are problems with the PD flows. The PD provided during this study is likely an under estimate (less flows) than the actual PD flows. This also effects the evaluation of scenario flows and the predictions are therefore of low confidence. If the PD flows are updated and refined during monitoring, the EcoSpecs set as part of Resource Quality Objectives determination must be updated.

Table 10-5: EWR NS1: Scenario consequences on the driver and response component ECs

Component	PES & REC	Sc NS1_CC	Comment
Physico-chemical (Water quality)	B (82.7%)	B/C (80.6%)	PES is driven by elevated turbidity and salts due to extensive subsistence farming and erosion. There is expected to be small impact on some variables under this scenario, particularly at low flows, but a significant impact is not expected.
Geomorphology	B (84.0%)	B/C (82.0%)	Erosion in the upper catchment likely to be increased but high flows slightly reduced increasing potential for deposition; small increase in deposition of fines in pools and in lee of coarse material in riffles.
Riparian vegetation	C (64.4%)	C (64.2%)	Stream permanency and seasonality remain unaltered. Flooding regime remains intact, slightly less than PD but more than required by EWR. Base flows lower than PD but more than the EWR. Inundation of marginal zone graminoids is slightly reduced compared to PD, but is more than the EWR requirement. Marginal zone vegetation likely to have slight increase with less inundation in the wet season and slight increase in deposition of fines (see geomorphology response). Negligible change to the VEGRAI score is evident.
Fish	C (67.9%)	C (65.8%)	As the scenario low flows are notably higher than the EWR flows and only slightly lower than PD (and Natural) low flows, no change in fish assemblage can be justified based on flow changes expected under this scenario. A slight change can possibly be expected due to increased sedimentation (catchment erosion), slight water quality deterioration (based on PAI) and

Component	PES & REC	Sc NS1_CC	Comment
			slightly reduced vegetative cover and spawning habitats (VEGRAI)
Macro-invertebrates	B/C (79.5%)	B/C (77.9%)	As the scenario low flows are notably higher than the EWR flows and only slightly lower than PD (and Natural) low flows, no change in macro-invertebrate assemblage can be justified based on flow changes expected under this scenario. The increase in salts and turbidity will influence the abundance and/or frequency of occurrence of taxa with a high requirement for unmodified physico-chemical conditions. A slight reduction in vegetative cover which serve as overhanging habitat for macro-invertebrates.
EcoStatus	C (68.4%)	C (67.5%)	All components indicate a slight decrease in category due to largely small changes in the drivers (increased turbidity and silt, decrease in velocity during the wet season and possible changes in marginal vegetation and water quality changes).

10.2.3 EWR BM1 (Black Mfolozi River)

Scenario BM1_CC was evaluated. A summary explanation of the Scenario consequences compared to the PES and the REC are provided in **Table 6.1**, with the rating of the scenarios shown in **Figure 6.1**.

Table 10-6: EWR BM1: Scenario consequences on the driver and response component ECs

Component	PES & REC	Sc BM1_CC	Comment
Physico-chemical (Water quality)	B/C (81.8%)	C/D (61.8%)	The scenario will have a significant impact, particularly at low flows, which will not be effectively balanced by higher flows. Intermittently elevated sulphates are likely to worsen in the short term due to disruptions of water availability to mines (impacting on pollution control dams, for example) Instream impacts on temperature and oxygen conditions are also expected, and increased sedimentation expected due to increased catchment erosion.
Geomorphology	A (93.4%)	C (73.5%)	Given the extensive afforestation the threat of forest fires is likely to increase, which could increase catchment erosion. Fire hazard in riparian zone could also increase impacting on bank and flood bench stability. Channel dominated by bedrock with limited potential for instream sediment deposition but reduced scouring by intermediate flows resulting in increased fine sediment deposition in low velocity areas. Increased deposition of fine gravels and silt at top of pool. Significant reduction in overbank floods impacts flood benches. Contraction of channel width, increased development of marginal zone and associated vegetation.
Riparian vegetation	C (74.9%)	C (68.5%)	Stream permanency and seasonality remain unaltered. Flooding regime remains intact, but magnitude is reduced compared to PD and to the EWR requirement. This reduction is likely to promote woody encroachment onto flood features. Base flows are lower than PD and the EWR requirement for both wet and dry season. Inundation of marginal zone graminoids will be reduced on average from 78 and 42% of the population for PD and the EWR requirement respectively to 26% for the climate change scenario in the wet season. Similarly, during the dry season, inundation of marginal zone graminoids will be reduced on average from 17% of the population to zero. Marginal zone vegetation is likely to shift and / or increase with less inundation in the wet season

Component	PES & REC	Sc BM1_CC	Comment
			along the riparian/ aquatic interface, but will also promote woody establishment in the upper reaches of the population. Encroachment by terrestrial woody species also likely in the upper zone and bank.
Fish	C (75.9%)	D (55.5%)	Significantly reduced flows will be expected, resulting in loss of fast habitats (especially FD and FI) during wet and dry seasons. This will especially impact rheophilic and semi-rheophilic species negatively. Although seasonal variation may be retained, seasonal variation in conditions will be reduced which will influence most species (especially breeding). Substrate quality is expected to be reduced (as a result of sedimentation and lower flows) impacting especially riffle dwelling species. Although vegetative cover may remain in an altered state, this will still change from current and is expected to impact species with a requirement for this habitat type. Overall deterioration in water quality will impact most species (especially water quality intolerant) while reduced migratory success (longitudinal and lateral) can be expected as a result of reduced depth and migratory cues. The food sources (esp. invertebrates) will also be negatively impacted resulting in overall deterioration of fish assemblage and condition.
Macro-invertebrates	B/C (81.3%)	C/D (58.03%)	The availability of fast flowing habitats (fast deep and intermediate flows) have been reduced extensively during both wet and dry seasons under this scenario. These flows will impact greatly on the presence and abundance of rheophilic macro-invertebrate taxa with a preference for moderately fast to very fast flowing water, especially cobble dwellers. The reduction of marginal vegetation inundation will impact adversely on macro-invertebrate overhanging vegetation habitat. Poor water quality will impact on sensitive species, while sedimentation and siltation will impact on the macro-invertebrate habitat types, especially pool- and backwater habitat.
EcoStatus	C (76.9%)	C (62.9%)	Impact due to change in flow regime, geomorphological impact and water quality changes.

10.2.4 EWR WM1 (White Mfolozi river)

scenarios. All scenarios are the same or higher than the EWR except for Sc WM1_CC which was marginally lower in the dry and drought season. As all other scenarios will meet the REC, the evaluation focussed on WM1_CC to determine if it meets the REC. A summary explanation of the Scenario consequences compared to the PES and the REC are provided in **Table 7.1**, with the rating of the scenarios shown in **Figure 7.1**.

Table 10-7: EWR WM1: Scenario consequences on the driver and response component ECs

Component	PES & REC	Sc WM1_CC	Comment
Physico-chemical (Water quality)	B (84.5%)	B (84.5%)	Wet and dry season flows are similar to the PD conditions under which the water quality state was assessed. Even with a potential slight elevation in instream sediment loads and turbidity levels, the integrated water quality state is not expected to change under this scenario.
Geomorphology	B/C (78.8%)	C (75.02%)	Peak flows from January to March are little impacted by climate change so there are no predicted flow related impacts. The upper catchment is already extensively degraded and is likely to be further impacted by climate change, increasing sediment supply.

Component	PES & REC	Sc WM1_CC	Comment
			This will increase the extent of sand deposition on the bed and also in the riparian zone. Strong flows at the site limit the impact of deposition, which at present is highly variable in time.
Riparian vegetation	B/C (81.3%)	B/C (78.9%)	All scenarios will similarly impact riparian vegetation: Stream permanency and seasonality remain unaltered. Flooding regime remains intact and more than the EWR requirement. Wet season base flows are similar to PD and more than the EWR requirement e.g. in March at the 60th percentile 40% of the marginal zone graminoid population is inundated. This increases to 45% for PD and the climate change scenario (31% if only low flows are considered for the climate change scenario) and to 47% for all other scenarios. There are no differences in these levels during dry season base flows. Given the slight increase in marginal and lower zone inundation and the potential for some sediment deposition (refer to geomorphology reasoning) there is likely to be an increase in marginal and lower zone non-woody cover and abundance and the abundance of *Salix mucronata* is also probable.
Fish	C (73.1%)	C (72.1%)	A slight impact (reduced availability) on fast habitats (especially FD) can be expected in the dry season, which will have a minor impact on rheophilic and semi-rheophilic species. Water quality is not expected to change and the potential impact of sedimentation on substrate quality of riffle dwelling species is also expected to be minimal. The remainder of the scenarios will be better than scenario CC, falling between CC and EWR flows and should also maintain the PES/REC.
Macro-invertebrates	B/C (81.1%)	B/C (80.7%)	Scenario flows are similar to the EWR flows and thus no significant changes are expected to take place. Most of the driver and response components are similar to PD conditions: sediment loads do not expect to have a major influence and vegetation-related changes will not influence the PES significantly.
EcoStatus	B/C (79.2%)	C (77.6%)	Change in geomorphology results in minor impacts on the responses.

10.2.5 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 (**Figure 8.1**). 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.

Although flow patterns between scenarios and PD are similar, the water quality state in this reach is already compromised, with a water quality priority area delineated in the SQ reach directly upstream of the reach containing the EWR site, i.e. SQ W31J-02469, with impacts being from the High Risk Mkuze Waste Water Treatment Works (WWTW). Although the MK1_IRR scenario (increased return flows due to increased irrigation supplied from Pongolapoort Dam) does not indicate a change in flows, any deteriorating quality of the return flows would impact on the integrated state.

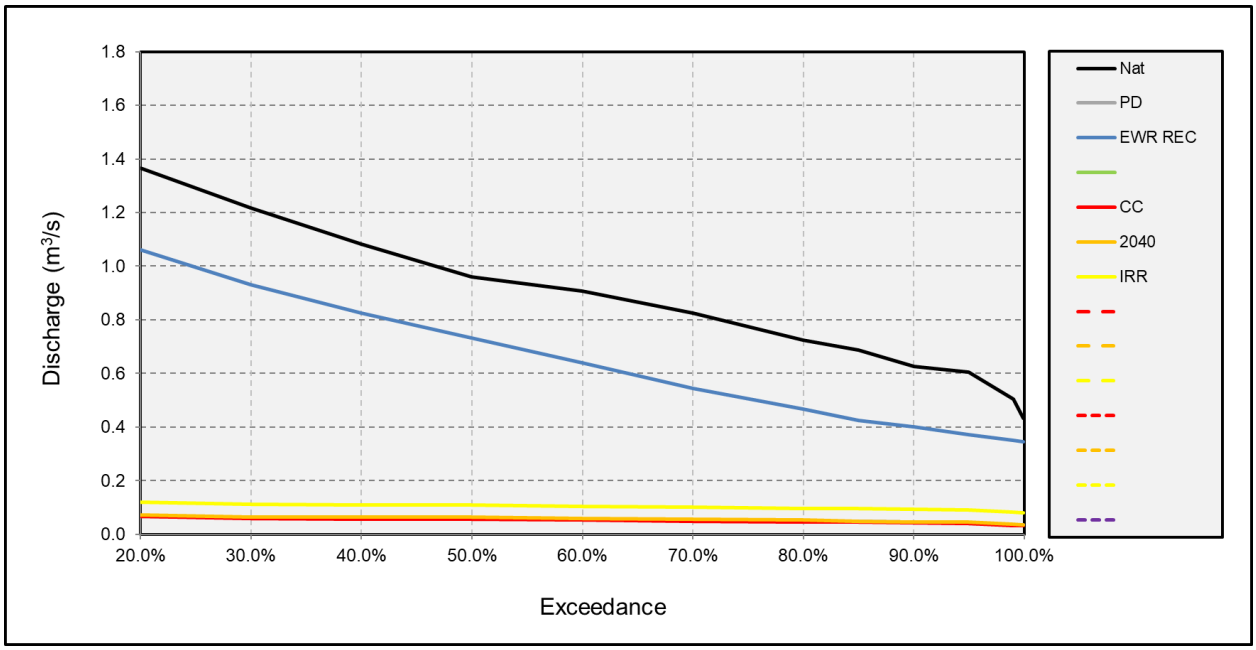


Figure 10-2: Flow duration curve for EWR MK1 during the driest month of August

10.2.6 EWR UP1 (Pongolo River)

All scenarios were evaluated, and showed that there is no discernible difference between the 2040 Scenario and the EWR, and this scenario will therefore meet the REC. Scenario UP1_CC is marginally lower than the EWR and was evaluated. A summary explanation of the Scenario consequences compared to the PES and the REC are provided in **Table 9.1**, with the rating of the scenarios shown in **Figure 9.1**.

Table 10-8: EWR UP1: Scenario consequences on the driver and response component ECs

Component	PES & REC	Sc UP1_CC	Comment
Physico-chemical (Water quality)	A/B (88.3%)	B (85.5%)	Lower flows under the CC scenario could have an impact on instream water quality parameters (temp, oxygen, clarity), but overall state will remain good.
Geomorphology	A/B (89.8%)	B (84.3%)	Sediment supply from middle of catchment increased as a result of more intense storms and reduced vegetation cover under CC. Increased frequency of forest and veld fires would strip vegetation and could also increase sediment supply. Local floods during decreased CC low flows in August and September could result in increased deposition of fine sediment on channel bed. Low flows during dry season could prevent activation of secondary channels.
Riparian vegetation	C (70.0%)	C (68.7%)	Stream permanency and seasonality remain unaltered. Flooding regime remains intact and more than the EWR requirement. Wet season base flows are similar to PD and more than the EWR requirement (considering total flows) e.g. in Feb at the 60th percentile 20% of the marginal zone graminoid population is inundated (climate change scenario). This increases to 25% for PD and the 2040 scenario while only 1% of the population is inundated by the EWR. If the base flow is considered using low flows only (no high flows or floods) then there is no inundation of the marginal zone graminoids for the climate change scenario in the wet season. During dry season base flows there is no inundation of marginal zone vegetation for any of the scenarios,

Component	PES & REC	Sc UP1_CC	Comment
			including PD and the EWR, but the climate change scenario flows (both total flows and low flows only) are less than the EWR requirement. Nevertheless, flows remain perennial and marginal and lower zone vegetation should survive the winter period. Given the slight increase in marginal and lower zone inundation in the growing season and the potential for some sediment deposition (refer to geomorphology reasoning) there is likely to be an increase in marginal and lower zone non-woody cover and abundance.
Fish	C (73.9%)	C (68.7%)	No notable change in habitat expected during the wet season (between EWR and PD). Some reduction in fast habitat expected in dry season (especially loss in FD) which will have negative impact on rheophilic and semi-rheophilic species. Only slight deterioration in water quality expected (minor impact on species with high requirement for unmodified water quality), slight increase in sedimentation/siltation of bottom substrate (impacting riffle dwelling species and reducing feeding and spawning habitat quality) while vegetative cover should remain largely unchanged and not impact any fish species notably. Sc 2040 should not have notable impact on fish assemblage (remains very similar to PD) and therefore no notable change in PES expected.
Macro-invertebrates	B/C (79.5%)	B/C (77.6%)	Scenario flows are similar to the EWR flows and thus no significant changes are expected to take place. Some reduction in fast flowing habitat expected during the dry season; mostly fast/deep. There will be a slight deterioration in temperature, oxygen and clarity expected, as well as a slight increase in the deposition of fine sediment on channel bed, but the overall state will remain good. Vegetative cover should remain largely unchanged and the lower zone vegetation should survive the winter period; thus, vegetation-related changes will not influence the PES significantly.
EcoStatus	C (73.5%)	C (71.1%)	Water quality impacts and changes in sedimentation have resulted in small response changes.

10.2.7 EWR AS1 (Assegaai River)

All scenarios were evaluated, and it was found that most scenarios are similar to PD and higher than the EWR, indicating that all scenarios should meet the REC. Scenario AS1_CC is marginally lower than the EWR and was evaluated. A summary explanation of the Scenario consequences compared to the PES and the REC are provided in **Table 10.1**, with the rating of the scenarios shown in **Figure 10.1**.

Table 10-9: EWR AS1: Scenario consequences on the driver and response component ECs

Component	PES & REC	Sc AS1_CC	Comment
Physico-chemical (Water quality)	B/C (80.6%)	B/C (80.6%)	The PD flows and CC scenario flows are very similar. No impact on water quality is expected under this scenario.
Geomorphology	C (70.8%)	C (65.7%)	There is a small to moderate reduction in high flows; this would exacerbate the impact of the Heyshope Dam as it would overtop less frequently. The main areas subject to erosion are upstream of the dam so increases in sediment supply to the EWR site are expected to be small. Bed armouring will continue to have a significant impact. There may be a slight decrease in scour of the marginal zone and subsequent loss of marginal zone habitat. Bed condition in runs should not be greatly impacted by increased

Component	PES & REC	Sc AS1_CC	Comment
			sediment due to sediment trapping upstream but less frequent flooding may result in a more stable bed structures with limited overturning of cobble.
Riparian vegetation	C (69.9%)	C (65.8%)	Stream permanency and seasonality remain unaltered. Flooding regime remains intact and more than the EWR requirement. Wet season base flows are similar to PD and more than the EWR requirement (considering total flows) e.g. in March at the 60th percentile 18% of the marginal zone graminoid population is inundated (climate change scenario). This is the same as PD at 18% and increases to 21% for the 2040 scenario while only 2% of the population is inundated by the EWR. If the base flow is considered using low flows only (no high flows or floods) then 9% of the marginal zone graminoids are inundated by the climate change scenario in the wet season. During dry season base flows less than 4% of marginal zone vegetation is inundated for any of the scenarios, including PD and zero inundation by the EWR. Nevertheless, flows remain perennial and marginal and lower zone vegetation should survive the winter period. Given the slight increase in marginal and lower zone inundation in the growing season there is likely to be an increase in marginal and lower zone non-woody cover and abundance, particularly reeds.
Fish	C (69.2%)	C (68.8%)	No loss of fast and slow habitat expected under scenario and no notable change in water quality. Only a small potential deterioration in substrate quality (reduced floods/flushing) expected (see geomorphology section) that may impact intolerant fish species with requirement for rocky and gravel substrates as habitats (feeding, spawning etc.). The expected overall impact on the fish assemblage is however very small and fish should remain in the PES/REC under all scenarios assessed for this site.
Macro-invertebrates	B/C (78.4%)	C (77.3%)	There is only a small reduction in high flows but it will not impact the macro-invertebrate assemblages and the water quality will also not change significantly. The deterioration in substrate quality due to reduced floods and flushing may have a small impact. Vegetative cover should remain largely unchanged and no impact is expected on the marginal vegetation taxa.
EcoStatus	C (74.2%)	C (69.7%)	All scenarios maintain the REC apart from Macroinvertebrates which drop by 0.1% to fall from a B/C to a C. The REC will therefore be the preferred scenario.

10.2.8 EWR NG1 (Ngempisi River)

All scenarios were evaluated and it was found that there is no discernible difference between the 2040 Scenario and the Sc NG1_CC. The scenarios are lower than the EWR during the dry season. Scenario NG1_CC is marginally lower than the 2040 and was evaluated. A summary explanation of the Scenario consequences compared to the PES and the REC are provided in **Table 11.1**, with the rating of the scenarios shown in **Figure 11.1**.

Table 10-10: EWR NG1: Scenario consequences on the driver and response component ECs

Component	PES & REC	Sc NG1_CC	Comment
Physico-chemical (Water quality)	B (85.5%)	B (85.5%)	The PD flows and CC scenario flows are very similar. No impact on water quality is expected under this scenario.
Geomorphology	B/C (83.3%)	B/C (80.2%)	Climate change has an insignificant impact on the geomorphology of the channel at this site. High flows are little altered relative to present day conditions; both are impacted by the upstream dams

Component	PES & REC	Sc NG1_CC	Comment
			which reduce floods and trap sand, gravel and coarser sediment and result in bed armouring and scour of marginal zones and flood benches. There may be a small increase in sediment supply but the lower catchment is at present generally well vegetated and unlikely to be affected significantly by climate change. There may be an increase in fire frequency but burning is already widely practiced, thereby reducing the severity of this impact.
Riparian vegetation	B/C (77.4%)	B/C (77.4%)	Stream permanency and seasonality remain unaltered. Flooding regime remains intact, similar to PD, and more than the EWR requirement. Wet season base flows are similar to PD and more than the EWR requirement. Similarly, dry season base flows are similar to PD and either meet the EWR requirement or are marginally lower. Nevertheless, flows remain perennial and marginal and lower zone vegetation should survive the winter period. Response by riparian vegetation should be minimal and no change to the PES.
Fish	C (72.8%)	C (69.6%)	Scenario CC is the only one that results the 60th percentile to be lower than PD and EWR during the wet season, with very small decrease in fast habitats (mostly FD) expected which would have slight impact on FROC of rheophilic and semi-rheophilic spp. No water quality changes expected that could influence fish assemblage and only very minor potential change in substrate condition due to sedimentation, affecting riffle dwelling spp. No notable change in vegetative cover expected under any of the scenarios. Overall, the impact on the fish assemblage expected to be very small under all scenarios assessed.
Macro-invertebrates	B (87.3%)	B (85.6%)	The wet season 60th percentile flows are lower than the EWR which will result in a very small decrease in fast deep habitats, while dry season base flows are similar to the EWR requirement or are marginally lower. Although there is very little change in water quality, bed armouring and scour of marginal zones and flood benches may have a small impact on macro-invertebrate marginal habitats.
EcoStatus	B/C (79.8%)	B/C (77.8%)	All Scenarios are very similar to the EWR and close to Present Day; therefore, all scenarios will maintain the REC.

10.3 ECOLOGICAL CONSEQUENSES OF SCENARIOS: ESTUARIES

10.3.1 aMatigulu/Inyoni Estuary

Four flow scenarios and one non-flow scenario were evaluated for the aMatigulu/iNyoni Estuary (see table below).

Table 10-11: aMatigulu/iNyoni Estuary: Summary of flow scenarios

Scenarios	Description	MAR[1] (X10^6 m^3)	% Remaining
Reference	Natural (~1750)	141.17	
Present	Present day	113.77	80.59
Scenario 1	Climate Change	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 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

1 Mean Annual Runoff

The **PES** of the aMatigulu/iNyoni Estuary is a **B/C** Category (see table below).

