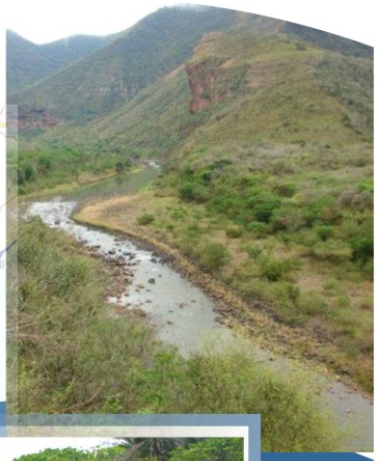
REPORT NUMBER: RDM/WMA11/00/CON/CLA/0114

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

PROJECT NUMBER: WP 10679

VOLUME 1:
EWR ESTIMATES OF THE RIVER DESKTOP BIOPHYSICAL NODES

MARCH 2014



water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

RfA05_2014

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

VOLUME 1: EWR ESTIMATES OF THE RIVER DESKTOP BIOPHYSICAL NODES

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REFERENCE
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2	Report Number: RDM/WMA11/00/CON/CLA/0113	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Status quo assessment, IUA and biophysical node delineation and identification.**
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6	Report Number: RDM/WMA11/00/CON/CLA/0212	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **BHNR**
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8.7	Report Number: RDM/WMA11/00/CON/CLA/1314	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 7: Recommended Management Classes.**
9	Report Number: RDM/WMA11/00/CON/CLA/0115	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Stakeholder Report**
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DEPARTMENT OF WATER AFFAIRS

CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

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

VOLUME 1: EWR ESTIMATES OF THE RIVER DESKTOP BIOPHYSICAL NODES

Approved for RFA by:

……. ……

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Project Manager

Date

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REPORT SCHEDULE

Version	Date
First draft	March 2014
Second draft	2 June 2014

EXECUTIVE SUMMARY

BACKGROUND

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu Water Management Area (WMA). Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

Volume 1 (this report) documents the quantification of the Ecological Water Requirements (EWR) at the desktop biophysical nodes in WMA 11. There are 288 biophysical nodes in the study area and an EWR is required at most of these nodes. Due to the large size of the study area and the subsequent large number of nodes, all EWRs cannot be determined at a detailed level. The desktop biophysical nodes are those with a low priority and require desktop EWR estimates. The number of desktop nodes and level of EWR assessments that needs to be undertaken are provided in the Table below.

Biophysical nodes and levels of EWR assessment

Secondary catchment	Desktop EWR	New EWR sites	Existing EWR sites	Extrapolated from EWR sites	Excluded /Comment
T4	14	1	0	5	17
T5	24	0	14	11	6
U8	14	0	0	0	19
U1	21	3	0	10	5
U7	10	1	0	3	2
U6	10	0	0	0	4
U2	33	4	0	5	11
U3	7	0	0	0	4
U4	22	2	0	3	0
U5	3				
TOTAL	**158**	**11**	**14**	**37**	**68**

The results of the desktop EWR assessments at 158 desktop biophysical nodes are provided in this report. Detailed EWR assessments will be undertaken at 11 EWR sites which are key biophysical nodes in the study area. There are 14 existing EWR sites where detailed EWR assessments are available and 37 nodes where results will be extrapolated from EWR sites. Sixty eight nodes will either be addressed by estuarine assessments or are located in protected areas and do not require EWR assessments.

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TERMINOLOGY AND ACRONYMS

CD: RDM	Chief Directorate: Resource Directed Measures
DWA	Department Water Affairs (Name change applicable after April 2009
DWAF	Department Water Affairs and Forestry
DRM	Desktop Reserve Model
DEM	Digital Elevation Model
EI	Ecological Importance
ES	Ecological Sensitivity
EWR	Ecological Water Requirements
GIS	Geographic Information System
GZ	Geomorphological zone
IEI	Integrated Environmental Importance
MAR	Mean Annual Runoff
NFEPA	National Freshwater Ecosystem Priority Area
NWRCS	National Water Resource Classification System
PD	Present Day
PES	Present Ecological State
PSP	Professional Service Provider
REC	Recommended Ecological Category
RQO	Resource Quality Objectives
RDRM	Revised Desktop Reserve Model
SRTM	Shuttle Remote Topography Mission
SPATSIM	Spatial and Time Series Information Modelling
SQ	Sub quaternary
WMA	Water Management Area

1 INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to UmzimkuluWater Management Area (WMA). Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

1.2 INTEGRATED STEP 3: QUANTIFY EWRS AND CHANGES IN NON-WATER QUALITY ECOSYSTEM SERVICES

This study entails Classification and setting of RQOs. Embedded in the National Water Resources Classification System (NWRCS) is the determination of the Reserve. Each of these three processes consists of distinctive steps which overlap. Integrated steps were designed and are provided below.

Table 1.1 Integrated steps combining the NWRC, RQO and Reserve processes

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

This report forms part of the outcomes of Step 3 (red above) for the River component of the study. Step 3 entails the application of different levels of Reserve assessment and Classification within Water Management Area (WMA) 11. The main deliverable of this Task as outlined in the Inception Report (DWA, 2012) is the EWR report (referred to as Report 5) consisting of the following volumes:

- **Volume 1: EWR estimates of the Desktop Biophysical Nodes.**
- Volume 2: EcoClassification and EWR assessment at the Rapid III level.
- Volume 3: EcoClassification and EWR assessment at the Comprehensive and Intermediate levels.

1.2.1 EWR assessment for the desktop biophysical nodes

Volume 1 (this report) documents the quantification of the Ecological Water Requirements (EWR) at the desktop biophysical nodes in WMA 11. There are 288 biophysical nodes in the study area and an EWR is required at most of these nodes. Due to the large size of the study area and the subsequent large number of nodes, all EWRs cannot be determined at a detailed level. A hotspot determination process (DWA, 2013a) was used to identify those nodes or rivers which require detailed assessment and also provided information at which levels other nodes should be addressed. The desktop biophysical nodes are those with a low priority and require desktop EWR

estimates. The number of desktop nodes and level of EWR assessments that needs to be undertaken are provided in Table 1.2.

Table 1.2 Biophysical nodes and levels of EWR assessment

Secondary catchment	Desktop EWR	New EWR sites	Existing EWR sites	Extrapolated from EWR sites	Nodes excluded
T4	14	1	0	5	17
T5	24	0	14	11	6
U8	14	0	0	0	19
U1	21	3	0	10	5
U7	10	1	0	3	2
U6	10	0	0	0	4
U2	33	4	0	5	11
U3	7	0	0	0	4
U4	22	2	0	3	0
U5	3				
TOTAL	**158**	**11**	**14**	**37**	**68**

The results of the desktop EWR assessments at 158 desktop biophysical nodes are provided in this report. Detailed EWR assessments will be undertaken at 11 EWR sites which are key biophysical nodes in the study area. There are 14 existing EWR sites where detailed EWR assessments are available and 37 nodes where results will be extrapolated from EWR sites. Sixty eight nodes will either be addressed by estuarine assessments or are located in protected areas and do not require EWR assessments.

The PES for the nodes are available from the Present Ecological State (PES) and Ecological Importance (EI) - Ecological Sensitivity (ES) referred to as the PES (11) (DWA, 2013b) study and modified during Task 1 status quo assessment, DWA (2013a) of this study. During this Task the Recommended Ecological Category (REC) had to be determinedfor the desktop biophysical nodes so that EWRs can be estimated for the REC.

This task provides the information for the next step, i.e. Step D4: Identification and evaluation of operational scenarios to determine consequences.

1.1.1 Information used from previous riverine Reserve determination studies

Available and applicable data from previous riverine Reserve determinations was sourced from the following documents:

- **Mvoti River:** An EWR study was undertaken by DWA during 1995 (DWAF, 1996). Four EWR sites were selected in this system.
- **MkomaziRiver:** A Comprehensive Reserve determination was undertaken during 1998 as part of the pre-feasibility investigations into a transfer scheme from the Mkomazi to the uMngeni catchment (DWAF, 1999a). Four EWR sites were selected and the estuary was assessed.
- **Umzimkhulu River:** Recent work (DWA, 2011) on this river included Reserve determinations and this work was reviewed.
- **uMngeni River:** Extensive monitoring activities are on-going and some Rapid Reserves (DWAF, 2005) have been undertaken.

- A range of Rapid III assessments have also been undertaken in this WMA and this data was further investigated during this Task.

1.2 REPORT STRUCTURE

The report outline is provided below.

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

Chapter 2: Desktop biophysical nodes: Resource Units, locality and EcoClassification
The Sub-Quaternary river reaches (SQs) forms the basis of the PES (11)(DWA, 2013b) assessment and are therefore surrogates for desktop level Resource Units. Desktop biophysical nodes are listed and a summary of results for the desktop biophysical nodes are provided.

Chapter 3: Desktop biophysical nodes: EWR estimation and results
This chapter provides the general approach used during this study to estimate the EWRs at the biophysical nodes using the Revised Desktop Reserve Model (RDRM) which includes the links and relationships between hydrology, hydraulics and ecological response.

Chapter 4: References

Chapter 5: Appendix A: Report Comments
Comments from the Client are provided.

2 DESKTOP BIOPHYSICAL NODES: RESOURCE UNITS, LOCALITY AND ECOCLASSIFICATION

2.1 DESKTOP RESOURCE UNITS

The Sub-Quaternary river reaches (SQs) as indicated in http://www.dwa.gov.za/iwqs/gis_data/river/rivs500k.html and http://www.dwa.gov.za/iwqs/gis_data/river/River_Report_01.pdf, forms the basis of the PESEIS 2011 (DWA, 2013b) assessment. A SQ changes when a significant tributary joins it. This means that a SQ may potentially be subdivided into various EcoRegions, geomorphic zones (slope zones) resource units (natural or management), etc. Such subdivisions are not addressed on a desktop level, and may be required when higher confidence assessments are done. The version of the 1:500 000 coverage that was used for the PES (11) (DWA, 2013b), was a version used by the National Freshwater Ecosystem Priority Areas (NFEPA) project in 2009(Nel *et al*., 2011).

