water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

RESERVE DETERMINATION STUDIES FOR SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE USUTU/MHLATUZE WATER MANAGEMENT AREA
WP 10544

DEVELOPMENT SCENARIOS

FINAL

OCTOBER 2014

Report No. RDM/WMA6/CON/COMP/0313

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF WATER AND SANITATION

CHIEF DIRECTORATE: WATER ECOSYSTEMS

CONTRACT NO. WP 10544

RESERVE DETERMINATION STUDIES FOR SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE USUTU/MHLATUZE WATER MANAGEMENT AREA

DEVELOPMENT SCENARIOS

FINAL

OCTOBER 2014

This report should be cited as:

Department of Water and Sanitation (DWS), 2014. Chief Directorate – Water Ecosystems: Reserve determination study of selected surface water and groundwater resources in the Usutu/Mhlathuze Water Management Area. Flow Related Development Scenarios. Report produced by Tlou Consulting (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/0313.

Contract Title: Reserve determination studies for selected surface water, groundwater, estuaries and wetlands in the Usutu - Mhlathuze Water Management Area

Report Title Flow Related Development Scenarios

Author T Tlou and W Nyabeze

Revision	Date	Report Status
Draft 1.2	30 April 2014	Draft for internal comment
Draft 2.1	5 May 2014	Draft for internal comment
Draft 2.3	30 May 2014	Draft for external comment
Final draft	17 September 2014	Final draft for external comment
Final	3 October 2014	Final

Consultants: Tlou Consulting (Pty) Ltd

Approved for the Consultants by:

……..

A Singh

Project Leader

Client: Department of Water and Sanitation

Approved for the DWS:

……..

N Mohapi

Chief Director: Water Ecosystems

ACKNOWLEDGEMENTS

This report was prepared by Mr Toriso Tlou with the valuable assistance, guidance and inputs from the following project members.

Project Team members:

C Brown Southern Waters

A Singh Tlou Consulting

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

DWA	Department of Water Affairs
EWR	Ecological Water Requirements
WMA	Water Management Area

GLOSSARY OF TERMS

- ***Ecological Water Requirements*** (EWR) should be used instead of the term Instream Flow Requirements (IFR) for various reasons, including international acceptance of the former term.
- ***Reserve*** refers to the modified EWR where operational limitations and stakeholder consultation are taken into account, also include both ecological and Basic Human Needs (BHN) requirements.
- ***Preliminary Reserve*** refers to Reserve signed off by the Minister or her representative in the absence of the Classification Process having been undertaken in the basin.
- ***Ecological Water Requirement Scenarios*** (EWRS) replaces the term Reserve Scenarios. EWRS is the term to use at all stages through the Reserve process until such time a decision has been made about the Reserve (at which time one of the EWRs will be selected as the Preliminary Reserve).
- ***Operational Scenarios*** refers to scenarios devised on the basis of issues other than ecological, i.e. availability of water, operational constraints in the system, other demands etc.
- ***Ecological Category*** (EC) replaces former terms used, namely: Ecological Reserve Category (ERC), Desired Future State (DFS) and Ecological Management Class (EMC).

1 INTRODUCTION

1.1 Background

Sustainable use of river ecosystems requires that they be managed in an integrated manner taking into account all water use, but with priority given to provision of the Reserve. The determination of the Ecological Water Requirements (EWR) for the different river reaches therefore requires that the needs of other users of the water resources within those river reaches be taken into account. This involves consideration of different scenarios based on the likely future water uses and water-resource developments that may change the flow regime of the river system and therefore impact on river ecosystems and the provision of the Reserve.

Nine EWR sites have been identified for the Usutu – Mhlathuze catchments (eight EWR sites identified on the river systems and one on the Pongola floodplain). Figure 1-1 shows the location of each of the EWR sites relative to quaternary catchments, local and district municipalities. For some EWR sites, the catchment upstream is wholly within one municipality but for others it is shared between two municipalities as shown in Table 1-1 and Figure 1-1. The sites in W42E and W11B are on rivers that form the boundary between two district municipalities. Figure 1-1 shows the locality of the EWR sites within the municipalities.

Five estuaries/lakes have been identified for rapid to intermediate Reserve assessments in the WMA. Table 1-2 provides the level of assessment being undertaken and their location in the WMA.