Table 10-12: aMatigulu/iNyoni Estuary: 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**
ECOLOGICAL STATUS	**B/C**	**C**	**C/D**	**D**	**B**	**B**

The Estuary Importance Score (EIS) takes size, the rarity of the estuary type within its biographical zone, habitat, biodiversity and the functional importance of the estuary into account (DWAF 2008; Turpie *et al*. 2012a;b). Biodiversity importance, in turn, is based on the assessment of the importance of the estuary for plants, invertebrates, fish and birds, using rarity indices. The scores have been determined for all South African estuaries, apart from functional importance, which is scored by the specialists in the workshop. The Estuary Importance Score for five components and the importance rating are presented below. The **functional importance** of aMatigulu/iNyoni Estuary is **very high** with a score of 90 (see table below)

Table 10-13: The Functional Importance Score of the aMatigulu/iNyoni Estuary

Calculation of the functional importance score	Score
a) Export of organic material generated in the estuary (regional scale)	40
b) Nursery function for fish and crustaceans (marine /riverine)	90
c) Movement corridor for river invertebrates and fish breeding in sea	80

d) Roosting area for marine or coastal birds	60
e) Catchment detritus, nutrients and sediments to sea	20
Functional importance score - Max (a to e)	**90**

The **EIS** for the aMatigulu/iNyoni Estuary, is 81, indicating that the estuary is rated as "**Highly Important**" (see table below).

Table 10-14: Estuarine Importance Score for the aMatigulu/iNyoni Estuary

Criterion	Weight	Score
Estuary Size	15	90
Zonal Rarity Type	10	30
Habitat Diversity	25	80
Biodiversity Importance	25	89
Functional Importance	25	90
Estuary Importance Score		**81**
Calculation of the functional importance score		**Highly important**

The **REC** is based on the Best Attainable State (BAS) for the aMatigulu/iNyoni Estuary which is a **B** Category. The Recommended Flow Scenario is Scenario 1 (Restoration Scenario) with non-flow interventions.

10.3.2 iNlabane Estuary

Four flow scenarios were evaluated for the iNhlabane Estuary (see table below).

Table 10-15: 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 (DWAF, 2000)	21.33	70.2
Scenario 3	Restoration of flow (+ 15%)	26.35	86.7
Scenario 4	Restoration of flow and non-flow interventions	26.35	86.7

The **PES** of the iNhlabane Estuary is an **E** Category (see table below).

Table 10-16: iNhlabane Estuary: 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

Component	PES		Estuary Scenarios			
	Estuary	North & South Lakes	1	2	3	4 (Sc 3 + NON-FLOW Interventions)
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
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: PES are also provided for South and North Lake to contextualise overall ecosystem condition (Low confidence).

The Estuary Importance Score for five components and the importance rating are presented below. The **functional importance** of iNhlabane Estuary is **high** with a score of 80 (see table below).

Table 10-17: The Functional Importance Score of the iNhlabane Estuarine Lake

Calculation of the functional importance score	Score
a) Export of organic material generated in the estuary (regional scale)	40
b) Nursery function for fish and crustaceans (marine /riverine)	80
c) Movement corridor for river invertebrates and fish breeding in sea	80
d) Roosting, foraging and/or nesting area for marine and coastal birds	40
e) Catchment detritus, nutrients and sediments to sea	20
Functional importance score - Max (a to e)	80

The **EIS** for the iNhlabane Estuary, is 69, indicating that the estuary is rated as “Important” (see table below).

Table 10-18: Estuarine Importance Score for the iNhlabane Estuarine Lake

Estuarine Importance	Score
Estuary Size	50
Zonal Rarity Type	70
Habitat Diversity	50
Biodiversity Importance	86
Functional Importance	80
ESTUARINE IMPORTANCE SCORE	**69**
Calculation of the functional importance score	**Important**

The **REC** is a **D** Category. The Recommended Flow Scenario is Scenario 3 (Restoration Scenario) coupled with interventions such as artificial breaching and dredging of the organic layer accumulated in the system.

10.3.3 uMhlatuze Estuary

Four flow scenarios were evaluated for the uMhlatuze Estuary (see table below).

Table 10-19: 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

The **PES** of the uMhlatuze Estuary is a **D** Category. Note that PES scores are also provided for Lake Mzingazi, Richards Bay and Lake Cubhu (Low confidence) (see table below).

Table 10-20: uMhlatuze Estuary: EHI Score 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**	**50**
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
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**

The Estuary Importance Score for five components and the importance rating are presented below. The **functional importance** of uMhlatuze Estuary is **very high** with a score of 100 (see table below).

Table 10-21: The Functional Importance Score of the uMhlatuze Estuary

Calculation of the functional importance score	Score
a) Export of organic material generated in the estuary (regional scale)	90
b) Nursery function for fish and crustaceans (marine /riverine)	100
c) Movement corridor for river invertebrates and fish breeding in sea	90

Calculation of the functional importance score	Score
d) Roosting, foraging and/or nesting area for marine and coastal birds	100
e) Catchment detritus, nutrients and sediments to sea	90
Functional importance score - Max (a to e)	**100**

The **EIS** for the uMhlatuze Estuary, is 94, indicating that the estuary is rated as "**Very high**" (see table below).

Table 10-22: Estuarine Importance Score for the uMhlatuze Estuary

Estuarine Importance	Score
Estuary Size	100
Zonal Rarity Type	80
Habitat Diversity	100
Biodiversity Importance	85
Functional Importance	100
ESTUARINE IMPORTANCE SCORE	**94**
Calculation of the functional importance score	**Highly important**

The **REC** is a **D** Category as the current state of the system is largely the result of the port development and the construction of weirs/barrages that divided the system in four components – and deemed irreversible from a restoration perspective. The flow requirements for the estuary are the same as those described for Scenario 2 and are summarised in **Table 4.9**. However, Scenario 3 (2030 development) and 4 (2040 development) with the above interventions for the estuary, Richards Bay and the associated lakes implemented to offset flow impacts also meet the criteria.

10.3.4 uMlalazi Estuary

Seven flow scenarios and one non-flow scenario were evaluated for the uMlalazi Estuary (see table below).

Table 10-23: uMlalazi Estuary: Summary of flow scenarios

Scenarios	Description	MAR ($X10^6$ m^3)	% Remaining
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, 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 reduced by 10% through abstraction from lower reaches of the river.	88.92	74.5
Scenario 7	Present 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

Scenarios	Description	MAR ($X10^6$ m^3)	% Remaining
Scenario 9	Present 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 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 EFZ. Monitor and control sand-mining in the upper reaches of the system.	99.55	83.4

The **PES** of the uMlalazi Estuary is a **B/C** Category (see table below).

Table 10-24: uMlalazi Estuary: 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**
ECOLOGICAL CATEGORY	**B/C**	**D**	**D**	**C**	**C**	**D**	**D**	**B**

The Estuary Importance Score for five components and the importance rating are presented below. The **functional importance** of uMlalazi Estuary is **very high** with a score of 90 (see table below).

Table 10-25: The Functional Importance Score of the uMlalazi Estuary

Calculation of the functional importance score	Score
a) Export of organic material generated in the estuary (regional scale)	80

b) Nursery function for fish and crustaceans (marine /riverine)	90
c) Movement corridor for river invertebrates and fish breeding in sea	60
d) Roosting, foraging and/or nesting area for marine and coastal birds	60
e) Catchment detritus, nutrients and sediments to sea	20
Functional importance score - Max (a to e)	**90**

The **EIS** for the uMlalazi Estuary, is 85, indicating that the estuary is rated as "**Highly Important**" (see table below).

Table 10-26: Estuarine Importance Score for the uMlalazi Estuary

Criterion	Weight	Score
Estuary Size	15	90
Zonal Rarity Type	10	30
Habitat Diversity	25	90
Biodiversity Importance	25	96
Functional Importance	25	90
Estuary Importance Score		**86**
Calculation of the functional importance score		**Highly important**

The **REC** is a **B** Category, and the Recommended flow scenario is Present with non-flow interventions.

10.3.5 iSiyaya Estuary

Three flow scenarios were evaluated for the iSiyaya Estuary:

Table 10-27: 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

The **PES** of the iSiyaya Estuary is a **D/E** Category (see table below).

Table 10-28: iSiyaya Estuary: 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**

The Estuary Importance Score for five components and the importance rating are presented below. The **functional importance** of iSiyaya Estuary is **low** with a score of 20 (see table below).

Table 10-29: The Functional Importance Score of the iSiyaya Estuary

Calculation of the functional importance score	Score
a) Export of organic material generated in the estuary (regional scale)	10
b) Nursery function for fish and crustaceans (marine /riverine)	20
c) Movement corridor for river invertebrates and fish breeding in sea	20
d) Roosting, foraging and/or nesting area for marine and coastal birds	10
Functional importance score - Max (a to e)	**20**

The **EIS** for the iSiyaya Estuary, is 37, indicating that the estuary is rated as of "**Low to Moderate Importance**" (see table below).

Table 10-30: Estuarine Importance Score for the iSiyaya Estuary

Estuarine Importance	Score
Estuary Size	30
Zonal Rarity Type	10
Habitat Diversity	60
Biodiversity Importance	47
Functional Importance	**20**
ESTUARINE IMPORTANCE SCORE	**37**
Calculation of the functional importance score	**Low to Moderate Importance**

The iSiyaya is a very small system and that sensitive to small increase in flows, in addition small changes in water quality would improve the system significantly. Using the degree to which non-flow interventions have modified the system and the reversibility of key impacts (i.e. removal of organic sludge and reduce high turbidity caused by mining activities), the **REC** is a **C** and the recommended flow scenario is Scenario 3 (Restoration Scenario) with additional non-flow intervention to achieve the REC.

10.3.6 Approach Flow Scenarios relevant to the St Lucia/Mmfolozi Estuarine Lake System

The St Lucia/uMfolozi Present Ecological State (PES) was not updated as part of this study as there was no new investment in the surveying and monitoring of the Greater St Lucia Estuarine Lake system. Funds are at present being secured by iSimangaliso Wetland Park to address this critical

information gaps need to guide the assessment of condition and management actions. In 2016 the St Lucia/uMfolozi PES was estimated as a D (DWS, 2016) and this will form the basis of the classification process. However, based on measurements and photographic imagery provided to the St Lucia Estuary Task Team over the last two years the various abiotic and biotic components of the system are likely varying between D and E Category due to flow reduction, reduced connectivity, high sediment input (especially from the uMfolozi River), nutrient pollution (with a focus on the uMfolozi and Mkuze rivers), artificial breaching, illegal catches (gill netting), and significant land-use change in the flood plain of the larger system. The system is currently on a trajectory of change, i.e. condition not stable, and while the mouth have been open for an extended period, little salt water has entered the system and significant deposits of fine muds/silts have formed in The Narrows. Some of the elements of the estuary ecosystem that have been negatively affected include: physical habitat (significant increase in fine sediments in The Narrows), water quality (low salinity and high turbidity); macrophytes (die-off of mangroves), invertebrates and fish (dominated by freshwater species) (issues raised in St Lucia Task Team discussions).

The DWS (2016) overarching Recommended Ecological Category (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 the Environment (DFFE) Ministerial Panel of Independent Experts also advocates for a REC of a B Category (DFFE, 2022).

DWS (2016) found that the total present flow from both the Mfolozi and the five St Lucia rivers is needed to achieve the REC of the greater St Lucia/uMfolozi Lake System, with an additional range of non-flow related activities needed to improve it to a B Category. DWS (2016) provides minimum recommend flows for a B/C Category, namely:

- Cap minimum discharge in the Mfolozi at 3 m^3/s to maintain an open mouth.
- Ensure a combined Mfolozi and Mkuze drought discharge of 5 m^3/s (including an additional 1.6 m^3/s in Mkuze).
- Improve the water quality coming from the Mkuze catchment.

The DWS (2016) EWR report clearly states that the total present flow from both the Mfolozi and the St Lucia rivers are needed to achieve the REC, i.e. any flow scenario that would involve flow reduction from the Present will not meet the REC. Less than 1% change can be made to Mfolozi flows, but that flow needs to be reallocated to the EWR of the St Lucia Rivers to ensure that the system attains in a C category (and does not decline during droughts). In addition to ensuring the required water quantity and quality, a range of non-flow interventions is needed to improve the system to a B/C in the short term and to a B in the long term. Note, that the DWS 2016 highlights that the system is very sensitive to Climate Change and that flow and non-flow interventions are urgently needed to increase resilience to droughts.

Non-Flow interventions to address ecological concerns include (DWS, 2016):

a) St Lucia/uMfolozi should have a single mouth and with no manipulation of the mouth (artificial breaching or closing)
b) Restore low-lying areas of the uMfolozi floodplain to natural vegetation to allow for natural processes (e.g. carbon sequestration, mouth closure)
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, invertebrates and fish);

g) 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; and
j) Illegal river abstractions on especially the Mkuze and uMfolozi Rivers must be eliminated. Note, ecological recommendations regarding mouth state is currently being re-evaluated by management due to social reasons at the recommendation of the (DFFE) Ministerial Panel of Independent Experts.

Future development scenarios need to be screened against these flow requirements to see if they meet the minimum set above. If they cannot meet the above, it means that the estuary cannot improve in condition, i.e. achieve REC, and may even decline further in condition over time.

10.4 ECOSYSTEM SERVICES CONSEQUENSES OF SCENARIOS

An Ecological Goods and Services Attributes (EGSA) analysis of multiple sites within the study area was undertaken. This included a profile of 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.

EGSA associated with the sites, 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. 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 sub quaternary (SQ) catchments are evaluated is examined against the nature of the particular Ecological Water Requirement (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 Water Management Area (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. The Estuary results were more marked. Some of the estuaries, notable 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. 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.

10.5 ECONOMIC CONSEQUENSES OF SCENARIOS

By using the scenarios determined and estimated in the different fields of expertise, the economic results expressed in direct Gross Domestic Product (GDP) and direct employment for the rivers and estuaries had the minimal impact on irrigation agriculture and commercial forestry where quantitative analysis (numbers) was calculated.

Assessing the Urban and Industries where scenarios were also identified, using a qualitative (non-numerical) analysis, the findings were that if water was increased, security from water as a driver made it possible to expand economic activities, thus increase GDP, employment opportunities and contribution to low-income households.

In scenarios such as climate change where water reduction is the result, decrease in domestic supply, restricts economic sustainability that threatens the standard of living of communities, especially the low-income households.

10.6 USER WATER QUALITY CONSEQUENSES OF SCENARIOS

Impacts on user water quality under operational scenarios were evaluated according to the methods outlined in the DWS (2016a) document on operationalising Resource Directed Measures, and focuses on EWR sites and river reaches potentially affected by scenarios.

The following information was gathered for identified water quality priority areas, and tested at a Technical Task Group meeting in November 2022:

- Water quality role players/users and their locations within Resource Units (RUs) and Integrated Unit of Analysis (IUAs).
- Driving users/role players in terms of water quality.
- Water quality variables that drive water quality state or requirements.

For the consequences step, the RUs and Sub-Quaternary catchments (SQs) which may be affected by the scenarios needed to be identified. Although all riverine Ecological Water Requirements

(EWR) sites will be affected by scenarios, i.e. they are positioned downstream of the implementation areas, there are few scenarios that could potentially have a significant enough impact to require evaluation. Of those identified, the Scenario Climate Change (Sc CC) was often marginally 'worse' than the other scenarios, which all met ecological requirements (DWS, 2023).

As the ecosystem is the most stringent 'user' in terms of water quality in the Water Quality (WQ) priority areas identified, it follows that if there is no discernible impact on the ecology, none would be expected for non-ecological water quality under implementation of the operational scenarios.

11 WATER RESOURCES CLASSES

The purpose of this chapter 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).

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 was applied to determine the Classes.

Table 11-1 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 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).

Table 11-2: 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
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.

Table 11-3: 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 Management Plan to

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
					interventions must be implemented to ensure estuary connectivity is re-established.	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 and water quality not improves); mechanical removal of reeds in lower reaches

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
						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
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	None

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
					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.	
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 (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

RU	River/ Estuary	PES	REC	TEC	Rationale	Actions
						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 Map indicating the classes is provided in **Figure A8** of **Appendix A**.

12 RESOURCE QUALITY OBJECTIVES

12.1 RIVERS

The table below provides an indication of the hydrological RQOs for Rivers expressed in terms of flow at the river Ecological Water Requirement (EWR) sites. These summarised statistics are representative of the required flow regime in the river where the variability is dependent on the seasonal and temporal pattern of natural flow conditions. The mean monthly flows represent low flow requirements of a representative wet and dry month as indicated in the table. Detailed hydrological RQOs can be found in the RQO reports for the study.

Table 12-1: Summary of key hydrological RQOs

RU	Biophysical Node	River	TEC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)	Mean of Monthly flows at the indicated frequency[3] (m^3/s)			
							Wet season		Dry season	
							90%	60%	90%	60%
IUA W11: Matigulu										
W11-2	EWR MA1: W11A-03612	Matigulu	B/C	55.17	23.6	34	0.149	0.348	0.142	0.28
							March		August	
IUA W12-b: Mfule, Mhlatuzana, Nseleni Tributary systems										
W11-8	EWR NS1: W12G-03229	Nseleni	C	31.23	4.7	21.9	0.10	0.16	0.04	0.10
							April		August	
IUA W21: Upper and Middle White Umfolozi										
W21-5	EWR WM1: W21H-02897	White Mfolozi	B/C	222.51	24.6	40.1	1.262	1.979	0.773	1.001
							February		September	
IUA W22: Upper Black Umfolozi										
W22-1	EWR BM1: W22A-02610	Black Mfolozi	C	166.72	11	26.1	0.40	0.70	0.20	0.39
							February		July	
IUA W31-b: Lower Mkuze										
W31J	EWR MK1: W31J-02480	Mkuze	B/C	55.17	23.6	34	0.149	0.348	0.142	0.280
							March		August	
IUA W42-a: Upper Pongola										
W42-2	EWR UP1: W42E-02221	Pongolo	**C**	356.84	15.4	27.3	1.19	1.98	0.12	0.50
							February		September	
IUA: W52: W5 Downstream major dams & Hlelo River										
W51-3	EWR AS1: W51E-02049	Assegaai	C	328.61	12.2	21.6	0.69	1.10	0.20	0.30
							February		September	
W53-3	EWR NG1: W53E-01790	Ngwempisi	B/C	156.33	19.5	32.5	0.60	1.00	0.09	0.19
							February		September	

Habitat and biota RQOs are provided as Ecological Categories. There are generic narrative and numerical RQOs associated with the Ecological Categories. **Table 12-2** describes these for each Ecological Category relevant for rivers. **Table 12-3** provides the habitat and biota RQOs for each IUA for High Priority RUs in rivers.

Table 12-2: Generic numerical and narrative RQOs associated with River Ecological Categories

Ecological Category	Generic narrative RQO	Instream and riparian habitat narrative RQO	Numerical RQO
A	Unmodified, near natural.	Very similar to natural reference conditions.	≥ 92%
A/B			≥ 88%
B	Largely natural with few modifications.	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	≥ 82%
B/C			≥ 78%
C	Moderately modified.	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	≥ 62%
C/D			≥ 58%
D	Largely modified.	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	≥ 42%
D/E			> 38%
E	Seriously modified.	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-≤ 38%
F	Critically / Extremely modified.	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	< 20%

Table 12-3: RQOs for habitat integrity, riparian vegetation, geomorphology, macroinvertebrates and fish in High Priority RUs

IUA	Water Resource Class	Quaternary catchment	Biophysical node	River	Instream Habitat Integrity	Riparian Habitat Integrity	Fish	Macro-inverteb rates	Riparian vegetati on	Geo-morpho logy
W11	I	W11A	EWR MA1	Matigulu	B/C	B/C	B	B/C	B/C	B
W12-b	I	W12G	EWR NS1	Nseleni	B/C	B	C	B/C	C	B
W21	II	W21H	EWR WM1	White Mfolozi	B/C	B/C	C	B/C	B/C	B/C
W21	II	W22A	EWR BM1	Black Mfolozi	B/C	C	C	B/C	C	A
W31-b	II	W31J	EWR MK1	Mkuze	B/C	B/C	C	B/C	B/C	B/C
W42-a	II	W42E	EWR UP1	Phongolo	B/C	B/C	C	B/C	C	A/B
W52	II	W51E	EWR AS1	Assegaai	C/D	C/D	C	B/C	C	C
W52	II	W53E	EWR NG1	Ngwempisi	C	C/D	C	B	B/C	B/C

Table D3 in **Appendix D** provides the Water Quality RQOs.

12.2 ESTUARIES

As per the DWS methodology, estuaries are sufficiently different in terms of state, functioning and management to form individual RUs. RQOs are set for the short to medium term (5 to 10-year period) for the following components:

- Quantity, pattern and timing of instream flow (hydrology).
- Mouth state (hydrodynamics).
- Water quality.
- Characteristics and condition of primary producers (e.g. macrophytes).
- Characteristics and condition of biota (e.g. fish).

The RQOs for the estuaries were derived from the EcoSpecs and Thresholds of Potential Concern (TPCs) set for systems that were assessed as part of EWR studies. For the uMgobezeleni Estuarine Lake system, the RQOs were based on the 2018 National Biodiversity Assessment and field studies. In terms of RQOs for recreational use (water quality), the recommended targets proposed for South Africa's coastal marine waters were applied as summarised in **Table 12-4**.

Table 12-4: RQOs for recreational use in estuaries are specified as risk-based ranges for intestinal enterococci and *E. coli* (microbiological indicator organisms) (DEA, 2012)

Category	Estimated Risk per Exposure	Enterococci	*E. coli*
		(Count per 100 ml)	**(Count per 100 ml)**
Excellent	2.9% gastrointestinal (GI) illness risk	≤ 100 (95 percentile)	≤ 250 (95 percentile)
Good	5% GI illness risk	≤ 200 (95percentile)	≤ 500 (95 percentile)
Sufficient or Fair (minimum requirement)	**8.5% GI illness risk**	**≤ 185 (90 percentile)**	**≤ 500 (90 percentile)**
Poor (unacceptable)	>8.5% GI illness risk	> 185 (90 percentile)	> 500 (90 percentile)

In South Africa, the minimum requirement for recreational use is the "Sufficient or Fair" category, thus also representative of the RQOs for estuaries used for full-contact recreation.

Ecological Categories for the eight estuaries represented below summarise the numerical and narrative RQOs in **Table 12-5** (as per DWS estuarine methods).