The SQs at desktop levels are therefore surrogates for desktop level Resource Units.

2.2 DESKTOP BIOPHYSICAL NODES

A desktop biophysical node represents a point at the end of the SQ for all SQs which do not contain key biophysical nodes. These desktop biophysical nodes are represented in Figure 2.1 to Figure 2.4.

2.3 DESKTOP ECOCLASSIFICATION

The PES (11) (DWA, 2013b) results were used to derive the REC(Table 2.1 to Table 2.8) at the desktop biophysical nodes. In cases where the Integrated Environmental Importance (IEI) is high or very high, an improved REC is recommended. The estimated EWR from the Revised Desktop Reserve Model (RDRM) is linked to the REC and these results are provided in the following chapter. It must however be noted that if the REC is not based on an improved flow regime, the EWR for the PES is used. Information is also supplied on what will be required to achieve the REC as well as whether this is attainable (column 6 and 7 in Table 2.1 to Table 2.8).

Table 2.1 to Table 2.8 summarises the results for the desktop biophysical nodes (DWA, 2013a) and forms the basis for the EWR estimation (see Chapter 3). Note that biophysical nodes which represent rivers with its source and 'end' in protected areas are not included for EWR estimation and are excluded from the tables below. If information is required on any of these nodes, please refer to DWA (2013a).

The description of the columns is as follows:

- Column 1: SQ number.
- Column 2: River name where available.
- Column 3: PES according to the results of the PES (11)(DWA, 2013b) study completed during 2011.
- Column 4: Ecological Importance and Sensitivityaccording to the results of the PES (11) (DWA, 2013b) study completed during 2011.
- Column 5: REC generated during this study and documented in this report, as well as in DWA (2013a) and the electronic data provided as part of this study.

- Column 6: Comments provided to indicate what would be required to improve the REC and whether it is attainable as well as information on whether the actions required would need flow- or non-flow-related measures.
- Column 7: A conclusion on whether the improvement is attainable.
- Column 8: Provides the EC for which the RDRM must be run. Therefore, if the RDRM category is different than the REC (i.e. the same as the PES), it means that the measures to achieve the REC do not require increased flows.

Table 2.1 T4 (Mtamvuna): Summary of results for the desktop biophysical nodes

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
T40A-05450	Mafadobo	**B**	H	**B**			**B/C**
T40A-05487	Goxe	**B/C**	H	**B**	Catchment management of informal agriculture and overgrazing will be required. Unlikely to be attainable.	Unlikely	**B/C**
T40B-05337	Weza	**C**	H	**C**			**C**
T40C-05566	Ludeke	**B**	M	**B**			**B**
T40C-05589	KuNtlamvukazi	**B**	H	**B**			**B**
T40C-05600	Ludeke	**B**	M	**B**			**B**
T40D-05615	Tungwana	**B**	M	**B**			**B**
T40D-05643	Gwala	**B**	H	**B**			**B**
T40D-05683	Ntelekweni	**B/C**	H	**B/C**			**B/C**
T40D-05707	Mtamvuna	**C**	M	**C**			**C**
T40D-05719	Londobezi	**B**	M	**B**			**B**
T40E-05767	Hlolweni	**B/C**	H	**B**	Catchment management of informal agriculture and overgrazing will be required. Unlikely to be attainable. Alien vegetation can be removed.	Unlikely	**B/C**
T40F-05666	Mbizana	**B**	H	**B**			**B**
T40G-05616	Vungu	**B/C**	H	**B**	WQ improvement of Uvongo needs to change ratings from a 3 to a 2 which will improve instream continuity.	Yes	**B/C**

Table 2.2 T5 (Umzimkulu): Summary of results for the desktop biophysical nodes

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
T51A-04522	Mzimude	**B**	H	**B**			**B**
T51A-04608		**B**	H	**B**			**B**
T51A-04551	Mzimude	**B/C**	H	**B**	Flow modification needs to improve from a 1.5 to a 1.	Yes	**B**
T51B-04421	Mzimkhulu	**B**	H	**B**			**B**
T51C-04606		**C**	M	**C**			**C**
T51D-04460	Pholelana	**D/E**	M	**D**	Lower 50% of catchment dammed. Upper section in a better state. Without removing dams, no improvement possible.	No	**B**
T51E-04536		**C**	M	**C**			**C**
T51F-04674		**C**	M	**C**			**C**
T51G-04751		**B**	H	**B**			**B**
T51G-04722	Ndawana	**C**	M	**C**			**C**

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
T51H-04913	Nonginqa	**B/C**	H	**B/C**			**B/C**
T51H-04923	Malenge	**B/C**	H	**B**	Riparian buffer reinstatement.	yes	**B/C**
T52C-04880		**C**	H	**C**			**C**
T52D-05024	Ncalu	**B/C**	H	**B**	Reduce sedimentation and establish buffer zone (forestry area)	Yes	**C**
T52D-05061	Mgodi	**B/C**	H	**B**	Reduce sedimentation and establish buffer zone (forestry area).	Yes	**C**
T52E-05053	Upper Bisi	**B/C**	H	**B**	Buffer zone reinstatement in forestry and other areas and alien veg removal.	Yes	**B/C**
T52F-05104	Little Bisi	**C**	M	**C**			**C**
T52F-05190	Mbumba	**B/C**	M	**B/C**			**B/C**
T52F-05139	Little Bisi	**B**	H	**B**			**B**
T52G-05226	uMbumbane	**B/C**	M	**B/C**			**B/C**
T52G-05171	Bisi	**B**	H	**B**			**B**
T52H-05244	Mahobe	**B/C**	H	**B/C**			**B/C**
T52H-05295	Magogo	**B**	H	**B**			**B**
T52K-05475	Nkondwana	**B/C**	H	**B/C**			**B/C**

Table 2.3 U8 (Mzumbe and Mtwalume): Summary of results for the desktop biophysical nodes

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U80B-05145	Mzumbe	**B**	H	**B**			**B**
U80B-05161	Mhlabatshane	**B**	H	**B**			**B**
U80C-05231	Mzumbe	**B**	H	**B**			**B**
U80C-05329	Kwa-Malukaka	**B**	H	**B**			**B**
U80E-05028	Mtwalume	**C**	H	**C**	14 dams in first 12 km. Without removal of dams, not possible to improve.	No	**C**
U80E-05212	Quha	**B**	H	**B**			**B**
U80F-05258	Mtwalume	**B/C**	H	**B**	Improve water quality of return flows.	Yes	**B/C**
U80F-05301	uMngeni	**B/C**	H	**B**	Improve water quality of return flows. Reinstate buffer zone.	Yes	**B/C**
U80G-05097	Fafa	**B/C**	H	**B**	Reinstate riparian zone. Improve flow (optimise irrigation methods) and agricultural return flows –water quality.	Yes	**B**
U80H-05109	Mzinto	**C/D**	H	**C**	Reinstate riparian zone. Improve flow (optimise irrigation methods) and agricultural return flows –water quality.	Yes	**C**
U80J-04979	Mpambanyoni	**B**	H	**B**			**B**
U80J-05043	Ndonyane	**B/C**	H	**B**	Reinstate riparian zone. Erosion control.	Yes	**B**
U80K-04952	Mpambanyoni	**C**	H	**B**	Water quality from irrigation return flows addressed. Reinstate riparian zone as buffer. Erosion control.	Difficult	**C**
U80L-05020	aMahlongwa	**B/C**	H	**B**	Reinstate riparian zone as buffer. Erosion control.	Difficult	**B/C**

Table 2.4 U1 (Mkomazi): Summary of results for the desktop biophysical nodes

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U10A-04202	Nhlathimbe	**B**	M	**B**			**B**
U10A-04301	Lotheni	**B**	M	**B**			**B**
U10B-04343	Mqatsheni	**B**	M	**B**			**B**
U10C-04347	Mkhomazana	**B**	H	**B**			**B**
U10D-04222	Rooidraai	**B**	M	**B**			**B**
U10D-04298	Nzinga	**B/C**	H	**B**	Catchment management - sedimentation. Reinstate buffer zone. Erosion control. This will improve instream habitat.	Unlikely	**B/C**
U10F-04560	Luhane	**B/C**	M	**B/C**			**B/C**
U10G-04388	Elands	**C**	H	**B**	Target improvement especially in the lower reach. Buffer zone, alien removal, water quality practices.	Yes	**B/C**
U10G-04405		**C**	M	**C**			**C**
U10G-04473	Elands	**C**	H	**B**	Target improvement especially in the upper reach. Buffer zone, alien removal, water quality practices. Also flow improvements.	Yes	**B**
U10H-04576	Tholeni	**B**	H	**B**			**B**
U10H-04666	Ngudwini	**B/C**	H	**B**	Address erosion to reduce sedimentation (overgrazing, forestry, informal agriculture).	Yes	**B/C**
U10H-04708	Ngudwini	**B**	H	**B**			**B**
U10H-04729	Mzalanyoni	**C**	H	**B**			**B**
U10J-04713	Mkobeni	**C**	H	**B**	Riparian buffer zone in forestry and agricultural areas. Also alien removal.	Yes	**C**
U10J-04721	Pateni	**B**	H	**B**			**B**
U10J-04820	Lufafa	**B/C**	H	**B**	Erosion control, riparian buffer.	Difficult	**B/C**
U10J-04837		**A/B**	H	**A/B**			**A/B**
U10K-04842	Nhlavini	**B**	M	**B**			**B**
U10K-04899	Xobho	**C/D**	M	**C/D**			**C/D**
U10K-04946	Nhlavini	**B/C**	H	**B/C**			**B/C**

Table 2.5 U7 (Lovu) and U6 (Mlazi): Summary of results for the desktop biophysical nodes

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U7 LOVU							
U70A-04599	Serpentine	**C**	M	**C**			**C**
U70A-04618		**C**	M	**C**			**C**
U70C-04710	Mgwahumbe	**C**	M	**C**			**C**
U70C-04724		**C**	M	**C**			**C**
U70C-04732		**C**	M	**C**			**C**
U70D-04800	Nungwane	**B/C**	M	**B/C**			**B/C**
U70E-04942	Umsimbazi	**C**	M	**C**			**C**