NOTE: The development scenarios for the estuaries and lakes that form part of the study (i.e, St Lucia, and Amatikulu/Nyoni), will be the same as those for the rivers on which they are situated. However in the case of St Lucia, were there is considerable development downstream of the Black and White Mfolozi EWR sites, these have been taken into consideration and additional scenarios have been prepared. In instances were no River EWR was present (e.g. Mlalazi and Hluhluwe Rivers), scenarios for the river just upstream of the Estuary were developed. Development scenarios were also presented for those systems, in which there is no substantial river inflow (Lake Sibayi & Kosi) and which need to be factored into the groundwater balance.

Table 1-1: Location of EWR sites within municipalities

Site Name	Quaternary	District Municipality	Local Municipality
Assegaai (Usutu) JMBS	W51D	Gert Sibande	Mkhondo
Pongola Upper Reach	W42E	Gert Sibande/Zululand	eDumbe/Mkhondo
Pongola Lower Reach	W43F	Umkhanyakude	Jozini
Mkuze	W31J	Umkhanyakude/ Zululand	Jozini
Black Mfolozi 1	W22A	Zululand	Abaqulusi
Black Mfolozi 2	W22C	Zululand	Nongoma
White Mfolozi	W21H	Zululand	Abaqulusi/Ulundi
Matigulu	W11B	Uthungulu/iLembe	UMlalazi/Mandeni
Nseleni	W12H	Uthungulu	Mfolozi/uMhlathuze