Table 12-5: Generic numerical and narrative RQOs associated with Ecological categories for Estuaries

	aMatigulu/iNyoni	iSiyaya	uMlalazi	uMhlathuze	iNhlabane	uMgobezeleni	Kosi	St Lucia/ uMfolozi
PES (trajectory)	B/C ↓	D/E↓	B/C ↓	D↓	E↓	B↓	A/B↓	D ↓↑
REC	B	C	B	D	D	A	A	B
TEC	B	D (short term) C (long term)	B	D	D	A/B	A	C (short term) B (long term)
Hydrology	C	B/C↑	C	C	D	B	A	C
Hydrodynamics	B	D ↑	B/C	D/E	C/D	B	A	C
Physical habitat (sediments)	B	B	B	D	E→D	A/B	A	C
Water quality (salinity)	A	B	B	C/D	E→D	A/B	A	D ↑
Water quality (general)	C	D ↑	C	D	D	B	A/B	D ↑
Microalgae	B	C	C	D	D	B	A	D ↑
Macrophytes	B	D→C	B/C	D	C/D	B	A/B	B
Invertebrates	B	D→C	B	E→D	E→D	A/B	B↑	D
Fish	B/C	D→C	B	D	E→D	B	B↑	C
Birds	B	D→C	B	C	D	A	A/B	C

X (short term; <5 years)→Y (long term; 5-10 years) - indicate the expected long-term trajectory of change to meet long-term TEC/RQO.
↓↑ - indicate that the trajectory of change is not stable.
↑ - indicate an improvement within a category (mostly associated with degraded components) and thus a focus for restoration.

12.3 GROUNDWATER, WETLANDS AND COASTAL LAKES

Tables D1 and **D2** in **Appendix D** provide the detailed wetland and groundwater RQOs produced. The RQOs for the groundwater fed coastal lakes are presented in **Table 12-6**.

Table 12-6: Resource Quality Objectives for Groundwater Fed Coastal lakes in the Usuthu to Mhlathuze catchments (W1 - 5, and 7) catchments

IUA	Class	Lake	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
W70-b	I	Sibaya	W70A1	Quantity	Abstraction	Water Allocations	The preferred scenario is to reduce direct lake abstraction as much as possible and transfer existing water use to groundwater. Abstraction to be restricted within the radius of influence of the borehole.	No afforestation or lake abstraction is possible and total groundwater abstraction in the lake catchment of 4.7 Mm^3 /a.
					Surface inflow	Hydrology	Due to land use changes, monitoring of surface water inflows is required.	
					Groundwater level	Water level	Water levels should not exhibit long term declining trends.	
					Lake level	Lake level	Lake levels need to be monitored to remain above the minimum drought level.	The minimum drought lake level is to be maintained above 16 mamsl for Category B/C.
W12-e	III	Mzingazi	W12J1	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new largescale abstraction requires an assessment of impacts on lake level. Abstraction to be restricted within the radius of influence of the borehole.	Total water allocations from the lake should not exceed 10.5 Mm^3 /a.
					Surface inflow	Hydrology	Due to land use changes, monitoring of surface water inflows is required.	
					Groundwater level	Water level	Water levels should not exhibit long term declining trends.	
					Lake level	Lake level	Lake levels need to be monitored to remain above the minimum drought level	The minimum drought lake level is to be maintained above 0.1 mamsl.
W12-d	III	Nhlabane	W12J2	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new largescale abstraction requires an assessment of impacts on lake level. Abstraction to be restricted within the radius of influence of the borehole.	Total water allocations from the lake should not exceed 7.9 Mm^3 /a without any support from the Mfolozi River.

IUA	Class	Lake	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Surface inflow	Hydrology	Due to land use changes, monitoring of surface water inflows is required.	
					Groundwater level	Water level	Water levels should not exhibit long term declining trends.	
					Lake level	Lake level	Lake levels need to be monitored to remain above the minimum drought level.	The minimum drought lake level is to be maintained above 3.5 mamsl.
W12-c	III	Cubhu	W12F2	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new largescale abstraction requires an assessment of impacts on lake level. Abstraction to be restricted within the radius of influence of the borehole.	Total water allocations from the lake should not exceed 0.4 Mm^3 /a.
					Surface inflow	Hydrology	Due to land use changes, monitoring of surface water inflows is required.	
					Groundwater level	Water level	Water levels should not exhibit long term declining trends.	
					Lake level	Lake level	Lake levels need to be monitored to remain above the minimum drought level	The minimum drought lake level is to be maintained above 1.2 mamsl.

13 OTHER ASPECTS COVERED IN STUDY

13.1 TRAINING

Training and capacity building has been ongoing throughout the duration of the study in the form of mentoring, site visit exposure as well as formal workshops and training courses. The detailed overview of the training provided in included in **Appendix B**.

13.2 SITE VISITS

Two site visits took place as part of the study. The first was the rivers site visit which was undertaken to the EWR river sites. An overview of this site visit is provided in **Appendix C**. The information gathered at the Estuary site visit is summarised and presented in **Section 9** of this document.

13.3 STAKEHOLDER ENGAGEMENT

Stakeholder engagement has taken place throughout the study. The study was initiated with a public meeting where members were introduced to the study and provided with an overview of the process. Members were then invited to elect a representative Project Steering Committee (PSC) which was engaged throughout the study. Five PSC meeting were held and members of the PSC were provided with all Technical reports produced along the way. They provided comments on all documentation. A second round of public meetings was held at two separate venues on completion of the technical work. An Issues and Responses Register was maintained throughout the study.

13.4 PUBLISHING OF THE GAZETTE

The final task of the study involves the production and publishing the gazette which presents the final classes and RQOs developed throughout the study. This process is ongoing as at the date of drafting of this report. The final IUA Table as published in the Gazette is presented in **Table 13-1**. Note that these IUA delineations represent the IUAs at the end of the study, and therefore represent a refinement from the IUA and RU delineation prepared at the beginning of the study (Table 2-5).

Table 13-1: Integrated Unit of Analysis per secondary catchment

Secondary Catchment	IUA No	IUA Descriptive Name	RU (& SQRs where relevant)
W1	W11	Matigulu	W11-1, W11-2, W11-3, W1-Matigulu Estuary
	W12-a	Upper Mhlathuze	W12-1, W12-2 W12-3, W12-4
	W12-b	Mfule, Mhlatuzane, Nseleni Tributary systems	W12-5, W12-7, W12-8
	W12-c	Lower Mhlathuze	W12-6, W12-Mhlathuze Estuary
	W12-d	Lake Nhlabane	W12-9, W12-Nhlabane Estuary
	W12-e	Lake Msingazi	W12-10, Lake Msingazi
	W13	Mlalazi	W13-1, W13-2, W13-Mlalazi Estuary, W13-Siyaya Estuary
W2	W21	Upper and Middle White Umfolozi	W21-1, W21-2, W21-3, W21-4, W21-5, W21-6, W21-7
	W22	Upper Black Umfolozi	W22-1, W22-2, W22-3, W22-4
	W23	Umfolozi Hluhluwe Game Reserve	W21-8, W22-5, W23-1, W23-2, W23-3: Mfolozi Swamps
W3	W31-a	Upper Mkuze	W31-1, W31-2, W31-3
	W31-b	Lower Mkuze	W31-4, W31-5, W31-6, W32-1
	W32-a	Upper Hluhluwe	W32-2
	W32-b	Nyalazi and Mzinene Tributaries	W32-3, W32-4, W32-5, W32-6

Secondary Catchment	IUA No	IUA Descriptive Name	RU (& SQRs where relevant)
W4	W41	Bivane River	W41-1, W41-2
	W42-a	Upper Pongola	W42-1, W42-2
	W42-b	Middle Pongola (Ithala)	W41-3, W42-3, W42-4, W42-5
	W44	Middle Pongola (Grootdraai)	W44-1
	W45	Lower Pongola (Floodplain)	W43-1, R45-1, W45-Pongola Floodplains
W5	W51-a	W5 Upstream major dams: Assegaai River	W51-1
	W51-b	W5 Upstream major dams: Ngwempisi, Usutu	W53-1, W53-2, W54-1
	W52	W5 Downstream major dams & Hlelo River	W51-2, W51-3, W51-4, W52-1, W53-3, W54-2
	W55	Mpuluzi & Lusushwana River systems	W55-1, W55-2, W55-Pan District (Chrissiesmeer)
	W57	Lower Usutu River	W57-1, W57-Ndumo Pans
W7	W70-a	Kosi Bay	W70-1, W70-Kosi Bay Lakes and Estuary
	W70-Muzi Swamps	Muzi Swamps	W70-Muzi Swamps
	W70-b	Sibaya	W70-2, W70-3, W70-Lake Sibaya, W70-uMgobezeleni Estuary
W2 & W3	IUA St Lucia	St Lucia	St Lucia and W2 and W3 feeder streams: W23-3: W23B-03231, W23C-03180, W23D-03108. W31-3: W31E-02456, W31F-02573, W31F-02555, W31F-02530, W31G-02455, W31G-02506. Hluhluwe Floodplain, Mpate Wetlands, Nyalazi Pan, i.e. W32H-02998, W32H-03048, W32H-02854, W32F-02835. W32-Mkuze Floodplain & Swamps: W32B-02535.

14 REFERENCES

Begg, G. 1989. The Wetlands of Natal (Part 3). The location status and function of the priority wetlands of Natal. Natal Town and Regional Planning Report Volume 73, Pietermaritzburg, South Africa.

Department of Water Affairs and Forestry (DWAF), South Africa. 1999. Resource directed measures for the protection of water resources. Volume 3: River ecosystems, version 1.0.

Department of Water Affairs and Forestry (DWAF), South Africa. 2007. Chief Directorate: Resource Directed Measures. Development of the Water Resource Classification System (WRCS) Volume 1 Overview and 7-step classification procedure. October 2006.

Department of Water Affairs and Forestry (DWAF) 2008a. Resource Directed Measures for Protection of Water Resources: Methodologies for the determination of the Basic Human Needs Reserve – Internal memorandum. Pretoria.

Department of Water Affairs and Forestry (DWAF) 2008b. Resource Directed Measures for Protection of Water Resources: Methodologies for the determination of ecological water requirements for estuaries. Version 2. Pretoria.

Department Water Affairs and Forestry (DWAF). 2009. Mhlathuze Water Availability Assessment Study (Final Report): Report no. PWMA 06/000/00/1007 conducted by WRP Consulting Engineers (Pty) Ltd in association with DMM Development Consultants CC, Laubscher Smith Engineers and WSM Leshika (Pty) Ltd. in 2009, for the Department of Water Affairs and Forestry Directorate: Water Resource Planning Systems, Pretoria, South Africa.

Department of Water and Sanitation (DWS) 2014a. Chief Directorate – Water Ecosystems: Reserve determination study of selected surface water and groundwater resources in the Usutu/Mhlathuze Water Management Area. River Delineation and Site Selection Report. Prepared by Tlou Consulting (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/0213

Department of Water and Sanitation (DWS), South Africa. 2014b. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Compiled by RQIS-RDM: http://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx.

Department of Water and Sanitation (DWS). 2015a. Resource Directed Measures: Reserve determination study of selected surface water and groundwater resources in the Usuthu/Mhlathuze Water Management Area. Lake Sibaya – Intermediate EWR Assessment Report. Report produced by Tlou Consulting (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/1713.

Department of Water and Sanitation (DWS). 2015b. Chief Directorate – Water Ecosystems: Reserve determination study of selected surface water and groundwater resources in the Usuthu/Mhlathuze Water Management Area. Pongola Floodplain – EWR Report. Prepared by Tlou Consulting (Pty) Ltd and Southern Waters Ecological Research and Consulting cc. Report no: RDM/WMA6/CON/COMP/1213.

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.

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.

Department of Water and Sanitation (DWS). 2020. Assessment of water quality and land use impacts in Primary Drainage Regions as per the 9 Water Management Areas (WMA): Report on the Planning Level Review of the Water Quality in the Pongola to Mtamvuna WMA. Prepared by Grobler, Viljoen and Mosoa. DWS Report No. P RSA 000/00/22618/24. Study Report Index No. 24.

Department of Water and Sanitation (DWS). 2022. Hydrology report to be compiled as part of the Development, Updating and Review of Strategies to Reconcile Water Availability and Requirement in the East Planning Area Comprising Water Supply Systems for Mbombela, Richards Bay, Mgeni and All Other Towns and Clusters of Villages – Hydrology Report. June 2022, DWS, Pretoria, South Africa.

Inkomati-Usuthu Catchment Management Agency (IUCMA). 2016. Water Availability Assessment Study for the Usuthu Catchment. Prepared by WRP Consulting Engineers (Pty) Ltd for the IUCMA, Nelspruit, South Africa.

Kleynhans, C.J. and Louw, M.D. 2007a. Module A: Ecoclassification and Ecostatus determination in River EcoClassification: Manual for Ecostatus determination (Version 2). Joint Water Research Commision and Department of Water Affairs and Forestry report. WRC Report No. TT 329/08.

Kleynhans, C.J., Mackenzie, J. and Louw, M.D. 2007b. Module F: Riparian Vegetation Response Index. In River EcoClassification: Manual for EcoStatus Determination (version 2) Water Research Commission Report No. TT 333/08. Joint Water Research Commission and Department of Water Affairs and Forestry report, Pretoria, South Africa.

Milner, A.M. 1994. System recovery. In, P.Calow and G.E. Petts (eds.): The rivers handbook. Vol. 2. Blackwell Scientific Publications. London.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Doeswnsborough, L. and Nienaber, S. 2011. Technical report for the national freshwater ecosystem priority areas project. WRC Report No. 1801/2/11. Water Research Commission, Pretoria, South Africa.

Resh, V.H., Brown, A.V., Covich, A.P., Gurtz, M.E., Li, H.W., Minshall, G.W., Reice, S.R., Sheldon, A.L., Wallace, J.B. and Wissma,r R.C. 1988. The role of disturbance theory in stream ecology. *Journal of the North American Benthological Society*. **7**: 433-455.

Statistics South Africa (Stats SA). 2016. Community Survey 2016, Statistical release P0301. 107 pp.

TPTC, 2008. Tripartite Permanent Technical Committee (TPTC) Republic of Moçambique, Republic of South Africa and Kingdom of Swaziland. Joint Maputo River Basin Water Resources Study – Moçambique, Swaziland and South Africa (EuropeAid/120802/D/SV/ZA).

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. and Snaddoesn, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