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U70E-04974	uMgababa	**C**	H	**C**	Reduce overgrazing, reinstate riparian buffer, erosion measure.	No, due to density of people.	**C**
U70F-04845	Manzimtoti	**C**	M	**C**			**C**
U70F-04893	Little Manzimtoti River	**C**	M	**C**			**C**
U6 (MLAZI)							
U60A-04533	uMlazi	**C**	M	**C**			**C**
U60B-04614	Mkuzane	**C/D**	M	**C/D**			**C/D**
U60C-04555	uMlazi	**C/D**	M	**C/D**			**C/D**
U60C-04556	Sterkspruit	**D**	H	**D**	Due to presence of townships, not possible to improve.	No	**D**
U60C-04613	Wekeweke	**C**	M	**C**			**C**

Table 2.6 U2 (uMngeni): Summary of results for the desktop biophysical nodes

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U20B-04074	Ndiza	**B/C**	H	**B**	Reinstate riparian zone in forestry.	Yes	**B/C**
U20B-04173	Lions	**C**	H	**B**	Reinstate riparian zone in forestry and wetland buffers. Address irrigation return flows (water quality) and town runoff.	Yes	**C**
U20C-04332	Gqishi	**B/C**	H	**B**	Riparian zone buffer to be improved.	Yes	**B/C**
U20D-04029	Yarrow	**B/C**	H	**B**	Agricultural area - wetland buffers.	Yes	**B/C**
U20E-04271	DoringSpruit	**B/C**	M	**B/C**			**B/C**
U20F-04011	Sterkspruit	**C/D**	M	**C/D**			**C/D**
U20F-04095	Mpolweni	**C/D**	M	**C/D**			**C/D**
U20F-04131	Mhlalane	**C/D**	M	**C/D**			**C/D**
U20F-04204	Sterkspruit	**B/C**	M	**B/C**			**B/C**
U20F-04224	Mpolweni	**B/C**	M	**B/C**			**B/C**
U20G-04194	Mkabela	**C/D**	M	**C/D**			**C/D**
U20G-04215	Cramond Stream	**B/C**	M	**B/C**			**B/C**
U20H-04410	Nqabeni	**C**	M	**C**			**C**
U20H-04449	uMnsunduze	**C**	M	**C**			**C**
U20J-04391	uMnsunduze	**C**	H	**C**	Water quality issues to be addresses. Unlikely to achieve required B.	No	**C**
U20J-04401	uMnsunduze	**D**	M	**D**			**D**
U20J-04452	Mpushini	**B/C**	H	**B**	Water quality from Ashburtontown and other aspects.	Yes	**B/C**
U20J-04459	uMnsunduze	**C**	H	**C**	Water quality issues to be addresses. Unlikely to achieve required B.	No	**C**
U20J-04461	Slang Spruit	**C/D**	M	**C/D**			**C/D**
U20J-04488	Mshwati	**B/C**	H	**B**	Lower section in worse state. Reinstate riparian zone, address erosion.	Yes	**B/C**
U20K-04181	Mqeku	**C**	M	**C**			**C**
U20K-04296	Tholeni	**C**	H	**B/C**	Riparian zone buffer to be improved.	Yes, but only to a B/C	**C**

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U20K-04411	Mqeku	**B/C**	H	**B**	Riparian zone buffer to be improved.	Yes	**B/C**
U20M-04625		**D**	M	**D**			**D**
U20M-04639	Palmiet	**D**	M	**D**			**D**
U20M-04642	Palmiet	**D**	M	**D**			**D**
U20M-04649	Mbongokazi	**C**	M	**C**			**C**
U20M-04653	Palmiet	**C/D**	M	**C/D**			**C/D**
U20M-04659	Palmiet	**C**	H	**C**	Urban area. Difficult to address.	No	**C**
U20M-04682		**C/D**	M	**C/D**			**C/D**

Table 2.7 U3 (Mdloti) and U5 (Nonoti): Summary of results for the desktop biophysical nodes

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U30A-04228	Mdloti	**B/C**	H	**B**	Improve riparian buffer zone, erosion control.	Yes	**B/C**
U30A-04360	Mdloti	**D**	M	**D**			**D**
U30A-04363	Mwangala	**B/C**	H	**B**	Improve riparian buffer zone, erosion control.	Yes	**B/C**
U30B-04465	Black Mhlashini	**B/C**	M	**B/C**	Extensive agriculture and urban area. Not possible to improve.	No	**B/C**
U30C-04227	Tongati	**B/C**	M	**B/C**			**B/C**
U30C-04272	Mona	**B/C**	H	**B**	Riparian buffer zone improvement.	Yes	**B/C**
U30E-04207	Mhlali	**C**	H	**C**	Improvement very difficult due to extensive agriculture.	No	**C**
U5 Nonoti							
U50A-04018	Zinkwazi	**B/C**	M	**B/C**	Extensive development catchment, sugarcane, will require removal etc. Have to reinstate about 13 km of riparian zone.	Unlikely	**B/C**
U50A-04021	Nonoti	**B/C**	H	**B/C**	Extensive development catchment, sugarcane, will require removal etc. Have to reinstate about 46 km of riparian zone.	Unlikely	**B/C**
U50A-04141	Mdlotane	**B/C**	M	**B/C**	Extensive development catchment, sugarcane, will require removal etc. Have to reinstate about 5 km of riparian zone.	Unlikely	**B/C**

Table 2.8 U4 (Mvoti): Summary of results for the desktop biophysical nodes

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U40A-03869	Mvoti	**B/C**	H	**B**	Improve riparian buffer in forestry and agriculture areas.	Yes	**B/C**
U40B-03708	Intinda	**C**	M	**C**			**C**
U40B-03740	Mvozana	**C**	M	**C**			**C**
U40B-03832	Mvozana	**C/D**	M	**C/D**			**C/D**
U40B-03896	Mvoti	**C**	M	**C**			**C**
U40C-03982	Khamanzi	**B/C**	H	**B**	Improve riparian buffer in forestry and agriculture areas.	Yes	**B/C**
U40D-03867	Mvoti	**B/C**	H	**B**	Erosion control, overgrazing, difficult.	Yes	**B/C**

1	2	3	4	5	6	7	8
SQ number	**River**	**PES**	**EIS**	**REC**	**REC Comment**	**Improvement attainable?**	**RDRM**
U40D-03908	Mtize	**B**	H	**B**			**B**
U40D-03957	Mvoti	**B**	H	**B**			**B**
U40E-04079	Faye	**B**	H	**B**			**B**
U40E-04082	Sikoto	**B**	H	**B**			**B**
U40E-04137	Sikoto	**B**	H	**B**			**B**
U40F-03690	Potspruit	**C**	M	**C**			**C**
U40F-03694	Hlimbitwa	**C**	M	**C**			**C**
U40F-03730	Cubhu	**C**	M	**C**			**C**
U40F-03769	Hlimbitwa	**C**	M	**C**			**C**
U40F-03790	Nseleni	**B/C**	M	**B/C**			**B/C**
U40F-03806	Hlimbitwa	**B**	M	**B**			**B**
U40G-03843	Hlimbitwa	**B**	H	**B**			**B**
U40H-04091	Pambela	**B/C**	H	**B**	Reinstate riparian zone.	Yes	**B/C**
U40H-04117	Nsuze	**B/C**	H	**B**	Reinstate riparian zone.	Yes	**B/C**
U40H-04133	Nsuze	**B/C**	H	**B**	Reinstate riparian zone, erosion control.	Yes	**B/C**

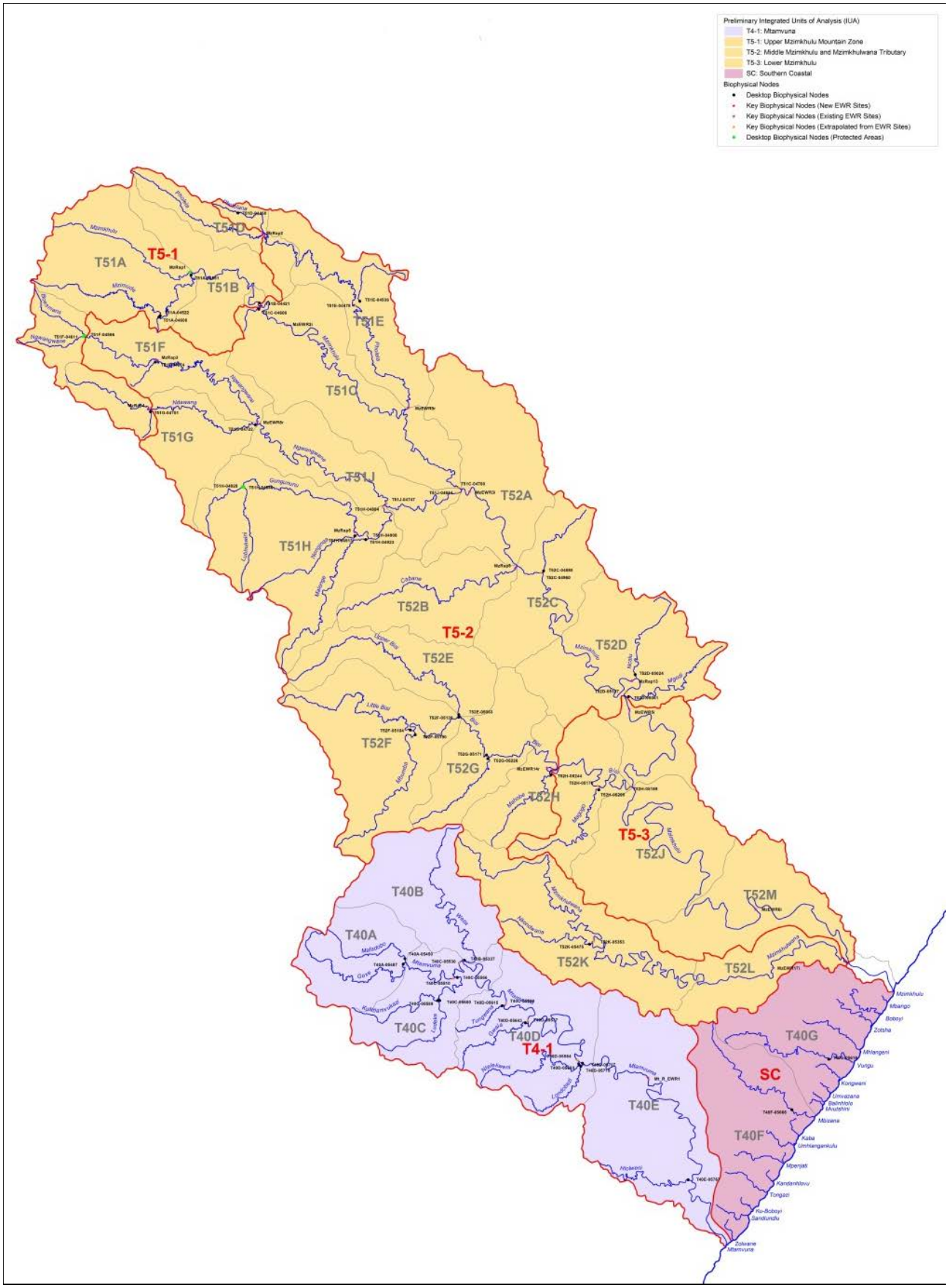

Figure 2.1 Desktop biophysical nodes located in T4 (Mtamvuna), T5 (Umzimkulu) and Mtwalume) and the Southern Coastal (SC)