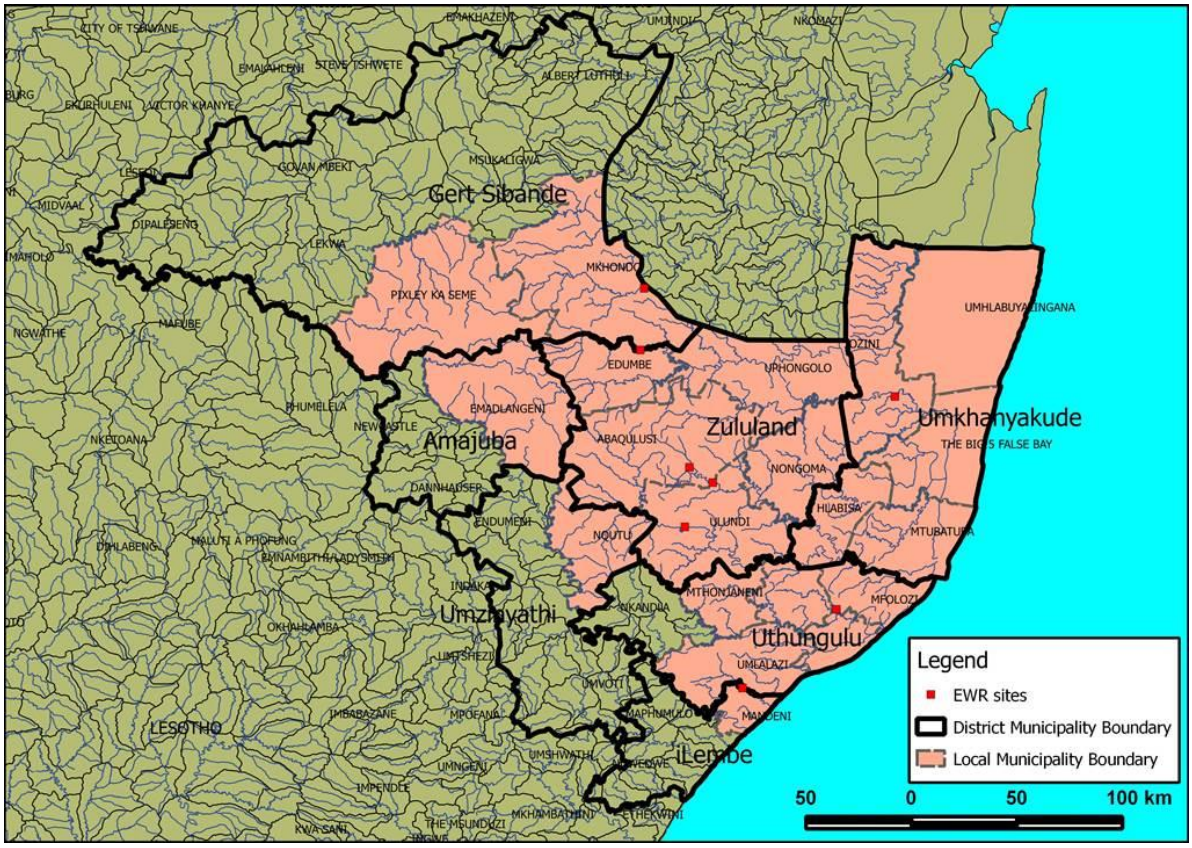

Figure 1-1: Location of EWR Sites within Local Municipalities

Table 1-2. Estuaries and Lakes being assessed

Estuary	Quaternary catchment	Level of Reserve Assessment
Mlalazi	W13B	Rapid
Amatikulu/Nyoni	W11C	Rapid
St Lucia	W32H	Intermediate
Lake Sibayi	W70A	Intermediate
Kosi Lakes and Estuary	W70A	Rapid

1.2 Context

Scenario analysis is the process of evaluating possible future events through consideration of alternative, plausible future states. Within the scenario-planning approach the DRIFT method provides the consequences of the changes in flow associated with water-resource development scenarios for a range of ecosystem components, e.g. biophysical disciplines: hydrology, hydraulics, fluvial geomorphology, sedimentology, chemistry, botany and zoology plus socio-economics for water managers and other stakeholders to consider before deciding on the preliminary Ecological Reserve.

Future developments that are likely to result in changes to the flow regimes at the nine River/Floodplain EWR sites that comprise the Intermediate Reserve Assessment locations and the 5 estuaries/lakes being assessed at a Rapid to Intermediate Reserve Assessment for the Usuthu-Mthlatuze Reserve Determination Study are presented in this document. The best available information was used to schedule the implementation of proposed water resource developments and/or water demands, and is referenced throughout. Most of the information was obtained from the "All Towns Reconciliation Strategies – Eastern Region", which were constructed at scheme and local municipality administrative level.

2 DESCRIPTION OF THE WATER-RESOURCE DEVELOPMENT SCENARIOS

2.1 Approach taken in developing scenarios

Implementing environmental flows requires either active management of infrastructure such as dams as is the case with the Assegai River, or restrictive management of run-of-river abstractions/diversions, e.g., allocation policies that ensure enough water is left in the river, or a combination of the two. For instance, in the case of the upper Pongola River system, the water-resource scenarios were developed based on both restrictive flow management of the consumptive uses from the river system and active management of the dams upstream of the EWR site.

Compliance to these management restrictions depends on people changing their behaviour and should be based on an informed decision that has broad societal support.

For each river system, two kinds of scenarios were developed:

- A baseline scenario, which captures all existing water use as at 2011, including irrigation, domestic, afforestation, augmentation schemes and existing infrastructure, such as dams.
- Future water-resource development scenarios, which capture future demand growth, possible changes in water use, planned infrastructure and augmentation schemes.

The future water-resource development scenarios are exploratory in nature and are based on the extrapolation of past trends, projections and patterns of water use in the domestic and industrial sectors to 2040. Other sectors remain at the baseline (2011) levels of water use and any improvements in water use efficiency levels in these sectors are assumed to be used by that sector.

The water-resource scenarios were developed using the following basic assumptions:

- the baseline water demands and infrastructure reflect the 2011 development level, with the upper level of demand defined by registered water use. Use above this level is unlawful water use, which is resolved through DWA's verification and validation processes;
- the baseline hydrology includes the impact of existing operating rules;
- only projected growth in domestic and industrial use was included;
    - no increase in forestry area;
    - no increase in irrigation area unless specified;
    - no increase in water transfers unless specified;
    - Eskom demands were kept at the baseline (2011) allocation levels;
- groupings of small dams did not contribute water for EWRs;
- forestry, dryland agriculture and vegetation remained at baseline (2011) unless specified otherwise.

Figure 2-1 illustrates the scenarios developed for the Usutu – Mhlathuze Catchments. There are maximum of six scenarios generated for each EWR site, depending on the site conditions.

For existing dams in the upstream catchment:

- the operating rules were adjusted to meet the EWR downstream as far as was practical and realistic taking into account other demands from the resource;
- where the existing dams had operational constraints in terms of the size and capacity of the outlets, the relevant sized floods were excluded from the scenarios.