15 APPENDIX A: MAPS AND FIGURES

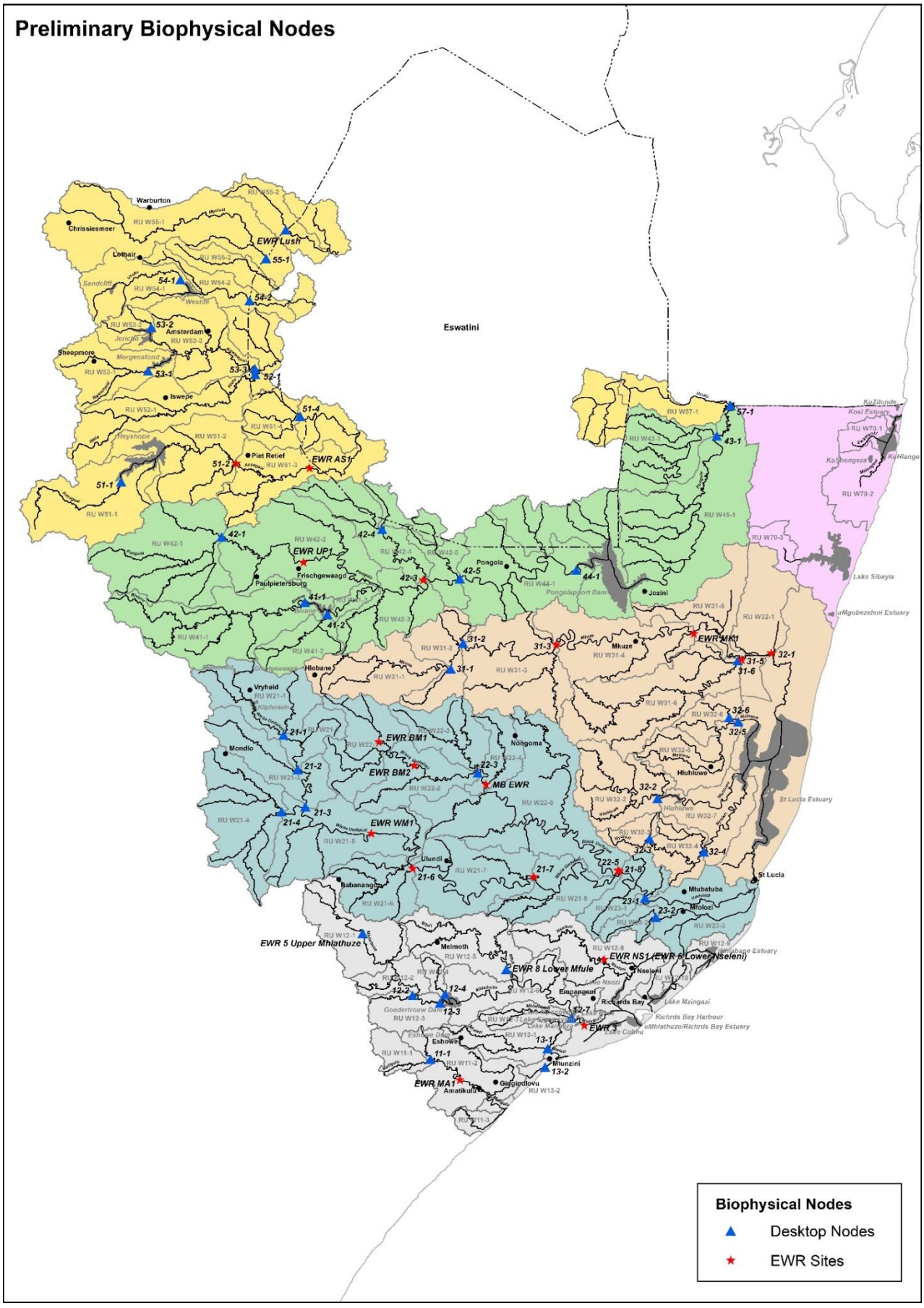


Figure A-1: Biophysical nodes and EWR sites

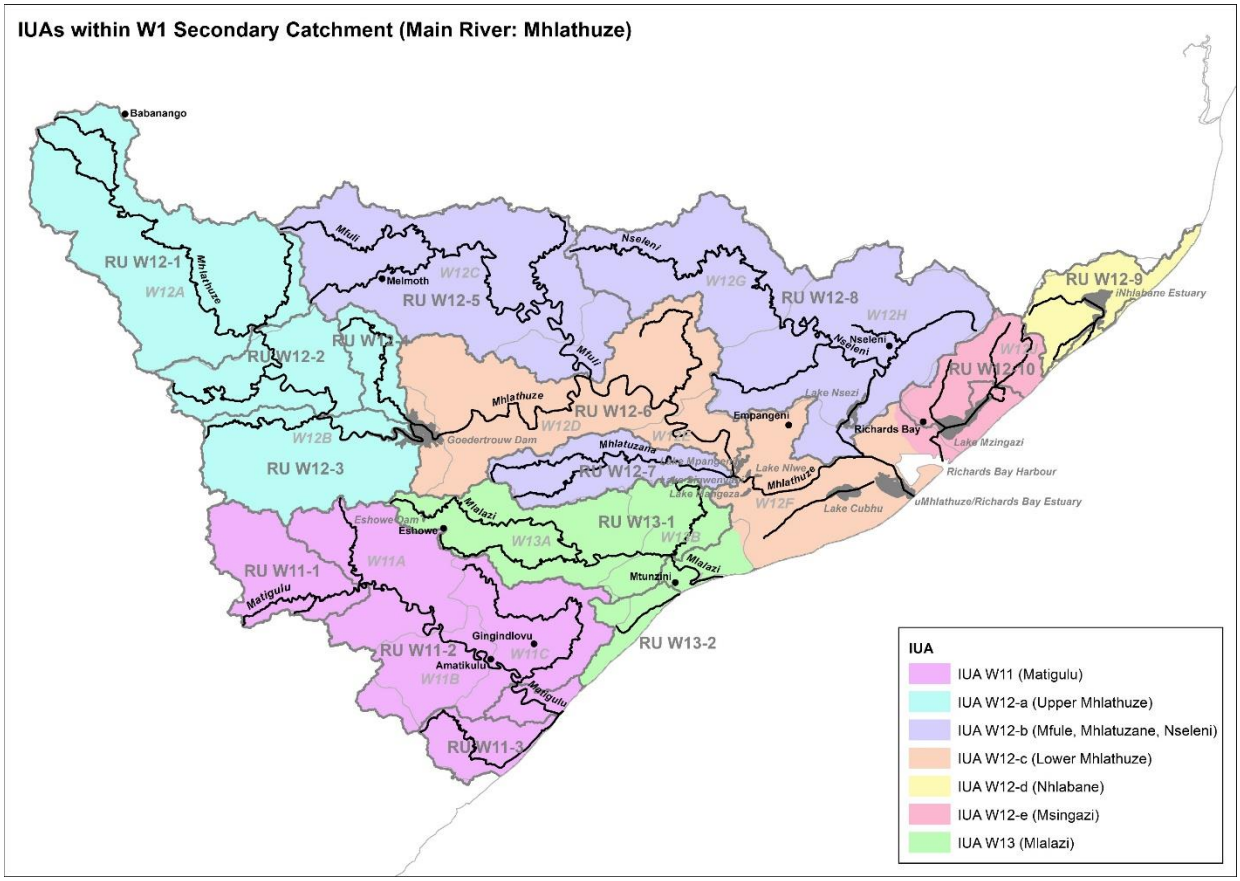


Figure A-2: Integrated Units of Analysis delineated for the W1 catchment

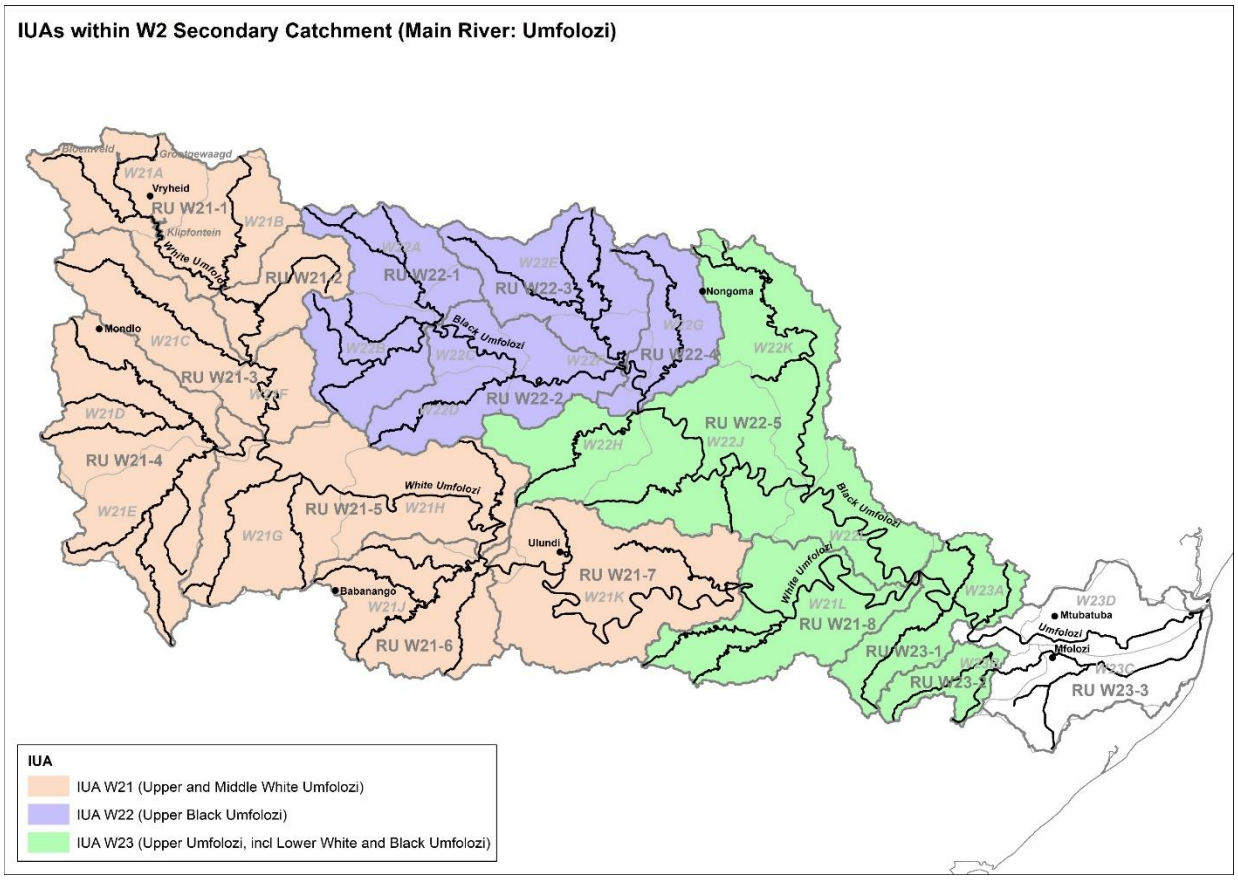


Figure A-3: Integrated Units of Analysis delineated for the W2 catchment

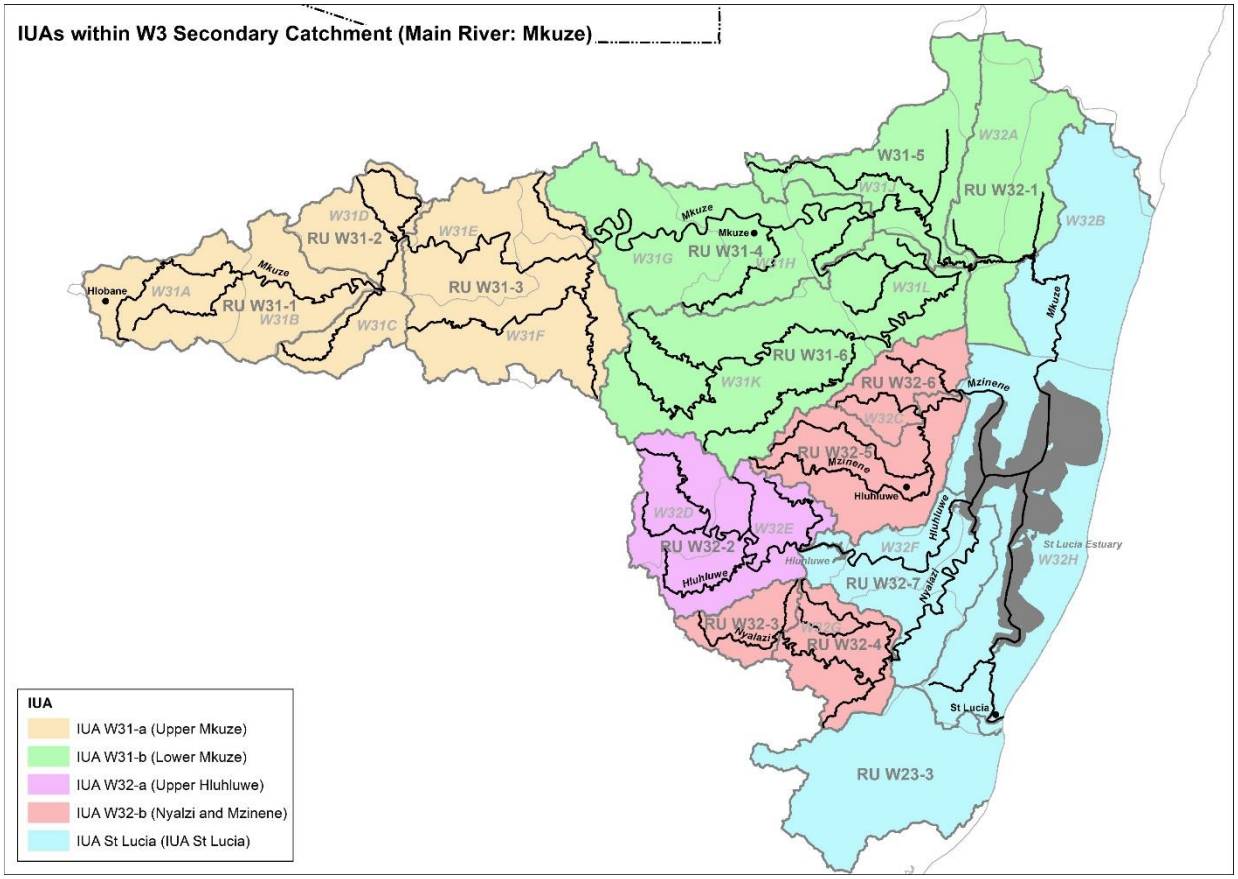


Figure A-4: Integrated Units of Analysis delineated for the W3 catchment

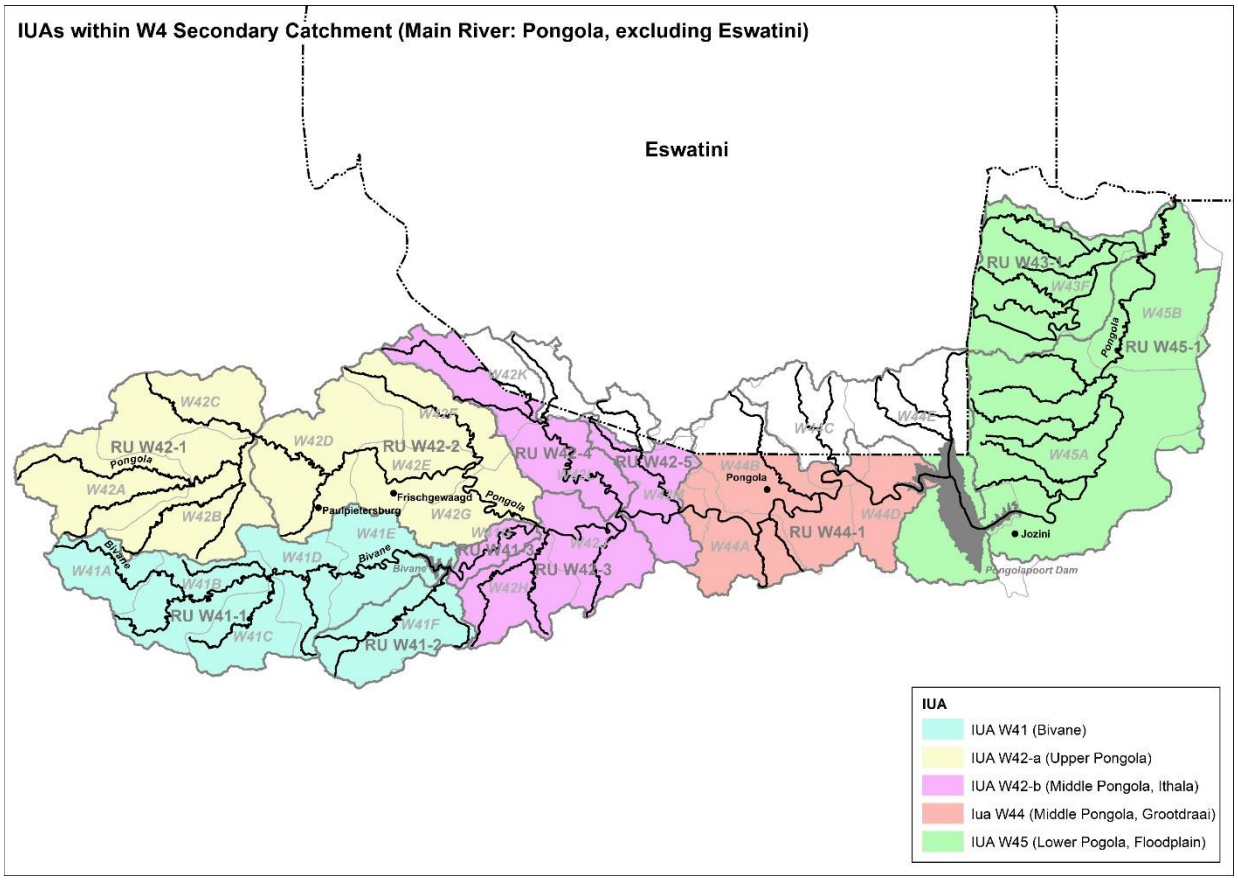


Figure A-5: Integrated Units of Analysis delineated for the W4 catchment

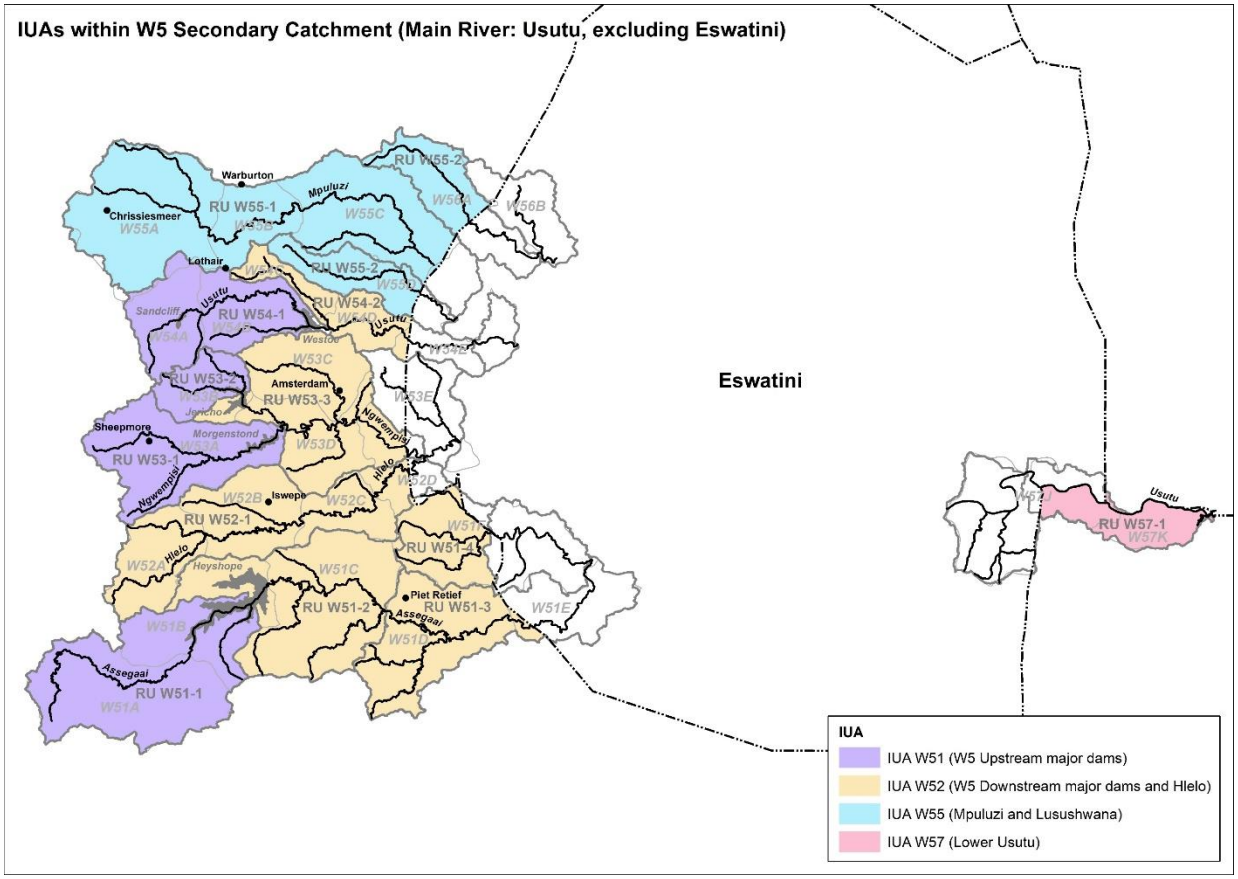


Figure A-6: Integrated Units of Analysis delineated for the W5 catchment

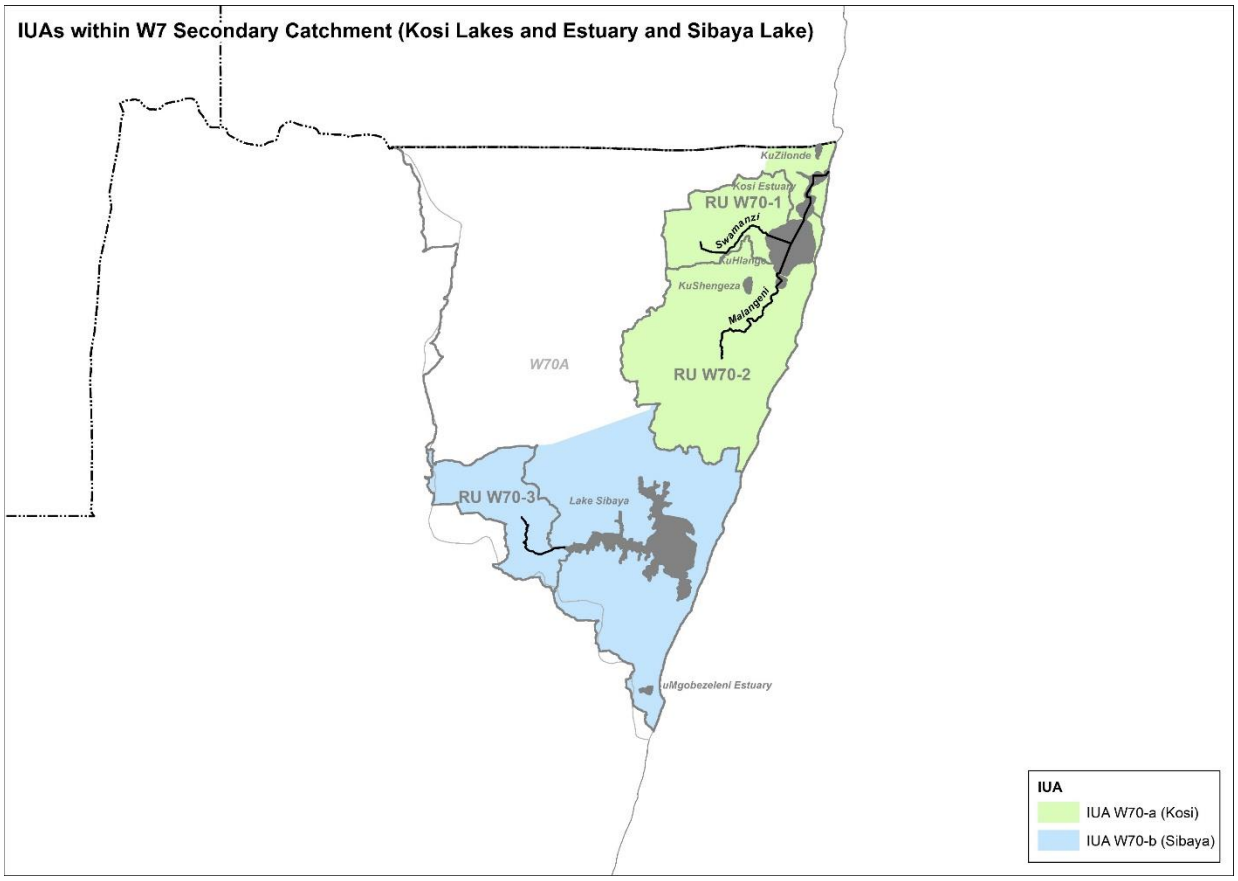


Figure A-7: Integrated Units of Analysis delineated for the W7 catchment

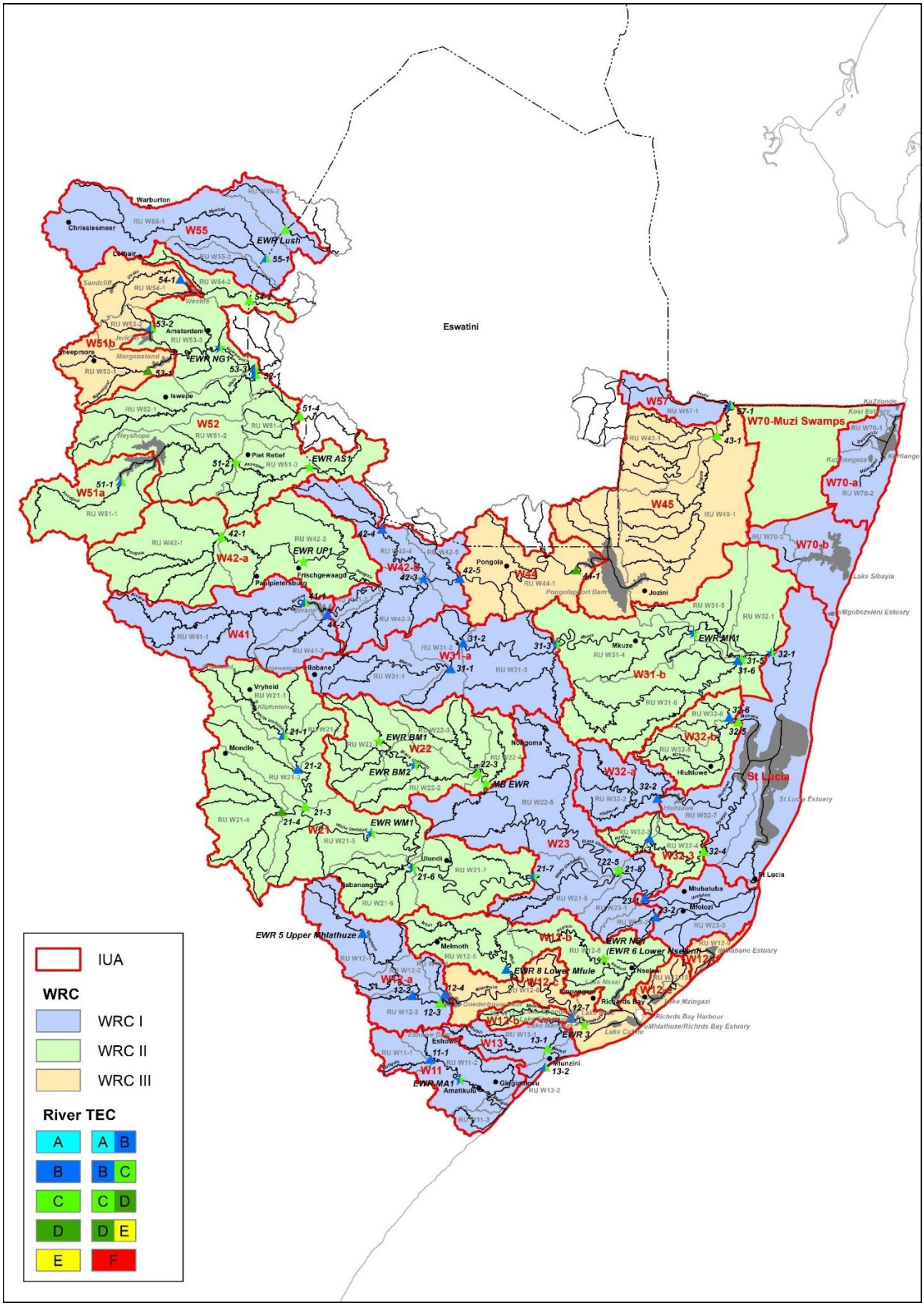


Figure A-8: Classes per IUA

16 APPENDIX B: OVERVIEW OF TRAINING

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES AND DETERMINATION OF RESOURCE QUALITY OBJECTIVES FOR WATER RESOURCES IN THE USUTU TO MHLATHUZE CATCHMENTS: *CAPACITY BUILDING COMPONENT*

Feedback is provided on the training and capacity building activities until May 2023, including Capacity Building Workshop 2. This short document will form part of the Capacity Building Report to be prepared at the closure of the study. *Section 1: Introduction* outlines the Capacity Building task as drafted in the March 2022 Inception Report.

1 INTRODUCTION

As itemized in the Terms of Reference, capacity building was planned to take place at three levels, i.e. (1) mentorship of Ms Sekoele (replacing Mr Mnisi) and Ms Makanda, as identified by DWS; (2) broad capacity building workshops that provide an overview of specific study components to DWS and IUCMA staff; and (3) stakeholder empowerment sessions.

The feedback provided here is on consolidated training opportunities provided throughout the study, with a focus on **Capacity Building Workshop 3** held on a virtual Teams platform on **18-19 April 2024**.