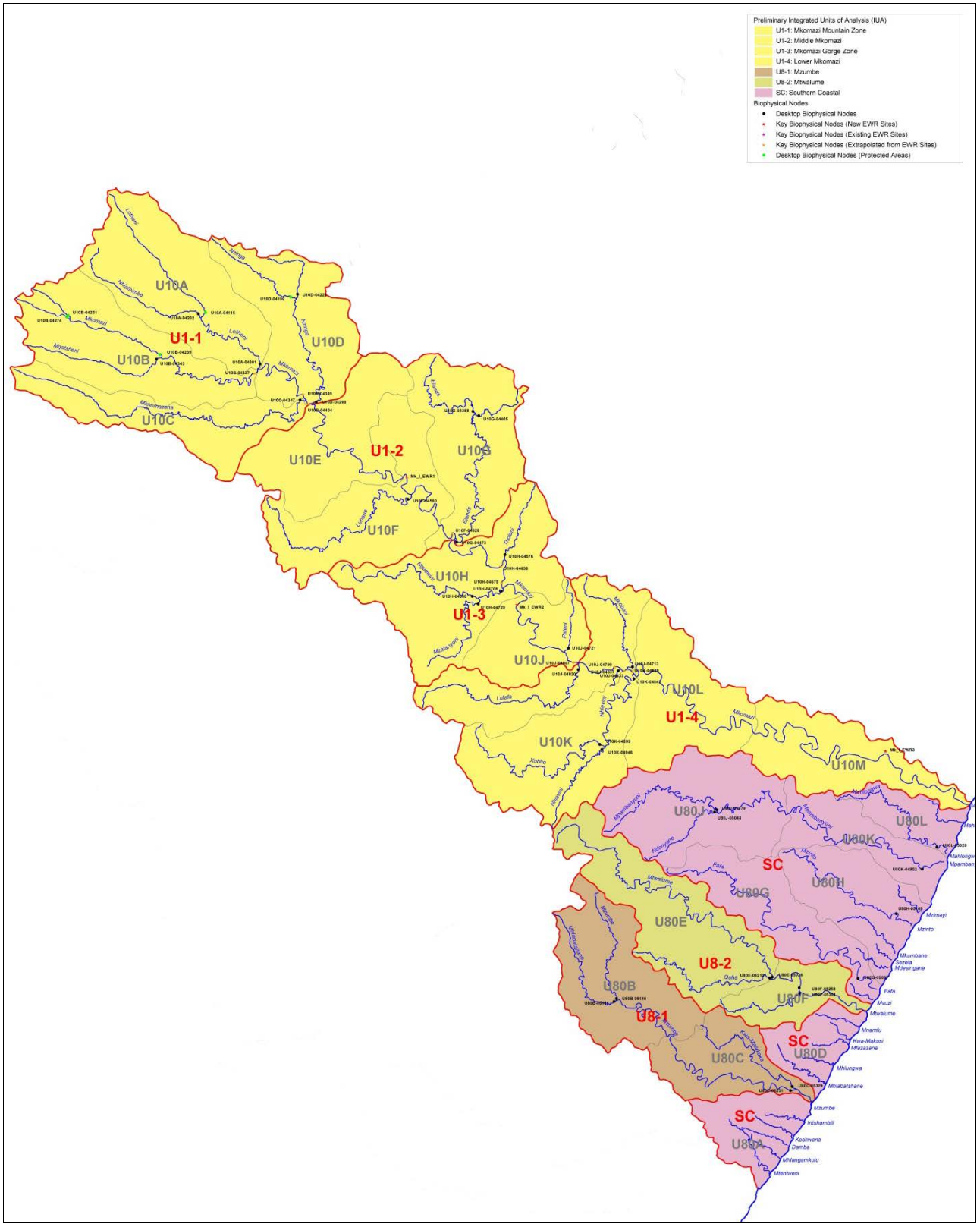

Figure 2.2 Desktop biophysical nodes located in U1 (Mkomazi), U8 (Mzumbe and Mtwalume) and the Southern Coastal (SC)

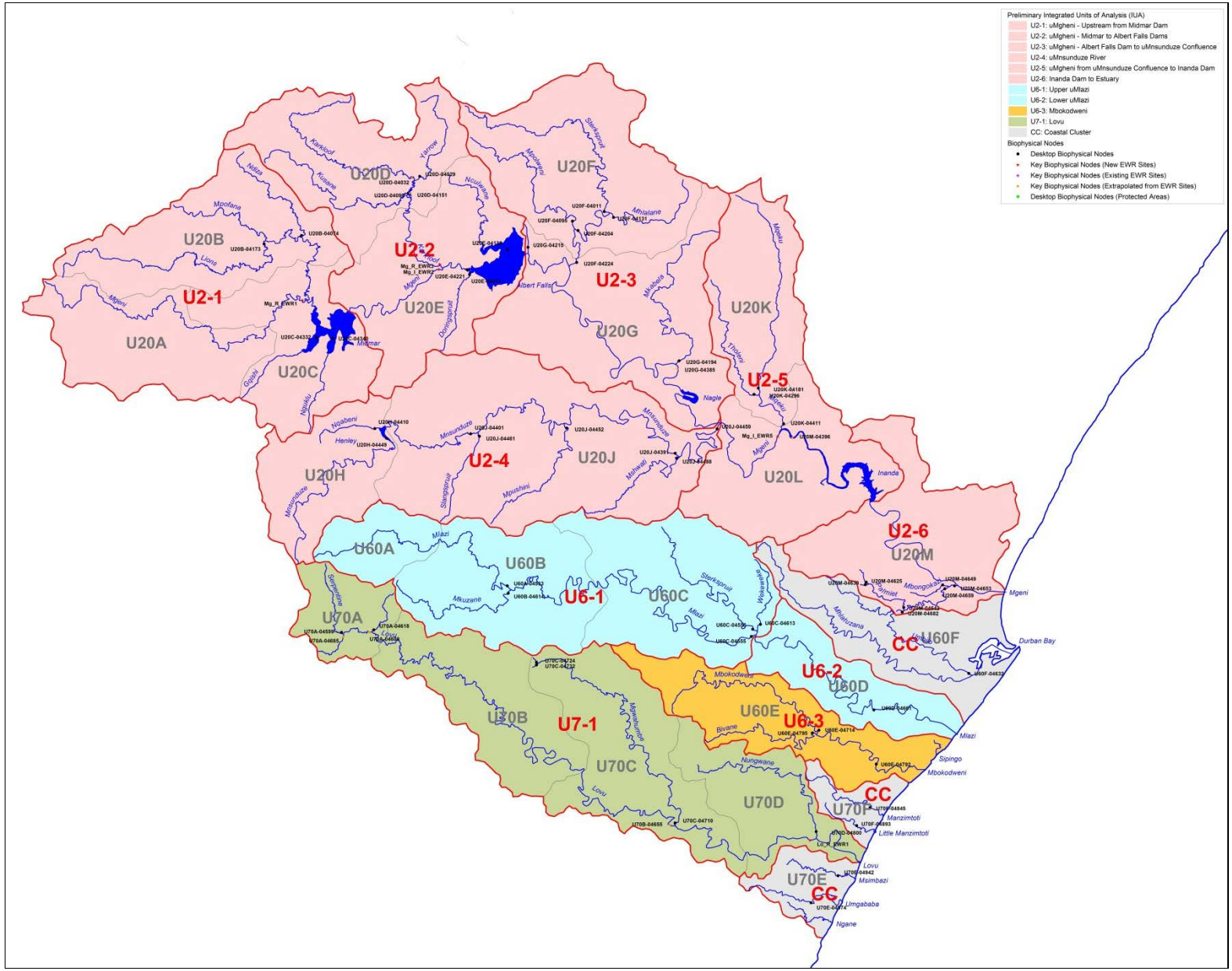

Figure 2.3 Desktop biophysical nodes located in U2 (uMngeni), U7 (Lovu) and U6 (Mlazi) and the Coastal Cluster (CC)