Changes in demands and new developments may require new operating rules for managing abstractions/water releases. Thus Scenarios 2, 3, 4 and 5 each include new operating rules to optimise use of the available water resources. Water conservation and demand management (Scenario 6) will be implemented only on Scenarios 3 and 5, with new operating rules.

2.1.1 Other optimised scenarios

The designed water-resource scenarios are based on the current levels of development and future development options and not the ecological category scenarios. These will be developed as part of the optimisation process as part of the trade-off between sustainable consumptive use of the water and need to ensure sustainable ecosystem functioning.

2.2 Use of the scenarios

The scenarios developed will be evaluated in terms of their ecological, social and economic impacts. The scenarios without EWRs will be generated first and used in DRIFT to guide the recommendations for EWRs. Thereafter, the EWRs will be recommended and the scenarios with EWRs will be generated and the ecological, social and economic impacts will be assessed for the full suite of scenarios at each site.

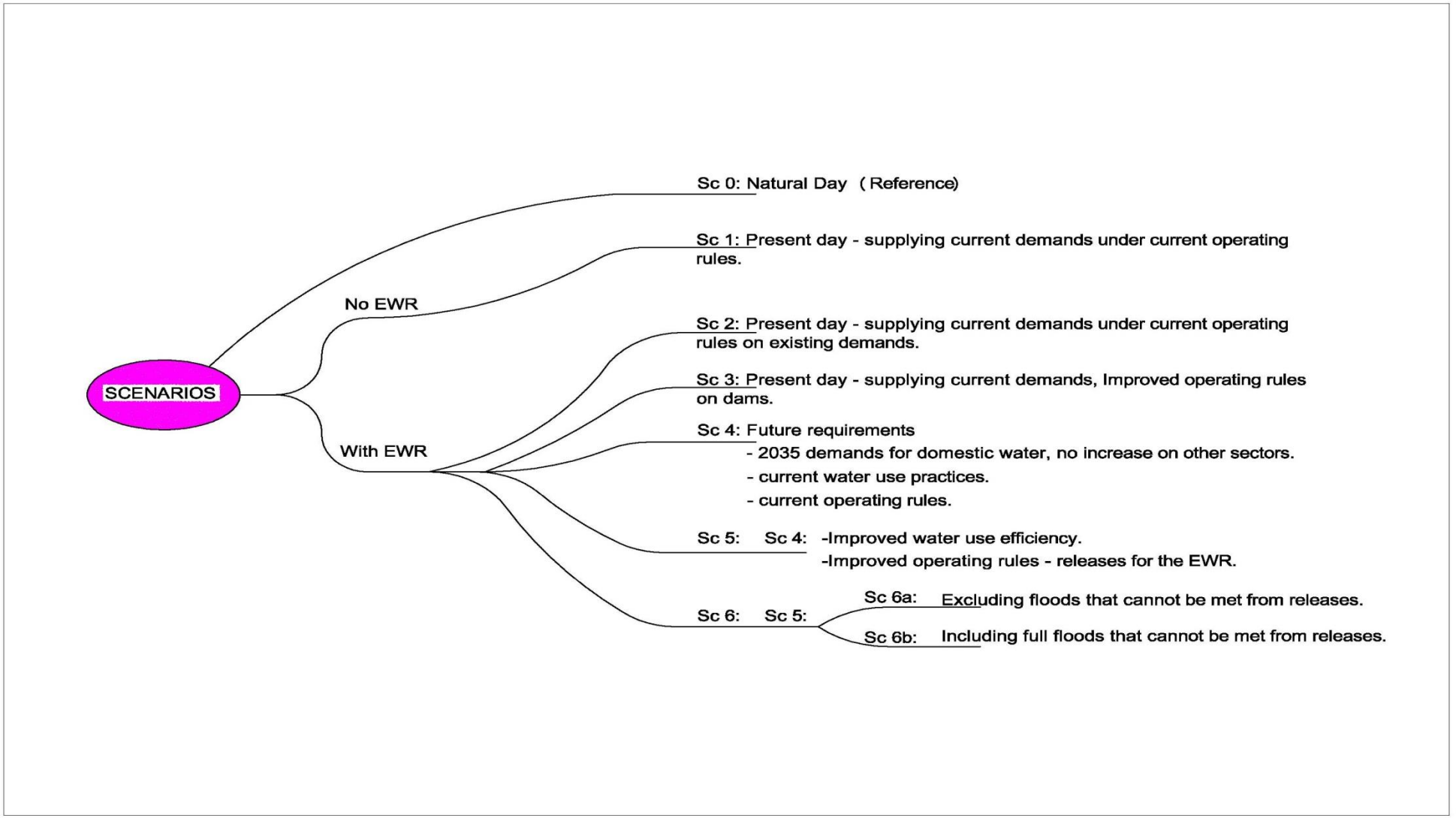

Figure 2-1: Framework of the future trend-based water-resource scenarios for Usutu-Mhlathuze Catchments