The proposed subject matter of the three proposed Capacity Building/Training workshops were as follows (taken from the Inception Report):

- Training Workshop 1: *An overview of Classification, Reserve and RQOs as RDM tools in Integrated Water Resource Management (IWRM)*.
- Training Workshop 2: *Operational scenarios – selection, modelling and evaluation – and Classes.*
- Training Workshop 3: *RQOs and gazetting*.

Three other training opportunities were held during the study, as follows:
- Attendance of the river field survey: 18-22 July 2022
- Exposure to the online rivers EWR working session held in September 2022
- Attendance of the estuary field survey from 3-9 October 2022

A short report was provided on each training opportunity (excluding that of April 2024; to be reported here), which are included as a consolidated report-back on training opportunities offered during the study. Opportunities are shown sequentially.

This workshop was designed to go through all the steps to be covered in the study in an interactive discussion session, so that all officials likely to be involved in management of the study catchment understand the intent behind each step, and the sub-steps and components to be covered by each step. The workshop was originally proposed as a short introductory 2hr session with Dr Scherman, but on a request from DWS to include delineation, the workshop was extended to a day, with Dr Scherman and Ms Delana Louw (river task leader) running the workshop. The workshop was undertaken virtually on the TEAMS platform on **29 July 2022**.

2 TRAINING WORKSHOP 1: OVERVIEW AND DELINEATION

2.1 AGENDA AND TRAINING MATERIALS

The agenda for the workshop was circulated to the list of eighteen trainees identified by DWS, and the Small, Medium and Micro Enterprise (SMME) trainee identified for the project, Mr Nathi Ncube, on 28 June 2022. **Table 1** shows the trainees invited and those who attended, as well as two additional participants:

Table 1 Attendees of Training Workshop 1

No.	Name & surname	Email address	Attended
1	Manisha Maharaj	maharajm@dws.gov.za	√
2	Michael Maluleke	malulekem4@dws.gov.za	√
3	Renelle Pillay	pillayr@dws.gov.za	√
4	Ziyanda Malibiji	malibijiz@dws.gov.za	√
5	Krishnee Naidoo	naidook@dws.gov.za	√
6	Lwandle Sibango	sibangol@dws.gov.za	√
7	Siphindile Shoba	shobas@dws.gov.za	√
8	Halalisiwe Mdletshe	mdletsheh@dws.gov.za	x
9	Ivor Hoareau	hoareaul@dws.gov.za	√
10	Neethan Singh	singhn2@dws.gov.za	x
11	Lodevikus Nel	nell@dws.gov.za	x
12	Nkosinjani Mkhize	mkhizen@dws.gov.za	x
13	Meso Kama	mesok@dws.gov.za	√
14	Mmangwedi Basetsane	Basetsanem@dws.gov.za	x email bounced back repeatedly
15	Mapule Mokoena	mokoenam@dws.gov.za	√
16	Mngomezulu Nhlanhla	mngomezulun@dws.gov.za	√
17	Makanda Koleka	Makandac@dws.gov.za	√
18	Mnisi Mkhevu	Mnisim2@dws.gov.za	x no longer with the project
19	Nathi Ncube	nathi.ncube@khapheni.co.ca	x
Additional participants			
20	Caroline Shai	ShaiC@dws.gov.za	√
21	S'nothile Khuzwayo	KhuzwayoS@dws.gov.za	√

The agenda is shown as **Table 2**.

Table 2 Agenda for Training Workshop 1

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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

TRAINING SESSION 1

Date: Friday, 29 July 2022
Venue: Virtual/Online

Aims: (1) Provide background to Resource Directed Measures (RDM) tools; (2) prepare delineation spreadsheets and other information required for Steps 1 and 2 of Classification, Resource Quality Objectives (RQO) and Reserve tasks; and (3) conduct delineation of a catchment into Resource Units (RUs) and Integrated Units of Analysis (IUAs).

Learning outcomes: The training session will provide an introduction to RDM tools, and equip trainees in the process of delination of a catchment for the purposes of conducting Water Resource Classification and determining Ecological Water Requirements (EWR).

Subject	Time
am	**Start 8:30 AM**
SESSION 1: BACKGROUND AND SPREADSHEETS	
1.1 Objectives of training session	Scherman
1.2 Basic concepts and definition of terms, and an introduction to RDM tools	Scherman
TEA	**10.30-10.50 AM**
1.3 Introduction to PES/EIS data used as input to delineation spreadsheets	Scherman + Louw
LUNCH	**13:00 PM**
pm	**Start 13:45 PM**
SESSION 2: DELINEATION	
1.4 Background/Introduction to delineation (Steps 1 and 2)	Louw
1.5 Practical exercise: Delineation of RUs	Louw + Scherman
1.6 Practical exercise: Delineation of IUAs	Louw + Scherman
1.7 Overview of next steps	Scherman
CLOSURE	**16:00 PM**

The following items were e-mailed to participants before the workshop, for their use during the training workshop. Secondary catchment W1 (Mhlathuze) was used as the catchment to be delineated for training purposes. As a large part of the workshop was to be the preparation of spreadsheets needed for delineation and all subsequent tasks, trainees were requested to ensure they had internet connections and Google Earth loaded on your machines. They were advised to work in teams across the various DWS offices participating in the workshop.

- W1 map (to be printed as an A3 map)

- W1 training spreadsheet (without delineated RUs)
- Google Earth files (from the 2014 DWS PES EIS study)
    - W1 RCode
    - W1 RNames
    - W1 Quats

2.2 WORKSHOP

Presentations included the following: 1.1 Objectives and 1.2 Background to RDM: Scherman; and 1.3 Training: Louw. Spreadsheets were completed by the trainee groups showing their delineation of RUs vs. those of the specialist team. The time allocation also allowed for a final session discussing the grouping of RUs into IUAs, and comparison to the RU1_RU2Map prepared by the specialists.

Trainees were also provided WeTransfer links to two photo guides for riparian and instream habitats, prepared in December 2008 by Louw and Kleynhans as part of Index of Habitat Integrity (IHI) documentation.

3 ATTENDANCE OF RIVER FIELD SURVEY

The river field survey was held from **18-22 July 2022** and attended by the following DWS personnel as a Capacity Building event.

Ms Lwandle Sibango	DWS: KwaZulu-Natal (KZN) regional office; Water Quality Management
Ms Ziyana Malibiji	
Ms Renelle Pillay	
Ms Manhisha Maharaj	
Mr Michael Singh	DWS: KZN regional office; Director: Water Resources Support
Ms Koleka Makanda	DWS: Pretoria (head office); Water Resource Classification
Mr Philani Khoza	DWS: Pretoria (head office); Reserve Determination: Groundwater Reserve Determination
Mr Molefi Mazibuko	DWS: Pretoria (head office); Reserve Determination: Surface Water Reserve Determination

The itinerary is shown below. Activities and outputs from the survey were documented in the River Survey Report[6] of July 2022.

[6] Department of Water and Sanitation, South Africa, June 2022. Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: River survey report. Prepared by: WRP Consulting Engineers (Pty) Ltd. DWS Report: WEM/WMA3/4/00/CON/CLA/0622.

Date	Day	Time	Activity
18 Jul	Day 1	11:40	Meet at EWR MA1
		13:00	Depart EWR MA 1 to EWR NS1
		14:30 – 16.00	EWR NS1
19 Jul	Day 2	09:30	Meet at EWR WM1
		11:30	Depart to EWR BM?
		13:00-15.30	EWR BM?
20 Jul	Day 3	08:00	Depart to EWR MK 1
		10:00-14.00	EWR MK1
21 Jul	Day 4	08:00	Depart to EWR UP1
		09:30	Arrive EWR UP 1
		12:30	Depart EWR UP 1
		14:00-16.30	EWR AS 1
22 Jul	Day 5	08:00-12.00	Select and work new site in W5

4 RIVERS EWR WORKING SESSION ATTENDANCE

The River EWR determination specialist working session was undertaken virtually on the TEAMS platform from **9-15 September 2022**, with planned training sessions shown on the agenda shown as **Table 3**.

Table 3 Agenda for the rivers EWR working session

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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

TRAINING SESSION 2: RIVERS EWR WORKSHOP

Date: Friday, 9 - 15 September 2022 (part-time dedicated sessions)
Venue: Virtual/Online

Aims: (1) Provide background to the EcoClassification and EWR steps (Step 2); (2) information requirements for EcoStatus and EWR determinations; (3) process of determining PES, EC and EWRs, and (4) dedicated question-and-answer sessions with the specialist team.

Learning outcomes: The training session will build on the delineation steps previously covered and provide an understanding of the EcoClassification and EWR determination steps of the process.

Subject	Time
START	**TUESDAY 13 SEPT; 9:00**
SESSION 1: ECOCLASSIFICATION	
Feedback session: EcoClassification and EcoStatus	Tuesday 13th, 9am-12pm: Scherman
SESSION 2: EWR DETERMINATION	
EWR 1 Matigulu	***Tuesday 13th***
EWR process and feedback	2-3pm
Training question and answer session	3.30-4pm
Other EWR sites: daily sessions	***Wednesday and Thursday, 14 and 15th***
Consolidate and feedback from specialists	8-9am
Training question and answer session	10-11am
Consolidate and feedback from specialists	2-3pm
Training question and answer session	3.30-4pm
CLOSURE	**THURSDAY 15 SEPT; 16:00**

Please note the following:
1. Times will be flexible. A WhatsApp group will be set up to confirm times to link in.
2. A single TEAMS link will be sent and used for the entire workshop.

Load-shedding impacted on virtual sessions, with training by Scherman (overview and EcoClassification results), Louw (assessing hydrology before using data for flow requirements), Kotze and Deacon (setting low flow requirements for aquatic biota) and Rowntree (setting high flow/flood requirements for geomorphology and riparian vegetation), conducted as training sessions during selected slots on 13 and 15 September 2022.

Training was attended by the following persons:

- Koleka Makanda
- Mohlapa Sekoele
- Renelle Pillay (selected sessions)
- Manisha Maharaj
- Ivor Hoareau
- Makhanya Kadija
- Phila Khoza
- Molefi Mazibuko
- Krishnee Naidoo
- Siphindile Shoba
- Nhlanhla Mngomezulu
- Nathi Ncube (selected sessions)

5 ATTENDANCE OF ESTUARY FIELD SURVEY

A detailed field visit was undertaken to six estuaries between 28 September and 8 October 2022, with trainees attending **the week of 3 October**. Transnet industrial action and civil unrest prevented access to uMhlathuze Sanctuary planned for 6 and 7 October 2022. This system was replaced with the sampling of the uMlalazi and aMatigulu/iNyoni estuaries at short notice.

3 October	Mgobezelini Estuary
4 October	Nhlabane Estuary
5 October	Siyaya Estuary
6 October	uMlalazi Estuary
7 October	aMatigulu/iNyoni estuaries

The following DWS personnel attended the survey as a Capacity Building event.

- Mohlapa Sekoele
- Lwandle Sibango
- Molefi Mazibuko
- Michael Singh
- Nhlanhla Mngomezulu

The following survey tasks were undertaken:

Water Quality: Longitudinal salinity and temperature profiles were recorded; as well as water quality measurements along the length of the estuary (surface and bottom) for system variable (pH, dissolved oxygen, suspended solids/turbidity) and inorganic nutrients.

Microalgae: Physico-chemical, phytoplankton, and benthic microalgae were sampled at each of the predetermined locations along the length of the study estuaries. At each site, abiotic and phytoplankton samples were collected from the water column at specified depth intervals.

Macrophytes: Vegetation surveys were conducted at each estuary to determine species composition and abundance.

Invertebrates: Recorded species and abundance of invertebrates across the estuary at each of a series of stations along the estuary, including sediment characteristics, water quality and habitat.

Fish: Record species and abundance of fish using seine-net sampling, and physico-chemical variables, habitat and vegetation.

Birds: Counts of all water-associated birds, identified to species level.

6 TRAINING WORKSHOP 2: ECOLOGICAL CONSEQUENCES

The workshop was held virtually on the TEAMS Platform on **18 May 2023** and covered river and estuary ecological consequences to scenarios. The river component was run in the morning by Ms Delana Louw, and the estuary component in the afternoon by Dr Lara van Niekerk. This workshop focussed on the river process for evaluating ecological consequences, as the EWR component was conducted in September 2022, while the estuary component focussed on methods for the EWR and consequences evaluation steps. The agenda is shown as **Table 4**.

Table 4 Agenda for Training Workshop 2

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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

TRAINING SESSION 3: RIVER/ESTUARY SCENARIO WORKSHOP

Date: Thursday, 18 May 2023
Venue: Virtual/Online

Aims: (1) Provide background to the EcoClassification and EWRs of estuaries and assessing ecological consequences; (Steps 3 and 4); (2) background to assessing ecological consequences for rivers (Step 4); (3) use of the Scenario Comparison Facility for rivers; and (4) exposure to the process using examples from the Usutu-Mhlatuze system.

Learning outcomes: The training session will build on the EcoClassification and EWR determination steps of the process, and provide exposure to the evaluation of ecological consequences to operational scenarios.

Subject	Time
START	**08:30**
SESSION 1: RIVERS	**Delana Louw**
Background to and explanation of the process followed to evaluate ecological consequences for rivers	08:30
Explanation of the Scenario Comparison Facility (SCF)	09:00
Trainee assessment of ecological consequences (broad-based assumptions) using the SCF	09:30
Discussion on outcomes and final conclusions	10:30
BREAK	**11:00**
START	**12:00**
SESSION 2: ESTUARIES	**Lara van Niekerk**
Introduction to estuaries	12:00
Delineation of Estuary Boundaries	
Overview of EWR Methods for Estuaries (including how methods integrate scenario assessment)	
Recent development in Water Quality EWR methods	
TEA	**14:00**
Confidence of EWRs: Importance of long-term data sets	14:20
Linking EWRs to Estuary Management Plans & Conservation Plans	
CLOSURE	**16:00**

The agenda for the workshop was circulated to the list of trainees, as previously identified by DWS. The following persons attended the training:

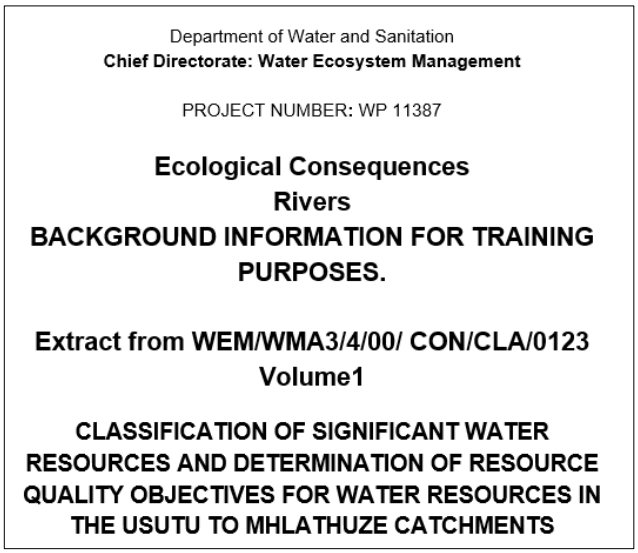
- Koleka Makanda
- Nolu Jafta
- Makhanya Kadija
- Phila Khoza
- Ziyanda Malibiji
- Nhlanhla Mngomezulu
- Krishnee Naidoo

- Camagwini Ngodi
- Siphindile Shoba
- Lwandle Sibango
- Kama Meso

Apologies were received from Renelle Pillay, Manisha Maharaj and Molefi Mazibuko, who were unable to attend due to a prior commitment.

The following items were emailed to participants before the rivers component of the workshop, for their use during the training.

- EcolConsRiverTrainingbackground (see cover shown below); i.e. an extract from the River Consequences Report focussing on the EWR river sites to be used for training purposes, i.e. EWR WM1 (White Mfolozi) and EWR AS1 (Assegaai River).



Department of Water and Sanitation
Chief Directorate: Water Ecosystem Management

PROJECT NUMBER: WP 11387

Ecological Consequences
Rivers
BACKGROUND INFORMATION FOR TRAINING PURPOSES.

Extract from WEM/WMA3/4/00/ CON/CLA/0123
Volume1

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

- The presentation prepared for the workshop, titled *Ecological Consequences Training2*
- A zipped folder titled *SCF Usutu-Mhlatuze (v310123)*, containing the Scenario Comparison Facility (SCF) files used by the trainees during the workshop. This part of the workshop was a hands-on session to demonstrate the use of the SCF for assessing ecological consequences.

7 TRAINING WORKSHOP 3: RIPARIAN VEGETATION; IMPLEMENTATION, MONITORING AND GAZETTING

Training Workshop 3 was planned to be on Resource Quality Objectives (RQO) and gazetting, but a request from DWS for a detailed RQO workshop to be held as working sessions with the regional offices in August 2023 (21-22 August: Durban; 24 August: Mbombela), resulted in the third training workshop covering implementation, monitoring and gazetting instead.

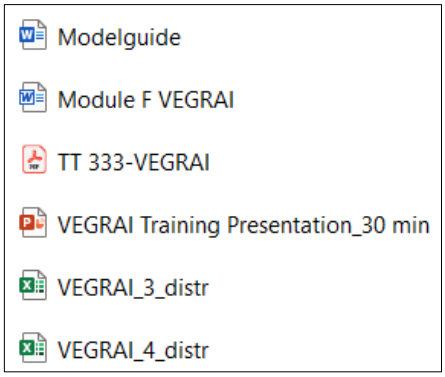
A further request from Ms Jafta of DWS for detailed training on riparian vegetation, particularly VEGRAI 4, confirmed the inclusion of this training in 18 April 2024. The training was held virtually on the TEAMS Platform on **18 and 19 April 2024**.

Note that the intent of the workshop was to provide short specialist presentations (excluding riparian vegetation and the legal presentation by Mr Hubert Thompson), with the focus being on discussion around implementation and monitoring. A slot was also left at the end of the day for general project discussion.

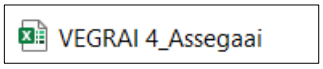
7.1 AGENDA AND TRAINING MATERIALS

The agenda for the workshop was circulated to the list of trainees originally identified by DWS, as well as colleagues from D: RQIS, CD: Water Resource Planning, the IUCMA and Compliance Monitoring: SFRA team (for the riparian vegetation session, in particular). The agenda circulated is shown as **Table 5**. The *Implementation and Monitoring Report* and *Draft Gazette* were also circulated.

The following material was circulated as input material for the Riparian vegetation session with James Mackenzie on Day 1. An updated Presentation was sent after training.



The Assegaai River was used as a training example, with the completed VEGRAI for the selected sites circulated after the workshop for comparative purposes, i.e. the following file:



Mr Thompson provided attendees with some literature in addition to his Legal presentation:

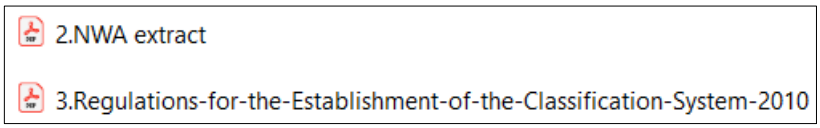


Table 5 Agenda for Training Workshop 3

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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

TRAINING/DISCUSSION SESSION 4: RIPARIAN VEGETATION PROCESS; MONITORING, GAZETTING AND IMPLEMENTATION

Date: Thursday-Friday, 18-19 April 2024
Venue: Virtual/Online

Aims: (1) Provide background to the Riparian Vegetation process throughout Classification and setting of RQOs (requested training); (2) background to preparation of a monitoring programme and Implementation Plan; (3) gazetting: background and setting up the gazette for the Usutu-Mhlatuze study.

Learning outcomes: The training/discussion session will build on previous knowledge of the study, provide an opportunity to discuss monitoring, gazetting and implementation, and any other matters relating to the study.

Subject	Time
DAY 1: THURSDAY, 18 APRIL, SESSION 1	**08:00**
RIPARIAN VEGETATION	**James Mackenzie**
Determining PES: 1) Presentation on VEGRAI; and 2) Interactive session doing the VEGRAI for one site in the system.	
Scenario consequences and RQOs: Using data from VEGRAI to assess consequences and determine RQOs using same site (mix of presentation and interactive).	
Monitoring: Presentation of methods.	
LUNCH	**13:00**
Q&A session	**13:45-14.15**
DAY 1: THURSDAY, 18 APRIL, SESSION 2	**14:30-16.00**
GROUNDWATER	**Karim Sami**
Monitoring & Implementation	
Q&A session	
CLOSURE	**16:00**

Subject	Time
DAY 2: FRIDAY, 19 APRIL, SESSION 1	**08:00**
GAZETTING	**Hubert Thompson**
Introduction & Background: Resource-directed measures and the law.	
NWA & Amendment; Inputs to the Usutu-Mhlatuze Gazette.	
Q&A session	
TEA	**10:00**
DAY 2: FRIDAY, 19 APRIL, SESSION 2	**10:30**
MONITORING & IMPLEMENTATION (excluding rip veg and groundwater)	**Team**
Presentations on Monitoring.	
Discussion session.	
LUNCH	**13:00**
Q&A: Project	
CLOSURE	**15:00**

7.2 ATTENDANCE

The workshop was joined by approximately 40 attendees, from a wide range of departmental and regional office representatives, as shown on **Table 6**.