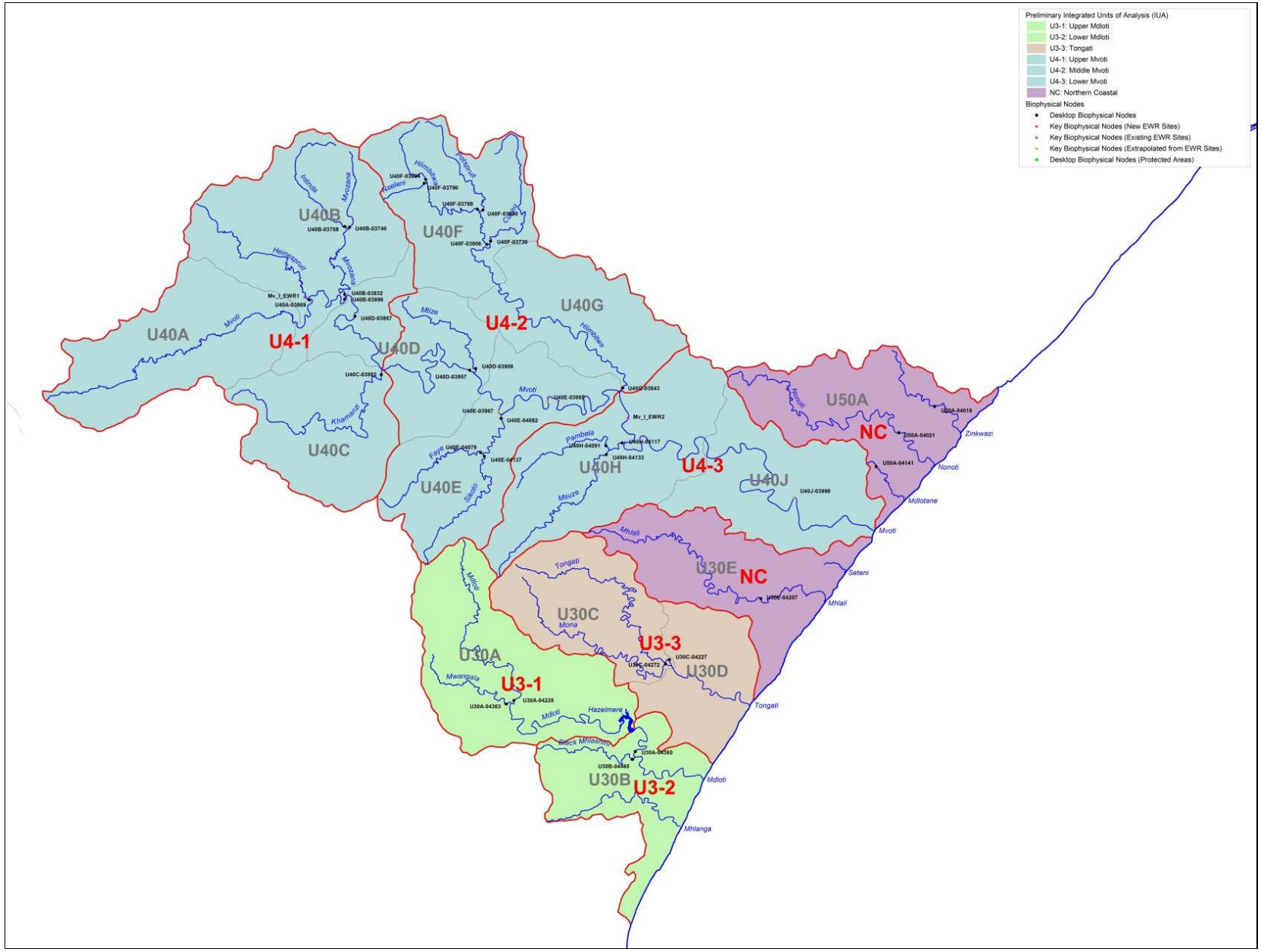

Figure 2.4 Desktop biophysical nodes located in U3 (Mdloti), U4 (Mvoti) and U5 (Nonoti), and the Northern Coastal Cluster (NCC)

3 DESKTOP BIOPHYSICAL NODES: EWR ESTIMATION AND RESULTS

3.1 BACKGROUND

The Desktop Reserve Model (DRM) of Hughes and Hunnart (2003) has been extensively used over the last decade for estimating Ecological Water Requirements (EWR) in this and other countries. The estimation of EWRs in this study makes use of the Revised Desktop Reserve Model (RDRM), that more explicitly includes the links and relationships between hydrology, hydraulics and ecological response. The RDRM was developed within a Water Research Commission (WRC) project, documented by Hughes *et al*. (2012), with more recent updates (Hughes *et al*., 2014).

3.2 APPROACH

3.2.1 Biophysical nodes and associated information provided

The SQ catchments requiring Desktop EWR assessments were provided by Rivers for Africa, together with the PES and REC. So-called 'biophysical nodes' are located at the SQ catchment outlets andare labelled according to their quaternary and NFEPA[1] codes. Of the 158 nodes requiring Desktop EWRs, 12 nodes[2] have an improved REC relative to the PES.

3.2.2 SPATSIM setup

THE RDRM runs within the Spatial and Time Series Information Modelling (SPATSIM) software. A new SPATSIM application was setup for the study area (which includes the catchments between (and inclusive of) the Mvoti and Umzimkulu Rivers), with Geographical Information System (GIS) coverages for the SQ catchments, rivers, major dams, biophysical nodes, and Rapid III sites (refer to Figure 3.1). **Detail in Figure 3.1 is as follows:**

- Mvoti catchment = blue
- uMngeni catchment = red
- Lovu catchment = grey
- Mkomazi catchment = yellow
- Umzimkulu catchment = green
- Mtamvuna catchment = orange
- Biophysical nodes = red
- Rapid III sites = green.
- The SQ catchments associated with biophysical nodes (requiring Desktop EWRs) are outlined darker, and nodes are located at catchment outlets[3].

The RDRM application setup is readily transferable to other computers running SPATSIM.

1National Freshwater Ecosystem Priority Areas Project (http://bgis.sanbi.org/nfepa/project.asp). The numerical NFEPA codes are unique to each SQ at a national level.

2T40A-05450, T51A-04551, T51D-04460, T52D-05024, T52D-05061, U10G-04388, U10G-04473, U10H-04729, U60E-04714, U80G-05097, U80H-05109, U80J-05043.

3Upstream of estuaries for rivers discharging into the sea.

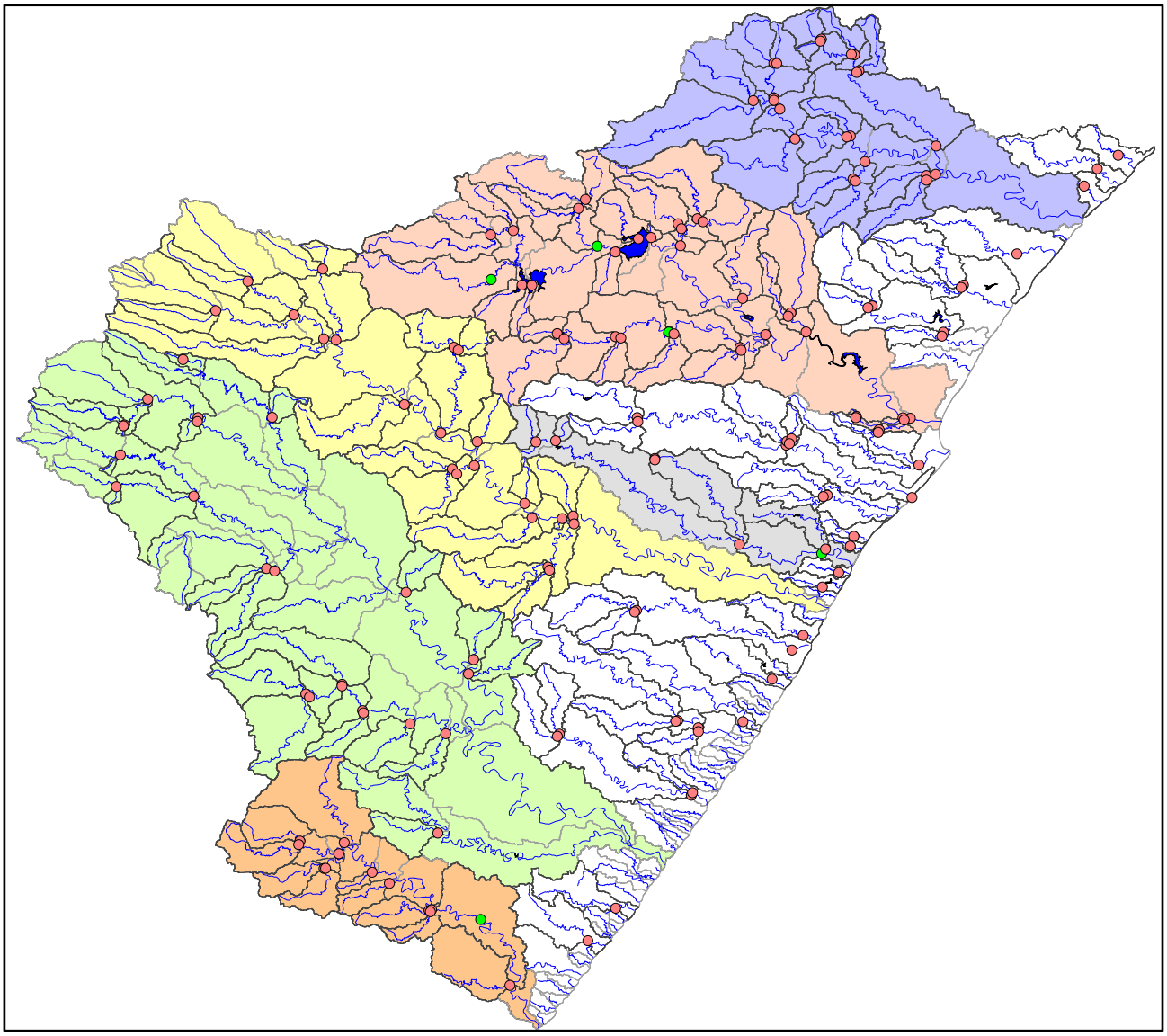

Figure 3.1 The Mvoti to MzimkhuluClassification Project visual setup in SPATSIM

3.2.3 Data requirements and assessment

The RDRM, run as a Desktop Application[4], has the following minimum data requirements:

- Hydrology[5]
  - Timeseries of monthly natural flows.
  - Baseflow separation parameters (refer to Hughes *et al*., 2002).
  - Percentage point on the low flow-temporal exceedance for the maximum low flow.
- Hydraulics
  - Flood region.
  - Valley slope.
  - Geomorphological zone (Gz).
  - Catchment area.