3 CODING OF SCENARIOS

Scenarios are coded according to the scenario number (Section 2) and EWR Site as shown in **Table 3-1**.

Table 3-1: Codes used for River scenarios

Scenario number	EWR Site AS1	EWR Site UP1	EWR Site LP1	EWR Site MK1	EWR Site BM1	EWR Site WM1	EWR Site NS1	EWR Site MA1
Scenario 1	AS1-1	UP1-1	LP1-1	MK1-1	BM1-1	WM1-1	NS1-1	MA1-1
Scenario 2	AS1-2	UP1-2	LP1-2	MK1-2	BM1-2	WM1-2	NS1-2	MA1-2
Scenario 3	AS1-3	UP1-3	LP1-3	MK1-3	BM1-3	WM1-3	NS1-3	MA1-3
Scenario 4	AS1-4	UP1-4	LP1-4	MK1-4	BM1-4	WM1-4	NS1-4	MA1-4
Scenario 5	AS1-5	UP1-5	LP1-5	MK1-5	BM1-5	WM1-5	NS1-5	MA1-5
Scenario 6	AS1-6	UP1-6	LP1-6	MK1-6	BM1-6	WM1-6	NS1-6	MA1-6

Where:

AS – is the Assegai river system

UP1 – Upper Pongola river system

LP1 – Lower Pongola River system

MK – Mkuze River system

BM – Black Mfolozi River system

WM- White Mfolozi River system

NS – Nseleni River system

MA – Matigulu River system

Additional Scenarios were developed were it was felt that the river scenarios were not sufficient, due to development below the River EWRs or no River EWR was determined or was not applicable. These scenarios and their codes are provided in Table 3-2.

Table 3-2. Codes for the scenarios impacting on estuaries/lakes

Scenario number	LMF1	HH1	KB1	LS1
Scenario 1	LMF1-1	HH1-1	KB1-1	LS1-1
Scenario 2	LMF1-2	HH1-2	KB1-2	LS1-2
Scenario 3	LMF1-3	HH1-3		LS1-3
Scenario 4	LMF1-4	HH1-4		
Scenario 5	LMF1-5	HH1-5		
Scenario 6	LMF1-6			
Scenario 7	LMF1-7			
Scenario 8	LMF1-8			

LMF – Mfolozi River, below the confluence of the Black and White Mfolozi Rivers

HH – Hluhluwe River

LS – Lake Sibayi

KB – Kosi Bay system

4 DETAILS FOR THE RIVER SCENARIOS

The baseline land cover and land use is shown in **Figure 4-1**. For each site, the relevant parameters on land use and land cover obtained from the WRSM2000 model (WRC, 2005) are discussed individually.

4.1 Water-resource scenarios for the EWR Site AS Assegai River system at Zandbank 156HT/0

4.1.1 Overview

The Assegai River is regulated with the Heyshope Dam located upstream of the EWR site. Therefore the water-resource scenarios that were developed are based on the active flow management through releases from Heyshope Dam. When active flow management is applied, an entire flow regime can be generated, including low flows and floods. The scenarios developed are based on changes in flow releases from the dam with changes in the consumptive water use by existing sectors and potential future consumptive requirements.

4.1.2 Scenario AS1-1: Sc 1 - Baseline scenario without the EWR

Scenario AS1-1 includes:

- baseline run-of-river abstractions by commercial agricultural and forestry according to registered water use in WARMS 2011 (Table 4-1);
- baseline allocation for the Eskom transfer from Heyshope Dam;
- baseline operating rules of compensation releases and releases for the Assegai's contribution for international obligations according to the Interim Inco-Maputo agreement;
- the baseline domestic and industrial demands for Driefontein and Piet Retief (Table 4-2).