Table 6 Attendees of Training Worksop 6

No.	Name & surname	Departmental details	Email address	Attended			
				18/4: Rip veg	18/4: Groundwater	19/4: Legal	19/4: Other
1	Michael Maluleke	DWS KZN, Water Resources Support	malulekem4@dws.gov.za	√	√	√	
2	Renelle Pillay	DWS KZN	pillayr@dws.gov.za		√		
3	Ziyanda Malibiji	DWS KZN	malibijiz@dws.gov.za		√	√	√
4	Ivor Hoareau	DWS KZN	hoareauI@dws.gov.za	√	√	√	
5	Ishmael Mpoyana	DWS Water Resource Regulations	Mpoyanal@dws.gov.za	√	√	√	√
6	Mapule Mokoena		mokoenam@dws.gov.za				
7	Mngomezulu Nhlanhla	DWS Water Resource Regulations	mngomezulun@dws.gov.za				√
8	Makanda Koleka	DWS Water Resources Classification	MakandaC@dws.gov.za	√	√	√	√
9	Nolu Jafta	DWS Water Resources Classification	JaftaN@dws.gov.za	√	√	√	√
10	Mohlapa Sekoele	DWS Water Resources Classification	SekoeleM@dws.gov.za	√	√	√	√
11	Mpho Mudau	DWS WARMS	MudauM@dws.gov.za		√	√	√
12	Tshiamo Mokwena	DWS Water Resource Regulations	OlifantT@dws.gov.za	√	√	√	√
13	Mershan Naidoo	DWS Compliance Monitoring: Afforestation (SFRA)	naidoom@dws.gov.za	√	√		
14	Noxolo Yoko	DWS Water Resource Regulations	YokoN@dws.gov.za	√		√	√
15	Nedzingahe Thiambi	DWS RQIS	NedzingaheW@dws.gov.za	√			
16	Baloyi Dikeledi	DWS Water Resource Regulations	Baloyid2@dws.gov.za	√			
17	Sphe Mnyango	DWS Source Directed Control	MnyangoS@dws.gov.za	√			
18	Molefi Mazibuko	DWS Reserve Determination	MazibukoM@dws.gov.za	√			
19	Tinyiko Neswiswi	DWS Reserve Determination	MpeteT@dws.gov.za	√			
20	Zipho Khoza	IUCMA	khozaz@iucma.co.za	√			
21	John Isaac Phangisa	DWS Compliance Monitoring: Afforestation (SFRA)	Phangisaj@dws.gov.za	√			
22	Hlalele Neo	DWS Water Resource Regulations	HlaleleN@dws.gov.za	√		√	√
23	Unknown ?			√			
24	James Berkland	DWS Water Resource Regulations	BerklandJ@dws.gov.za			√	√
25	Dr Bheki Maliba	IUCMA	malibab@iucma.co.za			√	√

No.	Name & surname	Departmental details	Email address	Attended			
				18/4: Rip veg	18/4: Groundwater	19/4: Legal	19/4: Other
26	Philani Khoza	DWS Reserve Determination	KhozaP@dws.gov.za			√	√
27	Caroline Tlowana	IUCMA	tlowanac@iucma.co.za			√	√
28	Thokozane Malibe	IUCMA	MalibeT@iucma.co.za			√	√
29	Nsovo Mhlarhi	DWS RQIS	MhlarhiN@dws.gov.za			√	√
30	Sibusiso Majola	DWS RQIS	Majola1S@dws.gov.za			√	√
31	Maletele B. Nkadimeng	IUMCA	NkadimengM@dws.gov.za			√	√
	Attendance numbers			*18*	*11*	*19*	*18*

Monitoring and Implementation presentations were presented in the following sequence:

- Riparian vegetation (as part of the day's module) by James MacKenzie, 18.04.2024
- Groundwater by Karim Sami, 18.04.2024
- Hydrology and Flow by Caryn Seago, 19.04.2024
- Rivers by Delana Louw, 19.04.2024
- Water quality by Patsy Scherman, 19.04.2024
- Wetlands by James MacKenzie, 19.04.2024
- Estuaries by Lara van Niekerk, 19.04.2024

17 APPENDIX C: RIVER SITE VISIT SUMMARY

17.1 EWR MA 1 (MATIGULU RIVER)

17.1.1 SITE DESCRIPTION AND LOCALITY

EWR MA 1 is situated in the Matigulu River (S29.0201 E31.4704) in RU W11-2 and IUA W11 (Matigulu). The Matigulu River at this site is a bedrock river with a pool-rapid morphology. The channel bed in the rapid is dominated by bedrock and boulder, sand bars have formed in shallow pools. Flood benches are dominated by large boulder and bedrock.

Photographs of the EWR site are illustrated in Figure C-1.

Figure C-1: EWR MA1: Upstream and across

17.1.2 INFORMATION COLLATED AT THE SITE

- Habitat Integrity observations
  The river reach was evaluated to allow for the compiling of the Instream and Riparian Index of Habitat Integrity. Driving to the site also allowed the specialists to observe the catchment conditions as input to the Index of Habitat Integrity (IHI).

- Aquatic invertebrates
  Sampled primary habitats present to confirm resident communities.

- Fish
  A fish survey using electrofishing was undertaken and the following species were collected.

SCIENTIFIC NAME	ENGLISH COMMON NAME	EWR MA1 Matikulu
Awaous aeneofuscus	Freshwater Goby	4
Labeobarbus natalensis	Scaly	8
Monodactylus falciformis	Cape Moony	12

- Fluvial geomorphology
  Morphological features are plotted onto previously surveyed transects and onto site images downloaded from Google earth. Notes are taken of material comprising the channel bed, flood benches and banks and presence of flood debris. Photographs are used to capture the diversity of physical habitat at the site.

- Photographic record
  Photographs of the habitat conditions at the cross-section were taken.

17.2 EWR NS (NSELENI RIVER)

17.2.1 SITE DESCRIPTION AND LOCALITY

EWR NS 1 is situated in the Nseleni River (S28.6341 E31.92517) in RU W12-8 and IUA W12-b (Mfule, Mhlatuzane, Nseleni). Access to the site was a problem as an electrified fence with no gates prevented access. Furthermore, the vegetation has become so encroached that movement within the riparian from far downstream access was impossible. Towards the end of the day, the team found access approximately 1 km upstream of the site. Dr Birkhead managed to cross the river and moved downstream on the left bank towards the site. He confirmed that the site has not changed significantly apart from the riparian bush encroachment since the 2003 and 2014 surveys. Time did not allow for any additional surveys to be undertaken.

Upstream the channel had steep banks with a pool riffle/rapid morphology. Small boulders dominated the riffle/rapid and was also found on the bed of the pool. Banks were comprised of sand with superficial silt deposits.

Below are photographs of the river upstream of the site.

Figure C-2: Photographs of the Nseleni River upstream of the EWR site

Figure C-3: Photographs of the Nseleni River at the EWR site

17.3 EWR WM (WHITE UMFOLOZI RIVER)

17.3.1 SITE DESCRIPTION AND LOCALITY

EWR WF1 is situated in the White Umfolozi River (S28.23146 E31.18666) in RU W21-5 and IUA W21 (Upper and Middle White Umfolozi). The White Umfolozi River at this site has a pool-rapid morphology dominated by boulder. An extensive point bar on the right bank is comprised of sand, cobble and boulder.

Photographs of the EWR site are illustrated in Figure C-4.

Figure C-4: EWR WM1

17.3.2 INFORMATION COLLATED AT THE SITE

- Habitat Integrity observations
  The river reach was evaluated to allow for the compiling of the Instream and Riparian Index of Habitat Integrity. Driving to the site also allowed the specialists to observe the catchment conditions as input to the Index of Habitat Integrity (IHI).

- Aquatic invertebrates
  Sampled primary habitats present to confirm resident communities.

- Fish
  A fish survey using electrofishing was undertaken and the following species were collected.

SCIENTIFIC NAME	**ENGLISH COMMON NAME**	**White Umfolozi**
Amphilius uranoscopus	Stargazer (Mountain-Catfish)	5
Labeobarbus natalensis	Scaly	4
Clarias gariepinus	Sharptooth Catfish	2
Labeo molybdinus	Leaden Labeo	8

- Fluvial geomorphology
  Morphological features are plotted onto previously surveyed transects and onto site images downloaded from Google earth. Notes are taken of material comprising the channel bed, flood benches and banks and presence of flood debris. Photographs are used to capture the diversity of physical habitat at the site.

- Photographic record
  Photographs of the habitat conditions at the cross-section were taken.EWR BM1 (BLACK UMFOLOZI RIVER)

17.3.3 SITE DESCRIPTION AND LOCALITY

EWR BM1 is situated in the Black Umfolozi River (S27.93890 E31.21030) in RU W22-1 and IUA W22 (Upper Black Umfolozi). The Black Umfolozi at this site has a bedrock cascade morphology with flat bedrock and bedrock steps. A long pool confined by reeds occurs downstream of the site. The dominant bed material is bedrock; sand dominates the flood benches

Photographs of the EWR site are illustrated in Figure C-5.

Figure C-5: EWR BM1

17.3.4 INFORMATION COLLATED AT THE SITE

- Habitat Integrity observations
  The river reach was evaluated to allow for the compiling of the Instream and Riparian Index of Habitat Integrity. Driving to the site also allowed the specialists to observe the catchment conditions as input to the Index of Habitat Integrity (IHI).

- Aquatic invertebrates
  Sampled primary habitats present to confirm resident communities.

- Fish
  A fish survey using electrofishing was undertaken and the following species were collected.

SCIENTIFIC NAME	ENGLISH COMMON NAME	Black Umfolozi
Enteromius eutenia (Barbus eutaenia)	Orangefin Barb	20
Enteromius paludinosus (Barbus paludinosus)	Straightfin Barb	5
Enteromius trimaculatus (Barbus trimaculatus)	Threespot Barb	5
Labeo molybdinus	Leaden Labeo	3
Oreochromis mossambicus	Mozambique Tilapia	2
Tilapia sparrmanii	Banded Tilapia	15

- Fluvial geomorphology
  Morphological features are plotted onto previously surveyed transects and onto site images downloaded from Google earth. Notes are taken of material comprising the channel bed, flood benches and banks and presence of flood debris. Photographs are used to capture the diversity of physical habitat at the site.

- Photographic record
  Photographs of the habitat conditions at the cross-section were taken.

17.4 EWR MK1 (MKUZE RIVER)

17.4.1 SITE DESCRIPTION AND LOCALITY

EWR MK1 is situated in the Mkuze River (S27.59210 E32.21800) in RU W31-4 and IUA W31-b (Lower Mkuze). The Mkuze River at this site is a sand-bed river with sand banks. Flood channels

are characteristic of the floodplain but these are choked with shrubs and woody debris. The recently erected fence has probably resulted in an increase in forest floor and bank vegetation since 2014 due to absence of animals such as elephant and grazers.

Photographs of the EWR site are illustrated in Figure C-6.

Figure C-6: EWR MK1

17.4.2 INFORMATION COLLATED AT THE SITE

- Habitat Integrity observations
  The river reach was evaluated to allow for the compiling of the Instream and Riparian Index of Habitat Integrity. Driving to the site also allowed the specialists to observe the catchment conditions as input to the Index of Habitat Integrity (IHI).
- Aquatic invertebrates
  Sampled primary habitats present to confirm resident communities.
- Fish
  A fish survey using electrofishing was undertaken and the following species were collected.

SCIENTIFIC NAME	**ENGLISH COMMON NAME**	**Mkuze**
Enteromius trimaculatus (Barbus trimaculatus)	Threespot Barb	30
Enteromius viviparus (Barbus viviparus)	Bowstripe Barb	100
Clarias gariepinus	Sharptooth Catfish	20
Labeo molybdinus	Leaden Labeo	3

Oreochromis mossambicus	Mozambique Tilapia	15

- Fluvial geomorphology
  Morphological features are plotted onto previously surveyed transects and onto site images downloaded from Google earth. Notes are taken of material comprising the channel bed, flood benches and banks and presence of flood debris. Photographs are used to capture the diversity of physical habitat at the site.
- Photographic record
  Photographs of the habitat conditions at the cross-section were taken.

17.5 EWR UP1 (PONGOLA RIVER)

17.5.1 SITE DESCRIPTION AND LOCALITY

EWR UP1 is situated in the Pongola River (S27.36413 E30.96962) in RU W42-4 and IUA W42-a (Upper Pongola). The Pongola River at this site has a pool-rapid morphology with the rapids dominated by large boulder; the flood bench comprises medium to large boulder within a sand -fine gravel matrix. Sand mining was a local disturbance on the flood bench. A secondary channel parallel to the right-hand bank provides significant low flow habitat comprised of riffle and run.

Photographs of the EWR site are illustrated in Figure C-7.

Figure C-7: EWR UP1

17.5.2 INFORMATION COLLATED AT THE SITE

- Habitat Integrity observations
  The river reach was evaluated to allow for the compiling of the Instream and Riparian Index of Habitat Integrity. Driving to the site also allowed the specialists to observe the catchment conditions as input to the Index of Habitat Integrity (IHI).
- Aquatic invertebrates
  Sampled primary habitats present to confirm resident communities.
- Fish
  A fish survey using electrofishing was undertaken and the following species were collected.

SCIENTIFIC NAME	ENGLISH COMMON NAME	Pongola
Chiloglanis anoterus	Pennant Tail Suckermouth (Or Rock Catlet)	30
Chiloglanis swierstrai	Lowveld Suckermouth (Or Rock Catlet)	10
Labeo cylindricus	Redeye Labeo	1
Marcusenius pongolensis	Bulldog	3
Opsaridium peringueyi	Southern Barred Minnow	2

- Fluvial geomorphology
  Morphological features are plotted onto previously surveyed transects and onto site images downloaded from Google earth. Notes are taken of material comprising the channel bed, flood benches and banks and presence of flood debris. Photographs are used to capture the diversity of physical habitat at the site.
- Photographic record
  Photographs of the habitat conditions at the cross-section were taken.

17.6 EWR AS1 (ASSEGAAI RIVER)

17.6.1 SITE DESCRIPTION AND LOCALITY

EWR AS1 is situated in the Assegaai River (S27.06230 E30.98880) in RU W51-3 and IUA W52 (W5 Downstream major dams and Hlelo). The Assegaai River has a pool-rapid morphology with the rapids dominated by boulder; silt and fine gravel deposits with limited cobble characterize the pools. The flood bench comprises medium to large boulder within a sand matrix. Island with reeds commonly develop on rapids. A truncated flood channel lies along the edge of the right bank flood bench, against the hillslope.

All observations were made from the right bank or mid channel as the flow was too deep and fast to permit safe crossing of the channel.

Photographs of the EWR site are illustrated in Figure C-8.

Figure C-8: EWR AS1

17.6.2 INFORMATION COLLATED AT THE SITE

- Habitat Integrity observations
  The river reach was evaluated to allow for the compiling of the Instream and Riparian Index of Habitat Integrity. Driving to the site also allowed the specialists to observe the catchment conditions as input to the Index of Habitat Integrity (IHI).
- Aquatic invertebrates
  Sampled primary habitats present to confirm resident communities.
- Fish
  A fish survey using electrofishing was undertaken and the following species were collected.

SCIENTIFIC NAME	ENGLISH COMMON NAME	Assegaai
Amphilius natalensis	Natal Mountain Catfish	1
Chiloglanis anoterus	Pennant Tail Suckermouth (Or Rock Catlet)	30
Tilapia sparrmanii	Banded Tilapia	1

Labeobarbus nelspruitensis (Vavicorhinus nelspruitensis)	Incomati Chiselmouth	3

- Fluvial geomorphology
  Morphological features are plotted onto previously surveyed transects and onto site images downloaded from Google earth. Notes are taken of material comprising the channel bed, flood benches and banks and presence of flood debris. Photographs are used to capture the diversity of physical habitat at the site.
- Photographic record
  Photographs of the habitat conditions at the cross-section were taken.EWR NGWEMPISI 1 (NGWEMPISI RIVER)

17.6.3 SITE DESCRIPTION AND LOCALITY

EWR NG1 was selected as an additional and new EWR site.

EWR NG1 is situated in the Ngwempisi River (S26.679448 E30.70213) in RU W53-3 and IUA W52 (W5 Downstream major dams and Hlelo). The site is downstream of a gauging weir and Jericho and Morgenstond Dams.

The site has a strong bedrock control and is dominated by bedrock and boulder. Channel morphology at the site is dominated by a complex island with multiple channels and downstream there is a pool-rapid sequence upstream of the gorge. The transect is located in a run across the downstream end of the island complex, crossing two main channels and a third minor channel running along the right bank (not visible on the photographs).

Photographs of the EWR site are illustrated in Figure C-9.

Figure C-9: EWR Ngwempisi 1

17.6.4 INFORMATION COLLATED AT THE SITE

- Habitat Integrity observations
  The river reach was evaluated to allow for the compiling of the Instream and Riparian Index of Habitat Integrity. Driving to the site also allowed the specialists to observe the catchment conditions as input to the Index of Habitat Integrity (IHI).
- Aquatic invertebrates
  A SASS survey was undertaken covering three habitat biomes
- Fish
  A fish survey using electrofishing was undertaken and the following species were collected.

SCIENTIFIC NAME	**ENGLISH COMMON NAME**	**Ngwempisi**
Amphilius natalensis	Natal Mountain Catfish	2
Enteromius crocodilensis	Rosefin Barb	1
Labeobarbus marequensis	Largescale Yellowfish	8
Labeobarbus polylepis	Smallscale Yellowfish	1
Chiloglanis anoterus	Pennant Tail Suckermouth (Or Rock Catlet)	30
Clarias gariepinus	Sharptooth Catfish	1
Marcusenius pongolensis/	Bulldog	1
Tilapia sparrmanii	Banded Tilapia	1

- Fluvial geomorphology
  Morphological features are plotted onto previously surveyed transects and onto site images downloaded from Google earth. Notes are taken of material comprising the channel bed, flood benches and banks and presence of flood debris. Photographs are used to capture the diversity of physical habitat at the site.
- Photographic record
  Photographs of the habitat conditions at the cross-section were taken.
- EcoHydraulics
  A cross-sectional survey was undertaken including measurements of slope, recent flood levels and some vegetation markers. Three painted benchmarks on bedrock was established. The discharge will be obtained from the upstream gauging weir.

18 APPENDIX D: WETLAND, GROUNDWATER AND WATER QUALITY RQOS

Table D1: Resource Quality Objectives for PRIORITY WETLAND CLUSTERS AND SYSTEMS in selected Resource Units in the Usuthu to Mhlathuze catchments (W1 - 5, and 7)

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
W12-b	Mhlathuze Floodplain	Floodplain (4809 Ha)	W12-8	W12H; W12F	D	D	Water quantity	Water Inputs	Hydrology	The quantity and timing of inputs, and the distribution and retention patterns within the wetland must be maintained to avoid the loss of wetland hydrological function.	The EWR determined for the upstream Nseleni and Mhlathuze rivers should be implemented.
								Water distribution and retention patterns	Flooding by damming within the wetland	The extent of damming within the wetland complex should not be permitted to increase.	The extent of damming within the delineated* wetland area shall not exceed 51 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; National Land Cover (NLC), 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 7% (335 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23, NLC,2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 38% (98 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7, NLC,2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not increase above 18% (564 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72, NLC,2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted to increase in extent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area shall not exceed 3.6% (170 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73, NLC,2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 50%.
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67, NLC,2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent within the wetland complex. Additional development of infrastructure should not be permitted within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 1% (36 Ha).

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be improved from an E (PES) to a D (TEC).	The overall wetland PES score should be improved to at least 42%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
W12-d	Nhlabane wetlands	Depressional & seepage wetlands (546.9 Ha) excluding the lake	W12-9	W12J	C/D	C/D	Water quantity	Water Inputs	Hydrology	Water quantity (i.e. flow and inundation regime) must maintain wetlands in the present ecological state where practical.	N/A
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 3% (18 Ha).
									Extent of indigenous herbaceous wetlands plants (land cover classes 22-23, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 17% (9 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7, NLC, 2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not exceed 48%.
									Land cover classes denoted to mines and quarries (classes 68-72, NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted and should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area shall not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 0.6% (3 Ha).
									Land cover classes denoted to built-up	Wetland habitat loss or fragmentation due to infrastructure	The aerial extent of built-up areas and

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									areas and infrastructure (classes 47-67, NLC, 2020)	and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent with the wetland complex. Additional development of infrastructure should not be permitted within the wetland complex.	infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 3.7% (20 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be a C/D or better.	The overall wetland PES score should be at least 58%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
W12-e	Lake Mzingazi	Lake (excluding surrounding channelled valley bottom wetlands)	W12-10	W12J	D	D	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain the lake in the present ecological state where practical and should establish and maintain connectivity between upstream wetlands and downstream estuary.	N/A
							Habitat	Present Ecological State (PES)	Wetland PES score and category	The overall PES for the lake should be a D category or better.	The overall wetland PES score should be at least 42%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
							Biota	Sensitive / threatened populations	Fish species abundance and diversity	Fish abundance and diversity should reflect conditions for the TEC (category D). Gill netting should be controlled, restricted and reduced from levels.	N/A
							Ecosystem Services	Eco-tourism	Important birding area (IBA)	The lake and surrounds should be maintained as an IBA, especially for water and wetland birds.	N/A

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
W12-e	Mzingazi wetlands	Valley bottoms with a channel (1275 Ha) excluding the lake	W12-Lake Msingazi	W12J	C	C	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain wetlands in the present ecological state where practical.	N/A
								Water distribution and retention patterns	Flooding by damming with the wetland	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 1.8% (23 Ha).
									Extent of natural wooded land within the wetland complex (land cover classes 1-4, NLC, 2020)	The extent of natural wooded land within the wetland should not decline.	The extent of natural wooded land within the wetland should not decline below 58% (746 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23, NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 1.2% (9.7 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7, NLC, 2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not increase above 8% (233 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72, NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted to increase in extent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area shall not exceed 0.3% (3.8 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73, NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 0.3% (3.2 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67, NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent with the wetland complex. Additional development of infrastructure should not be	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 13% (175 Ha).

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
										permitted within the wetland complex.	
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland complex PES should be maintained as a C category.	The overall wetland PES score should be maintained to at least 72%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
W22	Aloeboom wetlands	Hillslope seeps linked to the channel (84 Ha) and channelled valley bottom wetlands (260 Ha) along the Black Mfolozi River	W22-1	W22A	B/C	B/C	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain wetlands in the present ecological state where practical.	N/A
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should not increase from low levels.	The extent of damming within the delineated* wetland area shall not exceed 1 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 26% (89 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 35% (120 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7, 2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not increase above 22% (76 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area should not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
											shall not exceed 9.6% (33 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent with the wetland complex. Additional development of infrastructure should not be permitted within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 3.9% (13.6 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland complex PES should be a B/C or better.	The overall wetland PES score should be maintained to at least 78%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
W23	Mvamanzi River wetlands	Unchanneled valley bottom wetland leading depressional wetland (485 Ha) along the Mvamanzi River	W23-1	W23A	B/C	B/C	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain wetlands in the present ecological state where practical.	N/A
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 10% (46 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 19% (93 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7NLC,2020)	Planted forest within the wetland should remain absent.	The extent of planted forest within the wetland should not increase above 0% (0 Ha).