4It can also be applied at higher levels of Reserve determination (e.g. Rapid III, Intermediate and Comprehensive), with the use of additional information, such as, for example, surveyed cross-sectional river profiles and modelled rating relationships.
5Provided by WRP Consulting Engineers; hydrological record periods vary for different catchments.

- Ecology
  - Seasonal perenniality, viz. whether the EWR should have wet, wet and dry, or neither seasons perennial.
  - The stress index value (in the range 0 to 10) corresponding to the threshold discharge for the onset of fast flows (i.e. velocities ≥ 0.3 m/s).
  - The relative weighting of stress index-discharges for three velocity-depth classes (viz. fast-shallow, fast-intermediate, and fast-deep flows - refer to Table 3.1).

Default parameter values were used for the following variables:

- Hydrology
  - Percentage point (20%) on the low flow-temporal exceedance.
  - Regionalised baseflow separation parameters.
  - The (three) high flow EWR parameters.
- Ecology
  - The low and high flow stress index shifts (from natural) for the four ecological categories (A to D).

In addition to the monthly natural flows, timeseries of Present Day flows were also modelled and provided (refer to Footnote 5). The remaining parameters required for Desktop assessment were determined as follows:

- Hydraulics
  - Valley slopes were determined using the Shuttle Remote Topography Mission[6] (SRTM) 90m Digital Elevation Model (DEM). The 1:500,000 rivers coverage published by the DWA[7]was re-digitised for the study area using the SRTM DEM. The reason for this is to ensure that the rivers coverage corresponds to the lowest elevations in the underlying DEM, which is in-turn used to provide elevations for vertices along the river lines, and hence valley slopes. The SRTM DEM was pre-processed[8] and drainage lines (corresponding in position to the 1:500,000 DWA rivers coverage) were digitised for the SQs requiring Desktop EWR estimation. Valley slopes were computed[9] for the rivers coverage, and due to the resolution of the underlying DEM, average slopes[10] were computed upstream of the SQ catchment outlets.
  - The classified GZs at a national level are derived directly from valley slopes, and are subject to the resolution issues associated with the 1:500,000 rivers coverage-DEM, discussed above. The GZs corresponding to the 2km-averaged valley slopes (at the SQ catchment outlets) were determined using the gradient-Gz classification of Rountree and Wadeson (1999)[11].
  - Catchment areas were provided by WRP Consulting Engineers.
- Ecology
  - For each of the SQ catchments (requiring EWR estimates), the fish species present (from the results of the national PES (11) (DWA, 2013b)) were classified[12] into the presence or

6http://www2.jpl.nasa.gov/srtm/.

7 http://www.dwaf.gov.za/iwqs/gis_data/.

8Sinks filled and/or channels deepened.

9At the (approximately) 90 to 127 m spatial coverage of the SRTM DEM.

10Over 2 km; artificially impounded water bodies and estuarieswere excluded from the average slope calculations, using the DWA (major) dams coverage which was verified and refined (particularly for smaller dams) using Google Earth imagery.

11This results in GZs in the hydraulic component of the RDRM that are compatible with the valley slopes from which they are derived, and no corrections are necessary.

12By Dr P. Kotze and Dr A. Deacon.

absence of six broad guilds which differ in size (small or large) and their preference for fast-flowing water (i.e. Rheophiles, Semi-rheophiles and Limnophiles)[13]. This was also carried out for the macro-invertebrates using two broad groups: presence/absence of taxa that are either flow-dependent or of "medium" flow-dependence. Stress-index parameter values required in the RDRM were then determined as a function of the six broad fish guilds and the flow-dependent nature of macro-invertebrate taxa, and are presented in Table 3.1 below.

- The need for seasonal perenniality can be inferred from the presence/absence of the fish guilds in Table 3.1. For example, if Rheophilics are present, both (wet and dry) seasons must be perennial; for semi-rheophilics, the wet season needs be perennial; and Limnophilics do not require either season to be perennial.

Table 3.1 Stress-index parameter values for fish guilds used in the RDRM

Fish guild and macro-invertebrate group	Wet season[1] stress-index				Dry season[1] stress-index			
	Fast threshold	Relative weight			Fast threshold	Relative weight		
		FS	FI	FD		FS	FI	FD
LR[2] or FDI[3]	9	4	7	9	9	2	5	7
SR[4] or FDI	9	3	5	8	9	1	3	5
LSR[5] and FDI	9	2	3	4	9	1	2	5
SSR[6] and FDI	9	2	3	4	9	1	2	5
LL[7] and FDI	9	1	2	3	9	1	2	3
SL[8] and FDI	9	1	2	3	9	1	2	3
LSR or MFDI[9]	9	1	2	2	5	1	2	2
SSR or MFDI[9]	9	2	2	1	5	2	2	1
LL and MFDI[9]	5	1	1	1	1	1	1	1
SL and MFDI[9]	5	1	1	1	1	1	1	1
None or only limnophilic fish[10]	4	1	1	1	1	1	1	1

1 Critical period (i.e. month) 2 Large Rheophilics
3 Flow-Dependent Invertebrates 4 Small Rheophilics
5 Large Semi-Rheophilics 6 Small Semi-Rheophilics
7 Large Limnophilics 8 Small Limnophilics
9 Medium Flow-Dependent Invertebrates (no FDI)
10 No FDI or MDI
Fast: velocity ≥ 0.3m/s; Shallow: Depth < 0.1m; Intermediate: 0.1 ≤ Depth ≤ 0.3m;
Deep: Depth > 0.3m; FS: Fast Shallow; FI: Fast Intermediate; FD: Fast Deep

3.2.4 Modelling

Generally, for all biophysical nodes assessed, the EWR requirements were constrained to PD flows. Exceptions, however, are where the REC is higher than the PES (due to improvements in the existing hydrological flow regime), and secondly where there is a disparity between the (hydrologically) modelled perenniality and that inferred from the fish preference for flowing water. For the latter, given that this is a Desktop assessment a conservative approach was adopted where perenniality is included[14] in the EWRs to maintain the flow-dependent nature of the expected fish assemblages (and macro-invertebrate taxa). Of the 158 nodes addressed, such inconsistencies accounted for 9 nodes.

13 A rheophile is an organism that requires fast-flowing water, whereas limnophiles do not.
14Albeit at low discharges (high stress values).

For 17 of the nodes[15] the RDRM could not be used, and the DRM was applied, with theEWRs constrained to PD flows, if appropriate (i.e. REC=PES). The reasons for this were either:

- If the discharge at which fast flows commence (*i.e.* velocity > 0.3 m/s) exceeds the maximum baseflow, then no stress-discharge curve is constructed. This reduces the low flow EWRs to zero for all the minimum low flow months in the EWR timeseries, irrespective of natural conditions. This is a somewhat severe condition that requires consideration for possible refinement[16].
- There were sharp inflection points in the (modelled) stress-discharge curves that carried through to the discharge-duration curves. **Whether this is reasonable or not requires attention for possible refinement of the RDRM.**

For six of the SQs (refer to Figure 3.1) no Desktop EWRs are provided since the catchment areas (source catchments) are small, and they are unsuitable for a desktop assessment[17].

3.3 RESULTS

The EWR results are provided in the following formats as text files named according to the biophysical node:

- Timeseries of average monthly EWR flows (in $10^6 m^3$).
- Assurance rules for EWR low flows and total flows (in 10^6 m^3).
- RDRM generated reports[18].

A summary of low and high flow EWR requirements, including the naturalised and Present Day (PD) Mean Annual Runoff (MAR) is provided in Table 3.2.

15 T51A-04608, T51G-04751, T51C-04606, T51D-04460, T51F-04674, U10G-04473, U10H-04576, U10H-04666, U10H-04708, U10H-04729, U10J-04820, U10J-04837, U20G-04215, U20K-04296, U20M-04649
U40F-03790, U70F-04893.

16Since the ecological low flow component of the RDRM needs to be extended to include the requirements of biota not dependant on fast flow characteristics.

17 Small flows that are tooinaccurate at this resolution.

18Not relevant for the DRM.

Table 3.2 Summary of Desktop EWRs for the biophysical nodes in the Mvoti to Umzimkhulu study area

(na: Small SQ catchment areas and hence insufficient resolution for desktop analysis.)