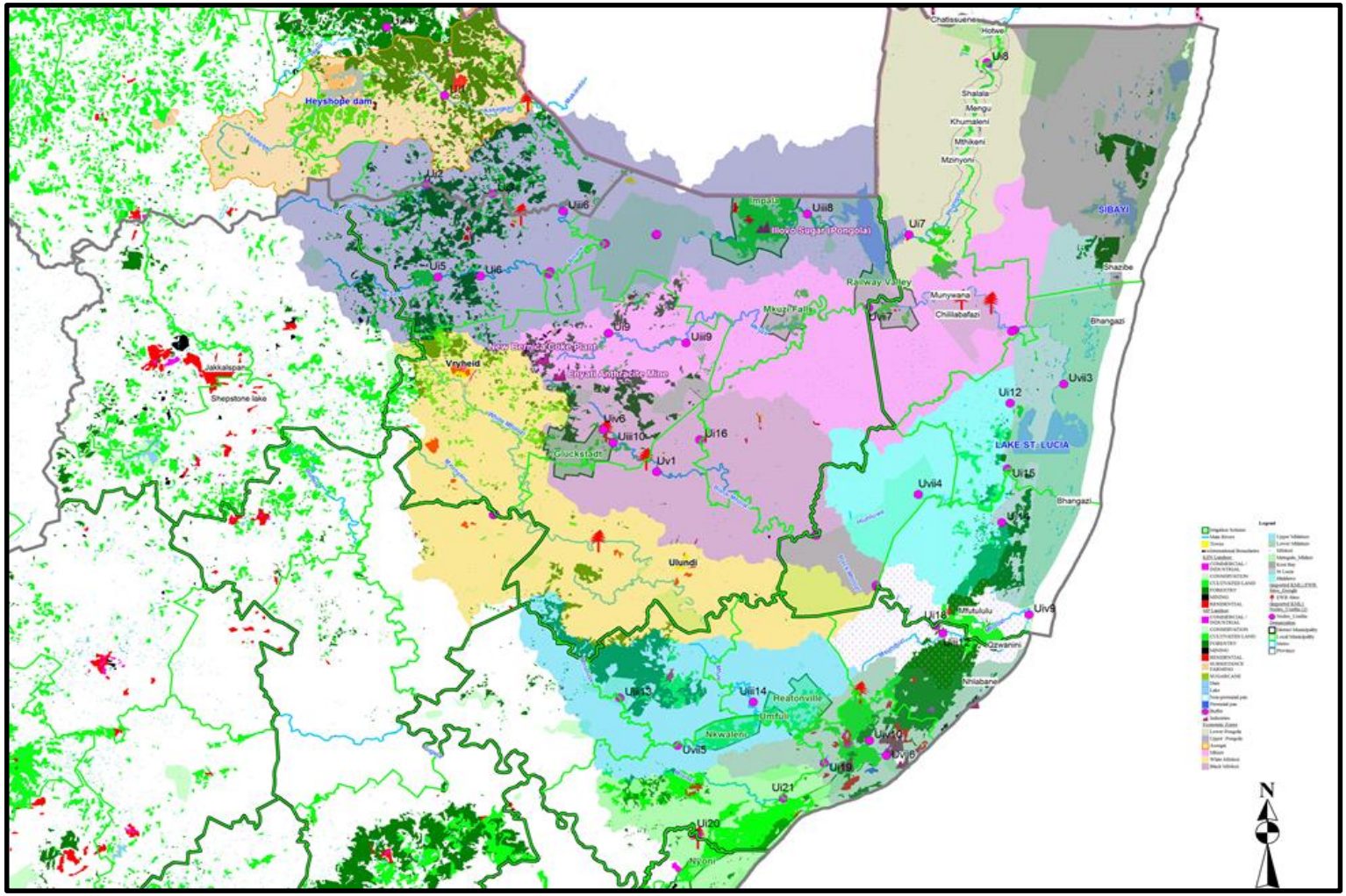

Figure 4-1: Land use and land cover (2010)

Table 4-1: Baseline (2011) Afforestation, alien vegetation and irrigated agriculture

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Registered Irrigation use (2011) $x10^6m^3$
W51A	624	0.5	1.3	4.13	85%	4.56
W51B	496	16.5	1.5	4.79	85%	6.88
W51C	678	153.7	3.1	3.97	85%	1.55
W51D	527	129.3	2.5	3.97	85%	1.21