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area should not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 16% (79 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent with the wetland complex. Additional development of infrastructure should not be permitted within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 12% (57 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland complex PES should be maintained as a B/C category.	The overall wetland PES score should be maintained to at least 78%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
W23	Mfolozi swamps	The Mfolozi and Msunduzi rivers both form part of the Mfolozi swamp in their lower reaches with extensive floodplains connecting the two rivers (11911 Ha)	W23-3	W23C; W23D	D	D	Water quantity	Water Inputs	Hydrology	The quantity and timing of inputs, and the distribution and retention patterns within the wetland must be maintained to avoid the loss of wetland hydrological function.	The EWR determined for the upstream Msunduzi and Mfolozi rivers should be implemented.
								Water distribution and retention patterns	Flooding by damming within the wetland	The extent of damming within the wetland complex should not be permitted to increase.	The extent of damming within the delineated* wetland area shall not exceed 84 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline 2.2% (264 Ha).

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 15% (1862 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not increase above 3.7% (442 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area shall not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 50% (6064 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent with the wetland complex. Additional development of infrastructure should not be permitted within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 1.9% (223 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in a D category.	The overall wetland PES score should be maintained to at least 42%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
							Ecosystem Services	Eco-tourism	Important birding area	Both floodplains should be maintained as an IBA, especially for water and wetland birds.	N/A

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
W31-b	Nhlohlela Pan	The Mkuze River and the Nhlohlela River confluence area including Nhlonhlela Pan, a depressional wetland (8.2 Ha)	W31-4	W31J	A	A	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain wetlands in the present ecological state where practical.	The EWR determined for the upstream Nhlohlela River should be implemented.
								Water distribution and retention patterns	Flooding by damming with the wetland complex	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 43% (3.5 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 53.8% (4.4 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	Planted forest within the wetland should remain absent.	The extent of planted forest within the wetland should not increase above 0% (0 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area shall not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 0% (0 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 0% (0 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in an A category.	The overall wetland PES score should be maintained to at least 92%.

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Moderate".	An ES score ≥2 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "High".	An EI score ≥3 should be maintained.
St Lucia	Hluhluwe Floodplain	The Hluhluwe River and its floodplain before entering the St Lucia estuary (1836 Ha)	W33-7	W32F	C	C	Water quantity	Water Inputs	Hydrology	The quantity and timing of inputs, and the distribution and retention patterns within the wetland must be maintained to avoid the loss of wetland hydrological function.	The EWR determined for the upstream Hluhluwe River should be implemented.
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should not increase.	The extent of damming within the delineated* wetland area shall not exceed 30 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 6.4% (117 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 32% (594 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	Planted forest within the wetland should remain absent.	The extent of planted forest within the wetland should not increase above 4% (76 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area should not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 41% (679 Ha).
									Land cover classes denoted to built-up areas and	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching	The aerial extent of built-up areas and infrastructure, including canals, furrows and

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									infrastructure (classes 47-67; NLC, 2020)	should not be permitted to increase in extent with the wetland complex. Additional development of infrastructure should not be permitted within the wetland complex.	trenching, within the delineated* wetland area shall not exceed 10.9% (15.5Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland complex PES should be a C category or better.	The overall wetland PES score should be maintained to at least 62%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
							Ecosystem Services	Eco-tourism	Important birding area	The floodplain should be maintained as an IBA, especially for water and wetland birds.	N/A
St Lucia	Nyalazi Pan	Depressional wetlands with swamp forest in the Nyalazi River catchment (43 Ha)	W33-7	W32H	C	C	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain wetlands in the present ecological state where practical.	N/A
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 66% (28.6 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 1.6% (0.7 Ha).
								Habitat fragmentation within the wetland delineation	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	Planted forest within the wetland should not increase beyond levels.	The extent of planted forest within the wetland should not increase above 32% (14 Ha).
									Land cover classes denoted to mines and	Wetland habitat loss or fragmentation due to mining	The aerial extent of mining activities within the delineated* wetland area

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									quarries (classes 68-72; NLC, 2020)	activities should not be permitted within the wetland complex.	shall not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 0% (0 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 0% (0 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in a C category.	The overall wetland PES score should be maintained to at least 62%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
St Lucia	Mpate River wetlands	Channelled valley-bottom and depressional wetlands in the Mpate River catchment that leads into St Lucia (237 Ha)	W33-7	W32H	A	A	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain wetlands in the present ecological state where practical.	N/A
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 12.8% (30 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 28% (66 Ha).

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not increase above 0.5% (1.2 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area shall not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 3% (7.2 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area should not exceed 0% (0 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained as an A category.	The overall wetland PES score should be maintained to at least 92%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "High".	An ES score ≥3 should be maintained
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
St Lucia	Mkuze swamps	Mkuze River including the Mkuze swamp system and the Mkuze floodplain (11223 Ha)	W32-7	W32B	B	B	Water quantity	Water Inputs	Hydrology	The quantity and timing of inputs, and the distribution and retention patterns within the wetland must be maintained to avoid the loss of wetland hydrological function.	The EWR determined for the upstream Mkuze River should be implemented.
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should not increase.	The extent of damming within the delineated* wetland area shall not exceed 13 Ha.

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 11% (1313 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 66% (7452 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	Planted forest within the wetland should remain absent.	The extent of planted forest within the wetland should not increase above 0% (0 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area should not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 17.5% (1988 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent with the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 4 Ha.
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland complex PES should be maintained in B category.	The overall wetland PES score should be maintained to at least 82%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "High".	An ES score ≥3 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
							Ecosystem Services	Eco-tourism	Important birding area	The floodplain should be maintained as an IBA, especially for water and wetland birds.	N/A

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
W45	Pongola floodplain	Floodplain and valley bottoms with a channel (11802 Ha)	W45-1	W45A; W45B	C	D	Water quantity	Water Inputs	Hydrology	The quantity and timing of inputs, and the distribution and retention patterns within the wetland must be maintained to avoid the loss of wetland hydrological function. The EWR determined in 2015 (DWS, 2015a), should be implemented for the TEC (D)	The EWR comprised a release scenario that represented the best outcome for the ecosystem and social aspects combined. The numerical RQO is the implementation of the specified flows (DWS, 2015a) which has an October flood of 600m3/s and the Heeg and Breen (1982) recommendations for a release regime from Jozini Dam.
								Water distribution and retention patterns	Flooding by damming within the wetland	The extent of damming within the wetland complex should not be permitted to increase.	The extent of damming within the delineated* wetland area shall not exceed 10 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 7% (824 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 27% (3233 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not increase above 0% (0 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area shall not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 48% (5715 Ha).
									Land cover classes denoted to built-up areas and	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including	The aerial extent of built-up areas and infrastructure, including

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									infrastructure (classes 47-67; NLC, 2020)	canals, furrows and trenching should not be permitted to increase in extent with the wetland complex.	canals, furrows and trenching, within the delineated* wetland area shall not exceed 0.5% (58 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in a D category.	The overall wetland PES score should be maintained to at least 42%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "High".	An ES score ≥3 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
							Biota	Waterbird species	Wetland / floodplain birds	Water quantity, vegetation condition and land use practices must be maintained so as to not cause any decline of diversity.	The number of bird species dependent on the floodplain should be maintained at ≥120.
W52	Assegaai River wetlands	Floodplains along the Assegaai River and channelled valley-bottom wetlands along tributaries (886 Ha)	W51-2	W51C; W51D	C	C	Water quantity	Water Inputs	Hydrology	The quantity and timing of inputs, and the distribution and retention patterns within the wetland must be maintained to avoid the loss of wetland hydrological function.	The EWR determined for the upstream Assegaai River should be implemented.
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 39% (350 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 23% (204 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not increase above 13% (115 Ha).
									Land cover classes denoted to mines and	Wetland habitat loss or fragmentation due to mining	The aerial extent of mining activities within the delineated* wetland area

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									quarries (classes 68-72; NLC, 2020)	activities should not be permitted within the wetland complex.	shall not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 19% (169 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent with the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 0.3% (2.2 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in a C category.	The overall wetland PES score should be maintained to at least 62%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
W51	Sandspruit River wetlands	Channelled valley bottom wetlands along the Sandspruit towards the headwaters (1676 Ha)	W53-1	W53A	C	C	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain wetlands in the present ecological state where practical.	The EWR determined for the upstream Sandspruit River should be implemented.
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 21% (350 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 8% (475 Ha).

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	Planted forest within the wetland should not be allowed to increase.	The extent of planted forest within the wetland should not increase above 3.7% (62 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area should not exceed 0% (0 Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 45% (755 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be permitted to increase in extent with the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 1.9 Ha.
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland complex PES should be maintained in C category.	The overall wetland PES score should be maintained to at least 62%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
W51	Upper Usutu wetlands	Extensive channelled valley bottom wetlands upstream of the Sandcliff Dam but not along an official SQ, rather a	W54-1	W54A	B/C	B/C	Water quantity	Water Inputs	Hydrology	Water quantity (i.e. flow and inundation regime) must maintain wetlands in the present ecological state where practical.	N/A
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should remain absent upstream of the Sandcliff Dam.	The extent of damming within the delineated* wetland area upstream of the Sandcliff Dam should not exceed 0Ha.

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
		tributary of the Usutu (767Ha).					Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 9% (72Ha).
									Extent of herbaceous wetlands (land cover classes 22-23, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 63% (486Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7, 2020)	Planted forest within the wetland should not be allowed to increase.	The extent of planted forest within the wetland should not increase above 2.6% (20Ha).
									Land cover classes denoted to mines and quarries (classes 68-72, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area should not exceed 0% (0Ha).
									Land cover classes denoted to cultivated areas (classes 32-46 & 73, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 24% (185Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should remain absent within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 0Ha.
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland complex PES should be maintained in B/C category.	The overall wetland PES score should be maintained to at least 78%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score >=4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score >=4 should be maintained.

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
W51	Seganagana River wetlands	Floodplain and channelled valley-bottom wetlands along the Seganagana upstream of the Westoe Dam (1265 Ha)	W54-1	W54B	A	A	Water quantity	Water Inputs	Hydrology	The quantity and timing of inputs, and the distribution and retention patterns within the wetland must be maintained to avoid the loss of wetland hydrological function.	The EWR determined for the Seganagana River should be implemented.
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should not be allowed to increase.	The extent of damming within the delineated* wetland area shall not exceed 1 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland should not decline.	The extent of natural grassland within the wetland should not decline below 26% (334 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands should not decline.	The extent of herbaceous wetlands should not decline below 63% (800 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	The extent of planted forest within the wetland should not increase.	The extent of planted forest within the wetland should not increase above 1.4% (17 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted to increase within the wetland complex.	The aerial extent of mining activities within the delineated* wetland area shall not exceed 1 Ha.
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 5.8% (74 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should remain absent within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area shall not exceed 0% (0 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in an A category.	The overall wetland PES score should be maintained to at least 92%.

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "Very High".	An ES score ≥4 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
W55	Mpumalanga pan district around Chrissiesmeer, Majosie se Vlei and Mpuluzi.	Most of the pans are not directly associated with an official SQ. The area has a high density of pans, extensive seepage wetlands and large areas of channelled valley-bottoms (21348 Ha)	W55-1	W55A; W55C	A/B	A/B	Water quantity	Water distribution and retention patterns	Flooding by damming within the wetland complex	Damming within the wetland complex should not be allowed to increase.	The extent of damming within the delineated* wetland complex area shall not exceed 0.4% (86 Ha).
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland complex should not decline.	The extent of natural grassland within the wetland complex should not decline below 40% (8621 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands throughout the complex should not decline.	The extent of herbaceous wetlands throughout the complex should not decline below 26% (5575 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	The extent of planted forest within the wetland complex should not increase.	The extent of planted forest within the wetland complex should not increase above 2.5% (538 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland complex should not exceed 0 Ha.
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland complex should not exceed 10% (227 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be allowed to increase within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland complex should not exceed 0.1% (11 Ha).

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland complex PES should be maintained in an A/B category.	The overall wetland complex PES score should be maintained to at least 88%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "High".	An ES score ≥3 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
							Biota	Endangered crane species	Counts of the number of breeding pairs of crane species.	Water quantity, vegetation condition and land use practices must be maintained so as to not cause any population decline.	The number of breeding crane pairs within the wetlands should be >0.
									Number of crane species	Water quantity, vegetation condition and land use practices must be maintained so as to not cause any decline in the number of crane species that occur in these wetlands.	The number of crane species found in the district should remain at 3. These are the Blue Crane (Anthropoides paradiseus), Grey Crowned Crane (Balearica regulorum) and Wattled Crane (Bugeranus carunculatus) (SANBI, 2014).
								Waterbird species	Wetland bird species	Water quantity, vegetation condition and land use practices must be maintained so as to not cause any decline of diversity.	The number of wetland / waterbird species found in the district should remain ≥83.
									Wetland is within 500m of a threatened waterbird point locality.	Water quantity, quality, vegetation condition and land use practices must be maintained so as to not cause any decline in waterbird population/s.	N/A
								Wetland plants	Number of wetland plant species	Water quantity, vegetation condition and land use practices must be maintained so as to not cause any decline in the number of wetland plant species that occur in these wetlands.	The number of wetland plant species found in the district should remain ≥57.
								Mammals	Spotted-necked otter (*Lutra maculicollis*) – Near-Threatened	Water quantity, vegetation condition and land use practices must be maintained so as to not cause any decline in the spotted-necked otter population.	The spotted-necked otter should remain within wetlands in the district.

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
							Ecosystem Services	Eco-tourism	Important birding area	The pans and surrounds should be maintained as an IBA, especially for water and wetland birds.	N/A
W57	Ndumo wetlands	Floodplains along W57K-02025 (tributary of the Usutu River) form part of the Pongola floodplains in the Ndumo Game Reserve area and Banzi Pan occurs along the Usutu River (W57K-01929), both are part of the RAMSAR site (1310 Ha)	W57-1	W57K	A	A	Water quantity	Water Inputs	Hydrology	The quantity and timing of inputs, and the distribution and retention patterns within the wetland must be maintained to avoid the loss of wetland hydrological function.	The EWR determined for the Usutu River upstream should be implemented.
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should not be allowed to increase.	The extent of damming within the delineated* wetland area shall not exceed 1.1% (13.8 Ha).
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland complex should not decline.	The extent of natural grassland within the wetland complex should not decline below 0.7% (9 Ha).
									Extent of natural wooded land within the wetland complex (land cover classes 1-4; NLC, 2020)	The extent of natural wooded land within the wetland complex should not decline.	The extent of natural wooded land within the wetland complex should not decline below 27% (364 Ha).
									Extent of herbaceous wetlands (land cover classes 22-23; NLC, 2020)	The extent of herbaceous wetlands throughout the complex should not decline.	The extent of herbaceous wetlands throughout the complex should not decline below 61% (806 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	Planted forest within the wetland complex should remain absent.	The extent of planted forest within the wetland should not increase above 0% (0 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should not be permitted within the wetland complex.	The aerial extent of mining activities within the delineated* wetland complex area should not exceed 0 Ha.
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland area shall not exceed 0.4% (5.7 Ha).
									Land cover classes denoted to built-up areas and	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including	The aerial extent of built-up areas and infrastructure, including

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									infrastructure (classes 47-67; NLC, 2020)	canals, furrows and trenching should remain absent within the wetland complex.	canals, furrows and trenching, within the delineated* wetland area shall not exceed 0% (0 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in an A category.	The overall wetland PES score should be maintained to at least 92%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "High".	An ES score ≥3 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
							Biota	Waterbird species	Wetland / floodplain birds	Water quantity, vegetation condition and land use practices must be maintained so as to not cause any decline of diversity.	The number of bird species dependent on the floodplain should be maintained at ≥120.
							Ecosystem Services	Eco-tourism	Important birding area	The pans and surrounds should be maintained as an IBA, especially for water and wetland birds.	N/A
W70-b	Lake Sibaya	Lake Sibaya (9108Ha) and surrounding wetlands comprised of seepage wetlands (650 Ha) and channelled valley-bottoms (410 Ha)	W70-3, W70-Lake Sibaya	W70A	B	B/C	Water quantity	Water Inputs	Hydrology	The EWR determined in 2015 (DWS, 2015b), should be implemented for the TEC (B/C), including additional recommendations from the Addendum to the EWR (Groundtruth, 2020).	Water levels for the TEC (B/C) should: 1) Reflect natural climate conditions (antecedent precipitation), in particular five to six year averages in rainfall, as well as shorter term (one year) rainfall conditions; 2) Retain variability, including cycles of high and low water levels; 3) Water levels should reflect at least 1 wet cycle over a 30-year period with levels >17 masl; 4) Should not have more than five consecutive years <16 masl (drought water level threshold); 5) If levels below 16 masl are unavoidable due to climate conditions (e.g. extended natural drought), these low levels should

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
											not be allowed to persist longer than is indicated by said climate conditions.
							Habitat	Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	The extent of planted forest within the wetland complex should not increase.	The extent of planted forest within the wetland complex should not increase above 0.3% (32 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland complex should not exceed 0 Ha.
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland complex should not exceed 1% (100 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be allowed to increase within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland complex should not exceed 0.1% (11 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in a B/C category.	The overall wetland PES score should be maintained to at least 78%.
							Habitat / Biota	Ecological sensitivity (ES)	Species / habitats sensitive to flow	The ES of the wetland complex should be maintained as "High".	An ES score ≥3 should be maintained.
								Ecological importance (EI)	Threatened, endangered or endemic species; threatened habitat types	The EI of the wetland complex should be maintained as "Very High".	An EI score ≥4 should be maintained.
							Biota	Waterbird species	Wetland is within 500 m of a threatened waterbird point locality.	Water quantity, quality, vegetation condition and land use practices must be maintained so as to not cause any decline in waterbird population/s.	N/A
									Wetland / floodplain birds	Water quantity, vegetation condition and land use practices	The number of bird species dependent on the

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
										must be maintained so as to not cause any decline of diversity.	floodplain should be maintained at ≥62.
								Mammals	Mammal species diversity (lake-dependent)	Water quantity, quality, vegetation condition and land use practices must be maintained so as to not cause any decline of diversity.	The number of reptile species associated with the lake should be maintained at ≥ 6.
									Hippos (VU)	Lake Sibaya hosts South Africa's second largest hippo population: Water quantity, vegetation condition and land use practices must be maintained so as to not cause any adverse population decline.	N/A
								Reptiles	Crocodiles	Water quantity, vegetation condition and land use practices must be maintained so as to not cause any adverse population decline.	N/A
									Reptile species diversity (lake-dependent)	Water quantity, quality, vegetation condition and land use practices must be maintained so as to not cause any decline of diversity.	The number of reptile species associated with the lake should be maintained at ≥8.
								Fish	Species diversity in the Lake	Water quantity, quality, vegetation condition and land use practices must be maintained so as to not cause any decline of diversity.	The number of fish species should be maintained at ≥18.
							Ecosystem Services	Eco-tourism	Important birding area	Portion of the lake and surrounds are within an IBA and should be maintained as such, especially for water and wetland birds.	N/A
W70-Muzi Swamps	Muzi swamps	Depressional and floodplain wetlands that comprise the Muzi swamps (25410 Ha)	W70-Muzi Swamps	W70A	C	C	Water quantity	Water Inputs	Hydrology	Water quantity (i.e., flow and inundation regime) must maintain wetlands in the present ecological state where practical.	N/A
								Water distribution and retention patterns	Flooding by damming within the wetland	Damming within the wetland complex should remain absent.	The extent of damming within the delineated* wetland area shall not exceed 0 Ha.
							Habitat	Wetland vegetation	Extent of natural grassland within the wetland complex (land cover classes 12-13; NLC, 2020)	The extent of natural grassland within the wetland complex should not decline.	The extent of natural grassland within the wetland should not decline below 32% (8158 Ha).
									Extent of herbaceous wetlands (land cover	The extent of herbaceous wetlands throughout the wetland complex should not decline.	The extent of herbaceous wetlands should not

IUA	Wetland	Wetland Type	RU	Quaternary Catchment	REC	TEC	Component	Sub-Component	Indicator	RQO	
										Narrative	Numeric
									classes 22-23; NLC, 2020)		decline below 24% (6204 Ha).
								Habitat fragmentation within the wetland delineation*	Extent of planted forest within the wetland complex (land cover classes 5-7; NLC, 2020)	The extent of planted forest within the wetland complex should not increase.	The extent of planted forest within the wetland should not increase above 4.2% (1075 Ha).
									Land cover classes denoted to mines and quarries (classes 68-72; NLC, 2020)	Wetland habitat loss or fragmentation due to mining activities should remain absent within the wetland complex.	The aerial extent of mining activities within the delineated* wetland complex should not exceed 0 Ha.
									Land cover classes denoted to cultivated areas (classes 32-46 & 73; NLC, 2020)	Wetland habitat loss due to direct agricultural activities and croplands should not be permitted to increase in extent within the wetland complex.	The aerial extent of agricultural activities and croplands within the delineated* wetland complex should not exceed 3.6% (920 Ha).
									Land cover classes denoted to built-up areas and infrastructure (classes 47-67; NLC, 2020)	Wetland habitat loss or fragmentation due to infrastructure and built-up areas, including canals, furrows and trenching should not be allowed to increase within the wetland complex.	The aerial extent of built-up areas and infrastructure, including canals, furrows and trenching, within the delineated* wetland area should not exceed 2.4% (600 Ha).
								Present Ecological State (PES)	Wetland PES score and category	The overall wetland PES should be maintained in a C category.	The overall wetland PES score should be maintained to at least 62%.