IUA	SQ node	River name	MAR (10^6 m^3)		REC	Long-term requirements				Desktop method
			Natural	PD		Low flows		Total flows		
						10^6 m^3	MAR	10^6 m^3	MAR	
IUA T4: Mtamvuna										
T4	T40A-05450	Mafadobo	27.58	26.23	B/C	6.22	22.5%	8.79	31.9%	RDRM
T4	T40A-05487	Goxe	30.01	28.42	B/C	6.39	21.3%	9.19	30.6%	RDRM
T4	T40B-05337	Weza	74.47	52.56	C	13.94	18.7%	20.37	27.4%	RDRM
T4	T40C-05566	Ludeke	28.72	28.14	B	7.56	26.3%	10.41	36.2%	RDRM
T4	T40C-05589	KuNtlamvukazi	12.22	11.94	B	3.55	29.1%	4.78	39.1%	RDRM
T4	T40C-05600	Ludeke	14.10	13.64	B	4.18	29.7%	5.57	39.5%	RDRM
T4	T40D-05615	Tungwana	2.23	2.04	B	0.65	29.3%	0.90	40.4%	RDRM
T4	T40D-05643	Gwala	5.62	5.29	B	1.55	27.7%	2.17	38.7%	RDRM
T4	T40D-05683	Ntelekweni	8.91	8.55	B/C	2.04	22.9%	2.94	33.0%	RDRM
T4	T40D-05707	Mtamvuna	213.74	182.12	C	40.16	18.8%	58.61	27.4%	RDRM
T4	T40D-05719	Londobezi	4.62	4.48	B	1.23	26.7%	1.75	37.9%	RDRM
T4	T40E-05767	Hlolweni	22.55	22.25	B/C	4.38	19.4%	6.99	31.0%	RDRM
T4	T40F-05666	Mbizana	34.99	34.26	B	6.43	18.4%	11.06	31.6%	RDRM
T4	T40G-05616	Vungu	23.15	23.13	B/C	4.52	19.5%	7.18	31.0%	RDRM
IUAT5: Umzimhkulu										
T5-1	T51A-04522	Mzimude	43.18	40.76	B	6.09	14.1%	11.20	25.9%	RDRM
T5-1	T51A-04551	Mzimude	58.78	54.27	B	10.08	17.1%	17.07	29.0%	RDRM
T5-1	T51A-04608[1]		1.57	1.55	B	0.24	15.5%	0.41	26.0%	DRM
T5-1	T51B-04421	Mzimkhulu	246.19	224.32	B	37.34	15.2%	65.33	26.5%	RDRM
T5-1	T51G-04751		2.99	2.46	B	0.48	15.9%	0.80	26.6%	DRM
T5-2	T51C-04606		3.77	2.45	C	0.36	9.6%	0.68	18.0%	DRM
T5-2	T51D-04460	Pholelana	3.03	2.88	B	0.58	19.2%	0.87	28.8%	DRM
T5-2	T51E-04536		8.65	6.85	C	1.31	15.1%	1.98	22.9%	RDRM
T5-2	T51F-04674		2.84	1.69	C	0.23	8.1%	0.49	17.1%	DRM
T5-2	T51G-04722	Ndawana	91.05	81.32	C	11.27	12.4%	20.66	22.7%	RDRM
T5-2	T51H-04913	Nonginqa	16.70	13.33	B/C	2.44	14.6%	4.06	24.3%	RDRM
T5-2	T51H-04923	Malenge	27.16	24.27	B/C	3.13	11.5%	5.72	21.1%	RDRM
T5-2	T52C-04880		12.65	6.97	C	1.46	11.5%	2.65	20.9%	RDRM
T5-2	T52D-05024	Ncalu	4.45	2.66	C	0.45	10.0%	0.97	21.8%	RDRM
T5-2	T52D-05061	Mgodi	5.41	3.39	C	0.51	9.3%	1.14	21.0%	RDRM
T5-2	T52E-05053	Upper Bisi	55.53	43.71	B/C	11.11	20.0%	16.35	29.4%	RDRM
T5-2	T52F-05104	Little Bisi	34.29	22.80	C	5.41	15.8%	8.46	24.7%	RDRM
T5-2	T52F-05139	Little Bisi	96.08	71.82	B	21.98	22.9%	31.72	33.0%	RDRM
T5-2	T52F-05190	Mbumba	47.30	35.24	B/C	9.38	19.8%	13.90	29.4%	RDRM
T5-2	T52G-05171	Bisi	171.17	131.38	B	36.47	21.3%	53.63	31.3%	RDRM
T5-2	T52G-05226	uMbumbane	19.21	16.92	B/C	3.32	17.3%	5.16	26.9%	RDRM
T5-2	T52H-05244	Mahobe	9.42	8.89	B/C	1.05	11.2%	2.17	23.0%	RDRM
T5-2	T52K-05475	Nkondwana	6.51	4.21	B/C	0.90	13.8%	1.46	22.4%	RDRM
T5-3	T52H-05295	Magogo	5.85	4.79	B	0.95	16.2%	1.56	26.7%	RDRM
IUA U1:Mkomazi										
U1-1	U10A-04202	Nhlathimbe	43.52	43.62	B	8.33	19.1%	12.73	29.3%	RDRM
U1-1	U10A-04301	Lotheni	208.88	208.16	B	41.22	19.7%	62.34	29.8%	RDRM
U1-1	U10B-04343	Mqatsheni	37.30	36.35	B	7.57	20.3%	11.34	30.4%	RDRM
U1-1	U10C-04347	Mkhomazana	96.05	91.71	B	18.79	19.6%	28.51	29.7%	RDRM

IUA	SQ node	River name	MAR (10^6 m^3)		REC	Long-term requirements				Desktop method
			Natural	PD		Low flows		Total flows		
						10^6 m^3	MAR	10^6 m^3	MAR	
U1-1	U10D-04222	Rooidraai	13.35	12.93	B	2.70	20.2%	4.05	30.4%	RDRM
U1-1	U10D-04298	Nzinga	82.42	80.42	B/C	12.58	15.3%	20.34	24.7%	RDRM
U1-2	U10F-04560	Luhane	36.30	33.08	B/C	5.84	16.1%	9.54	26.3%	RDRM
U1-2	U10G-04388	Elands	18.87	16.63	B/C	3.38	17.9%	5.29	28.0%	RDRM
U1-2	U10G-04405		8.66	6.94	C	1.52	17.5%	2.32	26.8%	RDRM
U1-2	U10G-04473	Elands	67.14	59.47	B	12.88	19.2%	20.51	30.5%	DRM
U1-3	U10H-04576	Tholeni	14.07	10.69	B	2.57	18.3%	4.15	29.5%	DRM
U1-3	U10H-04666	Ngudwini	20.35	13.15	B/C	2.48	12.2%	4.57	22.5%	DRM
U1-3	U10H-04708	Ngudwini	47.21	35.64	B	7.02	14.9%	12.40	26.3%	DRM
U1-3	U10H-04729	Mzalanyoni	22.98	19.63	B	4.40	19.1%	7.01	30.5%	DRM
U1-3	U10J-04721	Pateni	6.23	4.01	B	1.43	22.9%	2.13	34.3%	RDRM
U1-4	U10J-04713	Mkobeni	13.90	11.70	C	2.00	14.4%	3.30	23.8%	RDRM
U1-4	U10J-04820	Lufafa	26.09	21.53	B/C	4.26	16.3%	6.94	26.6%	DRM
U1-4	U10J-04837		0.39	0.32	A/B	0.06	16.1%	0.10	26.6%	DRM
U1-4	U10K-04842	Nhlavini	40.18	28.98	B	6.19	15.4%	10.48	26.1%	RDRM
U1-4	U10K-04899	Xobho	19.09	11.81	C/D	2.05	10.7%	3.61	18.9%	RDRM
U1-4	U10K-04946	Nhlavini	6.65	4.49	B/C	0.99	14.8%	1.65	24.8%	RDRM
IUA U2: uMngeni										
U2-1	U20B-04074	Ndiza	12.27	10.86	B/C	2.73	22.2%	3.89	31.7%	RDRM
U2-1	U20B-04173	Lions	39.85	34.29	C	6.64	16.6%	10.11	25.4%	RDRM
U2-1	U20C-04332	Gqishi	15.90	12.94	B/C	3.48	21.9%	4.91	30.9%	RDRM
U2-1	U20C-04340	Nguklu	7.02	5.88	C	1.35	19.3%	1.94	27.7%	RDRM
U2-2	U20D-04029	Yarrow	11.56	7.81	B/C	2.02	17.5%	3.18	27.5%	RDRM
U2-2	U20D-04098	Kusane	16.85	12.50	D	2.28	13.5%	3.48	20.7%	RDRM
U2-2	U20E-04136	Nculwane	14.19	10.73	C	1.88	13.3%	3.19	22.5%	RDRM
U2-2	U20E-04271	DoringSpruit	8.12	6.53	B/C	1.60	19.7%	2.36	29.1%	RDRM
U2-2	U20F-04011	Sterkspruit	30.34	13.44	C/D	3.33	11.0%	5.61	18.5%	RDRM
U2-3	U20F-04095	Mpolweni	17.59	7.76	C/D	1.44	8.2%	2.83	16.1%	RDRM
U2-3	U20F-04131	Mhlalane	14.48	6.31	C/D	1.52	10.5%	2.59	17.9%	RDRM
U2-3	U20F-04204	Sterkspruit	48.79	22.41	B/C	5.67	11.6%	9.61	19.7%	RDRM
U2-3	U20F-04224	Mpolweni	70.74	33.64	B/C	9.85	13.9%	15.43	21.8%	RDRM
U2-3	U20G-04194	Mkabela	19.91	16.79	C/D	1.60	8.0%	3.40	17.1%	RDRM
U2-3	U20G-04215	Cramond Stream	0.82	0.69	B/C	0.09	11.2%	0.17	21.0%	DRM
U2-4	U20H-04410	Nqabeni	5.54	5.54	C	0.93	16.8%	1.39	25.1%	RDRM
U2-4	U20H-04449	uMnsunduze	32.22	32.22	C	4.85	15.0%	7.51	23.3%	RDRM
U2-4	U20J-04391	uMnsunduze	85.31	101.52	C	14.78	17.3%	22.52	26.4%	RDRM
U2-4	U20J-04401	uMnsunduze	48.70	48.41	D	5.27	10.8%	8.91	18.3%	RDRM
U2-4	U20J-04452	Mpushini	6.76	5.40	B/C	1.43	21.2%	2.08	30.7%	RDRM
U2-4	U20J-04459	uMnsunduze	94.72	109.39	C	16.51	17.4%	25.26	26.7%	RDRM
U2-4	U20J-04461	Slang Spruit	3.98	3.85	C/D	0.58	14.5%	0.91	22.8%	RDRM
U2-4	U20J-04488	Mshwati	7.25	5.90	B/C	1.58	21.8%	2.27	31.3%	RDRM
U2-5	U20K-04181	Mqeku	19.52	17.67	C	4.03	20.7%	5.76	29.5%	RDRM
U2-5	U20K-04296	Tholeni	4.14	3.76	C	0.59	14.1%	0.93	22.4%	DRM
U2-5	U20K-04411	Mqeku	26.24	23.76	B/C	5.29	20.1%	7.78	29.6%	RDRM
U2-6	U20M-04625		0.32	0.32	D	na	na	na	na	
U2-6	U20M-04639	Palmiet	0.12	0.12	D	na	na	na	na	
U2-6	U20M-04642	Palmiet	1.60	1.60	D	0.24	15.1%	0.39	24.2%	RDRM
U2-6	U20M-04649	Mbongokazi	0.78	0.78	C	0.08	10.5%	0.15	19.5%	DRM
U2-6	U20M-04653	Palmiet	3.87	3.87	C/D	0.49	12.8%	0.87	22.4%	RDRM
U2-6	U20M-04659	Palmiet	2.92	2.92	C	0.57	19.6%	0.88	30.1%	RDRM