Table 4-2: Baseline domestic and industrial water demands

Town/Scheme	Quaternary	Current water use (2011) $x10^6m^3$
Driefontein	W51B	1.42
Piet Retief	W51D	3.10
Sub-total domestic demand		4.52
Eskom transfer		117.00

Source: All towns study

4.1.3 Scenario AS1-2: Scenario 2 – Baseline (2011) with the EWR

Scenario AS1-2 includes:

- the Reserve at EWR AS1 (including the EWR and Basic Human Needs)) as the priority "consumptive use", including full floods;
- water use as for Scenario AS1-1.

4.1.4 Scenario AS1 -3: Scenario 3- Baseline (2011) with EWR excluding full floods

Scenario AS1-3 will be an update of the above scenario but with:

- the Reserve flows (including the EWR and Basic Human Needs), excluding floods that cannot be released from the Heyshope Dam.

4.1.5 Scenario AS1-4: Scenario 4 - Future requirements with the EWR including full floods

Scenario AS1-4 includes:

- 2040 levels of domestic and industrial water requirements (Table 4-3);
- baseline (2011) levels of commercial agriculture and forestry (Table 4-1);
- the Reserve at EWR AS1 (including the EWR and Basic Human Needs), including all floods;
- managed releases from Heyshope Dam.

Table 4-3: Domestic and industrial water demand projections

Town/Scheme	Quaternary	Projected Water Demand ($x10^6m^3$)					
		2015	2020	2025	2030	2035	2040
Driefontein	W51B	1.68	1.89	2.08	2.24	2.38	2.52
Pier Retief	W51D	3.49	3.92	4.33	4.65	4.95	5.24
Sub-total domestic demand		5.16	5.81	6.41	6.89	7.33	7.76
Eskom transfer		117.00	117.00	117.00	117.00	117.00	117.00

4.1.6 Scenario AS1-5: Scenario 5 – Future requirements with improved water use efficiency

Scenario AS1-5 includes:

- water use as for Scenario AS1-4 with improved water use efficiency in the commercial agriculture and domestic sectors, based on the following rules:
  - 15% reduction in present day allocation for commercial agriculture
  - 21% reduction in future (2040) domestic requirements;
- managed flow releases for the Reserve at AS1, including floods.

4.1.7 Scenario AS1-6: Scenario 6: - Future requirements with the EWR excluding full floods

Scenario AS1-6 includes:

- the demands as in Scenario AS1-5;
- the Reserve for AS1 through managed releases from Heyshope Dam, excluding the flood releases.

4.2 Water-resource scenarios for EWR Site UP1 in the Upper Pongola River at Bendor 211HT/1)

4.2.1 Overview

In the case of the upper Pongola River system, the water-resource scenarios have been developed based on restrictive flow management of the consumptive uses from the river system.

4.2.2 Baseline Scenario (Scenario UP1-1): Sc1 – Baseline without the EWR

Scenario UP1-1 includes the following:

- baseline (2011) consumptive use by the domestic sector for Paulpietersburg and Simdlangentsha West Regional Water Supply Scheme (Table 4-4);
- baseline (2011) consumptive use by the commercial forestry and agriculture, which are dependent on run-of-river abstractions (Table 4-5).

Table 4-4: Baseline domestic water demand

Town/Scheme	Quaternary	Current consumptive use (2011) x10^6m^3
Paulpietersburg	W42D	1.32
Simdlangentsha West	W42E	1.93
Sub-total domestic demand		3.25

Table 4-5: Baseline (2011) Afforestation, alien vegetation and irrigated agriculture

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Irrigation demand (2011) / Registered use (x10^6m^3)
W42A	397	4.1	0	0	85%	1.13
W42B	417	44.7	0	0	85%	1.67
W42C	377	10.4	0	0	85%	0.78
W42D	489	165.4	0	3.64	85%	0.22
W42E	232	26.7	0	9.1	85%	0.39

4.2.3 Scenario UP1-2: Scenario 2 – Baseline with the EWR flows

Scenario UP1-2 includes:

- the Reserve for UP1 (EWR and basic human needs) as priority requirements;
- water use as for Scenario UP1-1, but with existing consumptive uses curtailed where necessary based on the following curtailment rules:
    - run-of-river irrigation will have the lowest priority
    - commercial forestry will have the second lowest priority.