** Wetland delineations were taken from the NWM5 of 2018 (van Deventer et al., 2018) as part of the National Biodiversity Assessment (NBA) 2018*.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

Table D2: Regional and Resource Unit specific Resource Quality Objectives for GROUNDWATER in priority Groundwater Resource Units in the Usutu to Mhlathuze catchments (W1 - 5, and 7) catchments

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
W11	I	W11-1	W11A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.44 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 87% of boreholes.
			W11B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 0.43 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 17% of boreholes.
		W11-2	W11C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 0.91 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 60% of boreholes.
W12-a	I	W12-1	W12A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.88 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W1R001 shall not be less than 1.9 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W12-2	W12B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.49 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W1R001 shall not be less than 1.9 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 81% of boreholes.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
W12-b	II	W12-1	W12C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 4.82 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W1H005 shall not be less than 0.01 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 92% of boreholes.
W12-c	III	W12-3	W12D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 3.11 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
W12-b, W12-c	III, II	W12-4	W12E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.64 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 37% of boreholes.
		W12-5	W12F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 19.25 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W1H032 shall not be less than 0.02 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 89% of boreholes.
		W12-3	W12G	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.93 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 28% of boreholes.
		W12-4	W12H	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and	The remaining Allocable groundwater is 2.67 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 69% of boreholes.
W12-d, W12-e	III	W12-5	W12J	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 19.22 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
W13	I	W13-1	W13A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.26 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W1H004 shall not be less than 0.01 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							implemented. Water levels should not exhibit long term declining trends.	
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 79% of boreholes.
			W13B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 0.40 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 81% of boreholes.
W21	II	W21-1	W21A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.64 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H030 shall not be less than 0.02 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 87% of boreholes.
		W21-2	W21B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 4.34 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H009 shall not be less than 0.02 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W21C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.47 Mm^3/a
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H005 shall not be less than 0.5 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
			W21D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 3.04 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H005 shall not be less than 0.5 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							implemented. Water levels should not exhibit long term declining trends.	
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 90% of boreholes.
			W21E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.1 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H005 shall not be less than 0.5 Mm^3/month,
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends,	Static water levels should not exhibit a declining trend in July for over 5 years,
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend,	Water quality to stay within the limits of Water Quality Class I.[1] in 83% of boreholes,
			W21F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.26 Mm^3/a,
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H005 shall not be less than 0.5 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W21-3	W21G	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence	The remaining Allocable groundwater is 2.52 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							conditions. Allocations for new users is to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H005 shall not be less than 0.5 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W21H	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.48 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H005 shall not be less than 0.5 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 85% of boreholes.
			W21J	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 3.95 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H005 shall not be less than 0.5 Mm^3/month.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 71% of boreholes.
		W21-4	W21K	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 6.19 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 55% of boreholes
W23	I		W21L	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 5.22 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 17% of boreholes.
W22	II	W22-1	W22A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence	The remaining Allocable groundwater is 3.34 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							conditions. Allocations for new users is to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H028 shall not be less than 0.03 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
			W22B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 3.58 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H006 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 50% of boreholes.
			W22C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.16 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H006 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							implemented. Water levels should not exhibit long term declining trends.	
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
			W22D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.73 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H006 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W22-2	W22E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 6.37 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H006 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W22-3	W22F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 3.17 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H006 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
		W22-4	W22G	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.01 Mm^3/a
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H006 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
W22, W23	I, II	W22-3	W22H	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.54 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H006 shall not be less than 0.67 Mm^3/month
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							implemented. Water levels should not exhibit long term declining trends.	
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend	Water quality to stay within the limits of Water Quality Class I.[1] in 75% of boreholes
W23	I	W22-4	W22J	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 5.06 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H006 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
			W22K	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.89 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 62% of boreholes.
		W22-5	W22L	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 2.72 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
		W23-1	W23A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 6.84 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 18% of boreholes.
			W23B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 3.09 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 31% of boreholes.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
		W23-2	W23C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 39.36 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
			W23D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 27.42 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W2H032 shall not be less than 2.05 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 85% of boreholes.
W31-a	I	W31-1	W31A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.72 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3H008 shall not be less than 0.06 Mm^3/month.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 87% of boreholes.
			W31B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.45 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3H008 shall not be less than 0.06 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W31C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.69 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3H008 shall not be less than 0.06 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
			W31D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and	The remaining Allocable groundwater is 1.51 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3H008 shall not be less than 0.06 Mm^3/month
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W31-2	W31E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 0.91 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3H008 shall not be less than 0.06 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 40% of boreholes.
			W31F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.31 Mm3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3H008 shall not be less than 0.06 Mm^3/month.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 33% of boreholes.
W31-a, W31-b	I		W31G	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.71 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3H008 shall not be less than 0.06 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
W31-b	II	W31-3	W31H	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.07 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend	Water quality to stay within the limits of Water Quality Class I.[1] in 44% of boreholes.
		W31-4	W31J	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence	The remaining Allocable groundwater is 8.26 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							conditions. Allocations for new users is to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 20% of boreholes.
		W31-3	W31K	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 4.75 Mm3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 31% of boreholes.
		W31-4	W31L	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 5.23 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 72% of boreholes.
		W32-1	W32A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 26.68 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
			W32B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 85.02 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
W32-b	II	W32-2	W32C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 15.66 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 25% of boreholes.
W32-a	I	W32-3	W32D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.37 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3HR001 shall not be less than 0.01 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 76% of boreholes.
			W32E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 4.19 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W3HR001 shall not be less than 0.01 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 66% of boreholes.
St-Lucia	II to II to I	W32-2	W32F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 4.32 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 40% of boreholes.
W32-b	II		W32G	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 17.65 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 42% of boreholes.
St-Lucia	II to II to I	W32-1	W32H	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 132.78 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 82% of boreholes.
W41	I	W41-1	W41A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.18 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H004 shall not be less than 0.59 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W41-2	W41B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.72 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H004 shall not be less than 0.59 Mm^3/month
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W41C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.19 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H004 shall not be less than 0.59 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 75% of boreholes.
		W41-3	W41D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.19 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H004 shall not be less than 0.59 Mm^3/month
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W41E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 1.43 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 75% of boreholes.
			W41F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.61 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
		W42-3	W41G	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 0.46 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years..

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
W42-a	II	W42-1	W42A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 3.00 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W42B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.70 Mm3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 85% of boreholes.
			W42C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.67 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W42-2	W42D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.87 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 90% of boreholes.
			W42E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.32 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 75% of boreholes.
			W42F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.69 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
		W42-3	W42G	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.24 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
W42-b	I		W42H	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 1.34 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
			W42J	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.18 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
			W42K	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.11 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W42L	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.05 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 75% of boreholes.
			W42M	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.46 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H003 shall not be less than 0.67 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining.g trend in July for over 5 years
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 20% of boreholes.
W45	III	W45-1	W43F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 6.51 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 27% of boreholes.
W44	III	W44-1	W44A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.99 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H006 shall not be less than 3.0 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 67% of boreholes.
			W44B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 4.43 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H006 shall not be less than 3.0 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 83% of boreholes.
			W44C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.80 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4H006 shall not be less than 3.0 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W44-2	W44D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.80 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4R001 shall not be less than 0.5 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 50% of boreholes.
			W44E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 1.95 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W4R001 shall not be less than 0.5 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 13% of boreholes.
W45	III	W45-1	W45A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.07 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 48% of boreholes.
			W45B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 3.67 Mm3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 33% of boreholes.
W51-a	II	W51-1	W51A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.40 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H022 shall not be less than 0.78 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W51B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.13 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H022 shall not be less than 0.78 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
W52	II	W51-2	W51C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 1.24 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H022 shall not be less than 0.78 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W51D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.11 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H022 shall not be less than 0.78 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 85% of boreholes.
		W51-3	W51E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.32 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W51F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 4.06 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W52-1	W52A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 0.96 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H005 shall not be less than 0.05 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
		W52-2	W52B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.03 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H005 shall not be less than 0.05 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W52C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 0.64 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H005 shall not be less than 0.05 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
W52	II		W52D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.00 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
W51-b	II	W53-1	W53A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.33 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5R003 shall not be less than 0.05 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W53B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.28 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5R001 shall not be less than 0.05 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W53C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.41 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H026 shall not be less than 0.11 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 71% of boreholes.
			W53D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.56 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H026 shall not be less than 0.11 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
W52	II		W53E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.89 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
		W53-2	W53F	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 3.70 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
W51-b	II	W54-1	W54A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.51 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5R002 shall not be less than 0.01 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
			W54B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.80 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5R002 shall not be less than 0.01 Mm^3/month.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
		W54-2	W54C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.18 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H008 shall not be less than 0.01 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
W52	II		W54D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.69 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H025 shall not be less than 0.08 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
		W54-3	W54E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is	The remaining Allocable groundwater is 2.39 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
W55	I	W55-1	W55A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 7.10 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H011 shall not be less than 0.1 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 90% of boreholes.
			W55B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.20 Mm3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	Dry season flow in July at hydrological station W5H011 shall not be less than 0.1 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
W55	I	W55-2	W55C	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 9.57 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years	Dry season flow in July at hydrological station W5H024 shall not be less than 1.6 Mm^3/month.
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 90% of boreholes.
			W55D	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 4.97 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes
W55	I	W55-3	W55E	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 2.92 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
		W56-1	W56A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 9.00 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
			W56B	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 6.85 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 100% of boreholes.
W57	I	W56-2	W57J	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and	The remaining Allocable groundwater is 4.04 Mm^3/a.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
							Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	
		W56-3	W57K	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 1.03 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 40% of boreholes.
W70a	I, II	W70-1	W70A	Quantity	Abstraction	Water Allocations	All existing users to comply with existing allocation schedules, including GA and Schedule 1, and individual licence conditions. Allocations for new users is to remain within the allocable groundwater volume.	The remaining Allocable groundwater is 135.65 Mm^3/a.
					Baseflow	Dry season flows	Dry season flow in July shall not exhibit a declining trend for over 5 years.	
					Water level	Borehole water levels	Local monitoring of wellfields and background monitoring should be implemented. Water levels should not exhibit long term declining trends.	Static water levels should not exhibit a declining trend in July for over 5 years.

IUA	Class	Groundwater Resource Unit	Quaternary Catchment	Component	Sub-component	Indicator	Narrative	Numeric
				Quality	Water Quality	Water quality analysis	Water quality should not exhibit a declining trend.	Water quality to stay within the limits of Water Quality Class I.[1] in 82% of boreholes.

* *General Authorization*

DWS Guidelines for Domestic Water Quality

Analyses	Unit	Classification				
		Class 0 IDEAL	Class I GOOD	Class II MARGINAL	Class III POOR	Class IV UNACCEPTABLE
pH		5.5 - 9.5	4.5-5.5 and 9.5- 10	4-4.5 and 10-10.5	3-4 and 10.5-11	< 3 or > 11
Conductivity	mS/m	< 70	70 - 150	150 - 270	270 - 450	> 450
TDS	mg/l	< 450	450 - 1000	1000 - 2400	2400 - 3400	> 3400
Total Hardness	$CaCO_3$	< 200	200 - 300	300 - 600	> 600	
Calcium	mg/l	< 80	80 - 150	150 - 300	> 300	
Copper	mg/l	< 1	1 - 1.3	1.3 - 2	2 - 15	> 15
Iron	mg/l	< 0.5	0.5 - 1	1 - 5	5 - 10	> 10
Magnesium	mg/l	< 70	70 - 100	100 - 200	200 - 400	> 400
Manganese	mg/l	< 0.1	0.1 - 0.4	0.4 - 4	4 - 10	> 10
Potassium	mg/l	< 25	25 - 50	50 - 100	100 - 500	> 500
Sodium	mg/l	< 100	100 - 200	200 - 400	400 - 1000	> 1000
Chloride	mg/l	< 100	100 - 200	200 - 600	600 - 1200	> 1200
Fluoride	mg/l	< 0.7	0.7 - 1	1 - 1.5	1.5 - 3.5	> 3.5
Nitrate NO_3 - N	mg/l	< 6	6 - 10	10 - 20	20 - 40	> 40
Nitrite NO_2 - N	mg/l	< 6	6 - 10	10 - 20	20 - 40	> 40
Orthophosphate (PO_4 as P)	mg/l	< 0.1	0.1 - 0.25	0.25 - 1	> 1	
Sulphate (SO_4)	mg/l	< 200	200 - 400	400 - 600	600 - 1000	> 1000
MPN *E. coli*	/100ml	0	0 - 1	1 - 10	10 - 100	> 100

Table D3: RIVERS: RQOs for water quality (ecological and user) in High Priority RUs containing EWR sites or High Priority WQ sites

IUA	Water Resource Class	Quaternary catchment[7]	RU[8]	Water resource	TEC	Sub-Component	Indicator	RQO	
								Narrative[3]	Numerical
W11	I	W11A	W11-2: W11A-03612 (EWR MA1)	Matigulu	B/C	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 55 mS/m (aquatic ecosystems: driver).
						Suspended sediments	Turbidity/clarity or TSS levels.	A moderate change from natural with unnaturally high sediment loads and turbidity during runoff events. Some sediment deposits evident (aquatic ecosystems: driver).	Not available
W11	I	W11C	W11-2: W11C-03713	Nyezane	B/C	Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W12-b	II	W12C	W12-5: W12C-03263	Mfulazane	B	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Ideal	95th percentile of the data must be less than or equal to 30 mS/m (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.

[7] Quaternary catchment representing the largest section of the RU as RUs may cross quaternary catchment boundaries.

[8] Note that each RU is represented by a biophysical node which has the same name as the RU. Where the RU includes an EWR site, the EWR site name follows the RU name in brackets.RU designation also lists sub-quaternary (SQ) catchments where water quality RQOs are applicable.

[3] Note that Reserve data available as A - F categories were converted to Ideal to Tolerable categories for water quality, as used to describe fitness for use.

IUA	Water Resource Class	Quaternary catchment[7]	RU[8]	Water resource	TEC	Sub-Component	Indicator	RQO	
								Narrative[3]	Numerical
W12-b	II	W12G	W12-8: W12G-03229 (EWR NS1)	Nseleni	C	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).
						Suspended sediments	Turbidity/clarity or TSS levels.	A moderate change from natural with unnaturally high sediment loads and turbidity during runoff events. Some sediment deposits evident (aquatic ecosystems: driver).	Not available
W12-b	II	W12H	W12-8: W12H-03401	Okula	C	Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W21	II	W21B	W21-1: W21B-02539	iShoba	B	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).
						Salts	Sulphate	Acceptable	95th percentile of the data must be less than or equal to 250 mg/L SO_4 (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W21	II	W21A, W21B (excl iShoba)	W21-1 excl iShoba	White Umfolozi	B	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).

IUA	Water Resource Class	Quaternary catchment[7]	RU[8]	Water resource	TEC	Sub-Component	Indicator	RQO	
								Narrative[3]	Numerical
						Salts	Electrical conductivity	Ideal	95th percentile of the data must be less than or equal to 30 mS/m (aquatic ecosystems: driver).
						Salts	Sulphate	Ideal	95th percentile of the data must be less than or equal to 80 mg/L SO_4 (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed [#].	Meet targets for use [#].
W21	II	W21H	W21-5: W21H-02897 (EWR WM1)	White Umfolozi	B/C	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 55 mS/m (aquatic ecosystems: driver).
						Suspended sediments	Turbidity/clarity or TSS levels.	A moderate change from natural with unnaturally high sediment loads and turbidity during runoff events. Some sediment deposits evident (aquatic ecosystems: driver).	Not available
W21	II	W21H	W21-7: W21K-02976 (Mbilane), W21K-03019 (Nhlungwane), W21K-02981 (White Umfolozi)	Mbilane Nhlungwane White Umfolozi	B/C	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 55 mS/m (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed [#].	Meet targets for use [#].

IUA	Water Resource Class	Quaternary catchment[7]	RU[8]	Water resource	TEC	Sub-Component	Indicator	RQO	
								Narrative[3]	Numerical
W22	II	W22A	W22-1: W22A-02610 (EWR BM1)	Black Umfolozi	C	Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 55 mS/m (aquatic ecosystems: driver).
						Salts	Sulphate	Ideal	95th percentile of the data must be less than or equal to 30 mg/L SO_4 (aquatic ecosystems: driver).
IUA-St Lucia	I	W23B, W23C, W23D	St Lucia, W2& W3 feeder streams: W23B-03231 + W23C-03180 (Msunduzi), W23D-03108 (Mfolozi)	Msunduzi Mfolozi	D➔C➔B (long-term; >10 yrs)	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed [#].	Meet targets for use [#].
W31-b	I	W31J	W31-4: W31J-02469	Mkuze	C	Microbial	Faecal coliforms and *E. coli*	Uses as listed [#].	Meet targets for use [#].
W31-b	II	W31J	W31-5: W31J-02480 (EWR MK1)	Lower Mkuze	B/C	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).
						Nutrients	Total Inorganic Nitrogen (TIN: nitrate + nitrite + ammonium-N)	Ideal	50th percentile of the data must be less than 0.28 mg/L TIN-N (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Tolerable	95th percentile of the data must be less than or equal to 275 mS/m (aquatic ecosystems: driver).

IUA	Water Resource Class	Quaternary catchment[7]	RU[8]	Water resource	TEC	Sub-Component	Indicator	RQO	
								Narrative[3]	Numerical
						Salts	Sulphate	Acceptable	95th percentile of the data must be less than or equal to 208 mg/L SO_4 (aquatic ecosystems: driver).
						Suspended sediments	Turbidity/clarity or TSS levels.	A moderate change from natural with high sediment loads and turbidity during runoff events (aquatic ecosystems: driver).	Not available
						Toxics	As listed in DWAF (1996) and DWAF (2008)	Ideal	95th percentile of the data must be within the TWQR or Rating 0 for toxics. Numerical limits can be found in DWAF (1996) and DWAF (2008) respectively.
						Toxics	DDT (Dichloro-diphenyl-trichloroethane)	The numerical guideline should not be exceeded in freshwater at any given time.	Levels should not exceed 0.41 µg/L at any time (aquatic ecosystems: driver) (EPA, 1979). Moderate reliability guideline value of 0.01 µg/L for 95% protection of aquatic life (ANZECC, 2000).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed [#].	Meet targets for use [#].
W44	III	W42E	W42-2: W42E-02221 (EWR UP1)	Upper Phongola	C	Suspended sediments	Turbidity/clarity or TSS levels.	Small changes from natural localized gully erosion (aquatic ecosystems: driver).	Not available
						Toxics	DDT (Dichloro-diphenyl-trichloroethane)	The numerical guideline should not be exceeded in freshwater at any given time.	Levels should not exceed 0.41 µg/L at any time (aquatic ecosystems: driver) (EPA, 1979). Moderate reliability guideline value of 0.01 µg/L for 95% protection of aquatic life (ANZECC, 2000).

IUA	Water Resource Class	Quaternary catchment[7]	RU[8]	Water resource	TEC	Sub-Component	Indicator	RQO	
								Narrative[3]	Numerical
W44	III	W42D	W42-2: W42D-02327	Gode	C	Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W44	III	W44A, W44B, W44C, W44D	W44-1: W44B-02248 (Manzawakho), W44B-02351 + W44C-02338 + W44D-02304 (Phongola)	Manzawakho Phongola	D	Nutrients	Orthophosphate	Tolerable	50th percentile of the data must be less than 0.075 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W45	III	W45A, W45B	W45-1	Phongola	D	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 55 mS/m (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W51-a	II	W51A	W51-1	Assegaai, tributaries flowing into Heyshope Dam. Includes Heyshope Dam	B/C	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 15 mS/m (Eskom abstraction from Heyshope Dam for cooling of coal-powered power stations: driver).

IUA	Water Resource Class	Quaternary catchment[7]	RU[8]	Water resource	TEC	Sub-Component	Indicator	RQO	
								Narrative[3]	Numerical
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W52	II	W51E	W51-3: W51D-02044 + W51E-02049 (EWR AS1)	Assegaai	C	Nutrients	Orthophosphate	Tolerable	50th percentile of the data must be less than 0.075 mg/L PO_4-P (aquatic ecosystems: driver).
						Toxics	As listed in DWAF (1996) and DWAF (2008)	Ideal	95th percentile of the data must be within the TWQR or Rating 0 for toxics. Numerical limits can be found in DWAF (1996) and DWAF (2008) respectively.
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W52	II	W53E	W53-3: W53E-01790 (EWR NG1), W53C-01679 (Thole)	Ngwempisi Thole	B/C	Nutrients	Orthophosphate	Tolerable	50th percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver).
						Nutrients	Total Inorganic Nitrogen (TIN: nitrate + nitrite + ammonium-N)	Acceptable	50th percentile of the data must be less than 1.0 mg/L TIN-N (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Ideal	95th percentile of the data must be less than or equal to 30 mS/m (aquatic ecosystems: driver).
						Suspended sediments	Turbidity/clarity or TSS levels.	Small increase in sediment supply from land use, as compared to natural state (aquatic ecosystems: driver).	Not available

IUA	Water Resource Class	Quaternary catchment[7]	RU[8]	Water resource	TEC	Sub-Component	Indicator	RQO	
								Narrative[3]	Numerical
						Toxics	As listed in DWAF (1996) and DWAF (2008)	Ideal	95th percentile of the data must be within the TWQR or Rating 0 for toxics. Numerical limits can be found in DWAF (1996) and DWAF (2008) respectively.
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W55	I	W55E	W55-1 (excl. Chrissiesmeer)	Mpuluzi	B/C	Nutrients	Orthophosphate	Acceptable	50th percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Ideal	95th percentile of the data must be less than or equal to 30 mS/m (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.
W55	I	W55A, W55C	W55-pans incl. Chrissiesmeer	Pans and lake	B	Nutrients	Orthophosphate	Tolerable	50th percentile of the data must be less than 0.225 mg/L PO_4-P (aquatic ecosystems: driver).
						Salts	Electrical conductivity	Acceptable	95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).
						Microbial	Faecal coliforms and *E. coli*	Uses as listed #.	Meet targets for use #.

TWQR = Target Water Quality Range (DWAF, 1996).

DWAF (1996): South African Water Quality Guidelines: Volume 7: Aquatic Ecosystems.

DWAF (2008): Methods for determining the water quality component of the Ecological Reserve for rivers.

EPA (1979): DDT: Ambient water quality criteria.

ANZECC & ARMCANZ (2000): Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

[#] **Health risk guidelines or RQOs for faecal coliforms/*Escherichia coli*** (as used by the National Microbial Monitoring Programme (NMMP) of South Africa (DWAF, 2002))

Water use attribute	Potential Health Risk			IMPORTANT NOTE
	Low	Medium	High	
	RAW RIVER WATER QUALITY			
	Faecal coliform or *E. coli* counts/100 ml			
1. Drinking untreated water	0	1 - 10	>10	
2. Drinking water after limited treatment	<2 000	2 000 – 20 000	>20 000	The guideline value refers to raw water; although water should only be used for drinking only AFTER limited treatment has taken place, so the E. coli counts shown on the table are BEFORE treatment. Limited treatment refers to treatment such as boiling and does not refer to more conventional and format treatment such as flocculation, sedimentation, filtration and disinfection.
3. Full or partial contact	<600	600 – 2 000	>2 000	Full contact refers to full-body immersion activities such as swimming or baptism, whereas partial contact refers to activities such as canoeing, where water may be splashed on to the body.
4. Irrigation of crops to be eaten raw	<1 000	1 000 – 4 000	>4 000	

DWAF (2002): National Microbial Monitoring Programme for Surface Water. Implementation Manual. Pretoria. South Africa.

Conversion of Reserve categories to Ideal-Intolerable categories:

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