IUA	SQ node	River name	MAR (10^6 m^3)		REC	Long-term requirements				Desktop method
			Natural	PD		Low flows		Total flows		
						10^6 m^3	MAR	10^6 m^3	MAR	
U2-6	U20M-04682		0.11	0.11	C/D	na	na	na	na	
IUA U3: Mdloti										
U3-1	U30A-04228	Mdloti	29.78	29.00	B/C	4.97	16.7%	8.42	28.3%	RDRM
U3-1	U30A-04360	Mdloti	73.88	61.40	D	6.40	8.7%	12.66	17.1%	RDRM
U3-1	U30A-04363	Mwangala	10.61	10.32	B/C	1.87	17.6%	3.10	29.2%	RDRM
U3-2	U30B-04465	Black Mhlashini	5.48	5.39	B/C	1.01	18.5%	1.63	29.7%	RDRM
U3-3	U30C-04227	Tongati	23.77	23.34	B/C	2.72	11.4%	5.36	22.6%	RDRM
U3-3	U30C-04272	Mona	17.14	16.82	B/C	1.95	11.4%	3.88	22.6%	RDRM
U3-NC	U30E-04207	Mhlali	33.23	31.95	C	4.58	13.8%	8.52	25.6%	RDRM
IUA U4: Mdloti										
U4-1	U40A-03869	Mvoti	52.13	26.65	B/C	10.06	19.3%	13.75	26.4%	RDRM
U4-1	U40B-03708	Intinda	8.18	2.34	C	0.54	6.6%	1.24	15.2%	RDRM
U4-1	U40B-03740	Mvozana	4.67	1.24	C	0.27	5.8%	0.68	14.5%	RDRM
U4-1	U40B-03832	Mvozana	22.36	6.12	C/D	1.74	7.8%	2.62	11.7%	RDRM
U4-1	U40B-03896	Mvoti	70.94	34.75	C	9.42	13.3%	14.86	21.0%	RDRM
U4-1	U40C-03982	Khamanzi	31.97	15.52	B/C	5.02	15.7%	7.59	23.7%	RDRM
U4-1	U40D-03867	Mvoti	31.97	15.52	B/C	15.03	15.6%	21.54	22.3%	RDRM
U4-2	U40D-03908	Mtize	7.64	7.34	B	1.57	20.5%	2.46	32.2%	RDRM
U4-2	U40D-03957	Mvoti	146.04	72.67	B	28.38	19.4%	39.67	27.2%	RDRM
U4-2	U40E-04079	Faye	13.35	10.73	B	2.25	16.9%	3.81	28.5%	RDRM
U4-2	U40E-04082	Sikoto	32.17	25.86	B	5.84	18.2%	9.57	29.8%	RDRM
U4-2	U40E-04137	Sikoto	15.38	12.36	B	2.89	18.8%	4.66	30.3%	RDRM
U4-2	U40F-03690	Potspruit	4.65	1.52	C	0.85	18.3%	1.04	22.3%	RDRM
U4-2	U40F-03694	Hlimbitwa	5.14	1.72	C	0.75	14.5%	0.99	19.2%	RDRM
U4-2	U40F-03730	Cubhu	4.88	1.60	C	0.70	14.3%	0.95	19.5%	RDRM
U4-2	U40F-03769	Hlimbitwa	11.00	3.88	C	1.82	16.6%	2.41	21.9%	RDRM
U4-2	U40F-03790	Nseleni	1.27	0.67	B/C	0.21	16.8%	0.33	25.7%	DRM
U4-2	U40F-03806	Hlimbitwa	17.89	6.55	B	3.71	20.7%	4.44	24.8%	RDRM
U4-2	U40G-03843	Hlimbitwa	64.60	51.33	B	13.30	20.6%	20.34	31.5%	RDRM
U4-3	U40H-04091	Pambela	13.18	13.19	B/C	2.05	15.6%	3.43	26.0%	RDRM
U4-3	U40H-04117	Nsuze	29.78	29.78	B/C	5.04	16.9%	8.22	27.6%	RDRM
U4-3	U40H-04133	Nsuze	15.70	15.69	B/C	2.66	17.0%	4.34	27.6%	RDRM
IUA U5: NCC										
U5	U50A-04018	Zinkwazi	10.99	10.74	B/C	2.62	23.8%	3.95	35.9%	RDRM
U5	U50A-04021	Nonoti	30.19	25.95	B/C	3.66	12.0%	7.31	23.9%	RDRM
U5	U50A-04141	Mdlotane	0.18	0.17	B/C	na	na	na	na	
IUA U6: Mlazi										
U6-1	U60A-04533	uMlazi	33.14	19.16	C	5.44	16.4%	7.95	23.9%	RDRM
U6-1	U60B-04614	Mkuzane	8.41	3.05	C/D	1.54	18.1%	1.86	21.9%	RDRM
U6-1	U60C-04555	uMlazi	76.13	38.76	C/D	12.29	16.2%	17.32	22.8%	RDRM
U6-1	U60C-04556	Sterkspruit	9.54	8.72	D	1.50	16.1%	2.25	24.2%	RDRM
U6-1	U60C-04613	Wekeweke	1.83	1.05	C	0.20	11.1%	0.38	21.1%	RDRM
U6-2	U60D-04661	uMlazi	102.21	65.23	C/D	17.19	16.9%	25.13	24.7%	RDRM
U6-3	U60E-04714	Mbokodweni	16.83	15.67	B/C	2.97	17.6%	4.81	28.6%	RDRM
U6-3	U60E-04792	Mbokodweni	26.15	24.32	C	4.40	16.8%	7.04	26.9%	RDRM
U6-3	U60E-04795	Bivane	6.56	6.08	B/C	1.17	17.8%	1.89	28.8%	RDRM
U6-3	U60F-04632	Umbilo	12.68	19.43	D	1.82	14.4%	2.90	22.9%	RDRM
IUA U7: Lovu										

IUA	SQ node	River name	MAR (10^6 m^3)		REC	Long-term requirements				Desktop method
			Natural	PD		Low flows		Total flows		
						10^6 m^3	MAR	10^6 m^3	MAR	
U7-1	U70A-04599	Serpentine	10.43	6.04	C	1.68	16.1%	2.57	24.6%	RDRM
U7-1	U70A-04618		3.46	2.16	C	0.59	17.1%	0.89	25.8%	RDRM
U7-1	U70C-04710	Mgwahumbe	22.20	20.19	C	5.28	23.8%	7.35	33.1%	RDRM
U7-1	U70C-04724		0.09	0.07	C	na	na	na	na	
U7-1	U70C-04732		0.05	0.04	C	na	na	na	na	
U7-1	U70D-04800	Nungwane	15.16	9.32	B/C	3.28	21.6%	4.34	28.6%	RDRM
U7-SC	U70E-04942	Umsimbazi	7.88	7.73	C	1.38	17.5%	2.10	26.7%	RDRM
U7-SC	U70E-04974	uMgababa	4.98	4.86	C	1.03	20.7%	1.49	29.9%	RDRM
U7-SC	U70F-04845	Manzimtoti	4.74	4.62	C	0.69	14.5%	1.20	25.3%	RDRM
U7-SC	U70F-04893	Little Manzimtoti River	1.44	2.37	C	0.16	11.3%	0.29	20.5%	DRM
IUA U8: Mzumbe and Mtwalume										
U8-1	U80B-05145	Mzumbe	7.85	6.42	B	1.86	23.6%	2.74	34.9%	RDRM
U8-1	U80B-05161	Mhlabatshane	8.78	8.08	B	2.12	24.1%	3.11	35.4%	RDRM
U8-1	U80C-05231	Mzumbe	47.86	44.68	B	10.70	22.4%	16.59	34.7%	RDRM
U8-1	U80C-05329	Kwa-Malukaka	9.40	9.10	B	2.19	23.3%	3.33	35.4%	RDRM
U8-2	U80E-05028	Mtwalume	27.83	18.10	C	3.91	14.1%	6.08	21.9%	RDRM
U8-2	U80E-05212	Quha	11.19	10.64	B	3.01	26.9%	4.30	38.4%	RDRM
U8-2	U80F-05258	Mtwalume	42.59	32.21	B/C	5.88	13.8%	10.27	24.1%	RDRM
U8-2	U80F-05301	uMngeni	7.24	7.14	B/C	1.40	19.3%	2.20	30.4%	RDRM
U8-SC	U80G-05097	Fafa	46.44	38.58	B	8.76	18.9%	14.02	30.2%	RDRM
U8-SC	U80H-05109	Mzinto	22.90	19.89	C	3.17	13.9%	5.75	25.1%	RDRM
U8-SC	U80J-04979	Mpambanyoni	12.62	10.21	B	3.09	24.5%	4.55	36.1%	RDRM
U8-SC	U80J-05043	Ndonyane	6.52	5.67	B	1.29	19.7%	2.04	31.3%	RDRM
U8-SC	U80K-04952	Mpambanyoni	57.96	53.11	C	5.79	10.0%	11.72	20.2%	RDRM
U8-SC	U80L-05020	aMahlongwa	10.48	10.06	B/C	2.55	24.3%	3.73	35.6%	RDRM

1 Where there is no information provided under River name it means that the river has no name and this cell was therefore left blank.

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5 APPENDIXA: REPORT COMMENTS

Page/ Section	Report statement	Comments	Changes made?	Authorcomment
12 May 2014: Comments from Tovhowani Nyamande				
Table 1.2		"Excluded/Comment" column, what does it entail OR what sites are those?	Yes	
30 May 2014: Comments from MmaphefoThwala				
		General editing comments	Yes, where applicable.	
Table 2.7	U30A-04360	Should there not be an option of ensuring that the selected REC will be able to cater for the needs of the estuary in the long run? Hazelemere dam going to be raised		This would be a scenario that the estuary component would consider, but it is not relevant for the river reach.
Figure 2.1 – 2.4		I have made suggestions for increasing the font size on maps very difficult to read on screen and more so when printed. These maps will be very useful when included in the scenario documents as well.	Yes	The maps will be changed accordingly (A3 size) once the report is finalized and print ready.