The eDumbe Dam, which regulates the flows for Paulpietersburg town and its townships, is unable to meet the present day demands and is not envisaged to be able to release flows for the EWR.

4.2.4 Scenario UP1-3: Scenario 3- Future requirements with the EWR flows without restrictive flow management

Scenario UP1-3 includes:

- the Reserve for UP1, as priority requirement;
- the projected 2040 water requirements for the domestic sector (Table 4-6), based on current water use efficiency;
- baseline (2011) water requirements for the commercial forestry and irrigated agriculture sectors (Table 4-5); curtailed were necessary according to the following curtailment rules:
    - baseline agriculture demands as lowest priority;
    - baseline commercial forestry as second priority.

Table 4-6: Domestic water demand projections

Town/Scheme	Quaternary	Projected Water Demand ($x10^6m^3$)					
		2015	2020	2025	2030	2035	2040
Paulpietersburg	W42D	1.68	2.09	2.59	3.15	3.80	4.36
Simdlangetsha West	W42E	2.34	2.77	3.25	3.81	3.96	4.07
Sub-total domestic demand		4.02	4.86	5.85	6.97	7.76	8.43

4.2.5 Scenario UP1-4: Scenario 4- Future requirements with the EWR flows and improved water use efficiency

Scenario UP1-4 includes:

- the Reserve at UP1;

- water uses as provided in Scenario UP1-3, with
    - Improved water use efficiency in the domestic and agricultural sectors.

4.3 Water-resource scenarios for the Lower Pongola River Reach Site (Ui8) (LP1)

4.3.1 Overview

The lower Pongola River systems is highly regulated with the Bivane and Pongolapoort Dams providing consumptive users in the lower reaches including meeting international obligations as part of the Interim Inco-Maputo Agreement. In addition there are flood releases to maintain the flood plains downstream of Pongolapoort where the communities are dependent on the farming on the floodplains after floods recede.

The water-resource scenarios developed for the lower Pongola River system are based on the active management of the existing dams. These are discussed below.

4.3.2 Baseline Scenario (Scenario LP1-1): Scenario 1 - Present Day without the EWR

The node Ui22 (LP1) (created to capture the floodplain area) is located at the outlet to quaternary catchment W45B. This site will be used when assessing floodplain requirements.

Scenario LP1-1 includes:

- baseline (2011) domestic and industrial demands for Kwanganase, Mandlakazi and Shemula Schemes (Table 4-7);
- baseline (2011) water requirements for commercial afforestation, irrigated agriculture and alien vegetation (Table 4-8);
- current operating policies and rules for Pongolapoort Dam, which include:
    - floodplain releases of 250 million m^3/a from the Pongolapoort Dam over a period of 31 days;
    - flow releases to meet international requirements;
    - the safe capture and discharge of large floods;
    - operating the dam at 80% full supply capacity because of dam safety requirements.

Table 4-7: Baseline (2011) domestic and industrial water demand

Town/Scheme	Quaternary	Current water use (2011) $x10^6m^3$
Kwanganase Water Supply Area	W45A	1.29
Mandlakhazi Water Supply Area	W45A	1.58
Shemula Supply Area	W45B	2.90
Sub-total domestic demand		5.77

Table 4-8: Baseline afforestation, alien vegetation and irrigated agriculture

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Irrigation demand (2011) / Registered use ($x10^6m^3$)
W45A	1289	0	4	16.97	85%	38.15
W45B	509	0	1	2.89	85%	

4.3.3 Scenario LP1-2 – Scenario 2- Baseline scenario with the EWR flows

Scenario LP1-2 includes:

- Reserve requirements (including the EWR and basic human needs) as priority requirements on present day consumptive uses;
- water uses as provided in Scenario LP1-1, with curtailment if necessary based on the following rules:
    - irrigated agriculture as the lowest priority;
    - industrial sectors as the second lowest priority;

The Pongolapoort Dam will be actively managed to meet the EWR flows including floods and freshets.

4.3.4 Scenario LP 1- 3 - Scenario 3 – Future water requirements without the EWR flows

Scenario LP1-3 will include the following:

- future water requirements (2040) for domestic, industrial and agriculture (Table 4-9 and Table 4-10);
- current operating rules and practices of Pongolapoort Dam, including:
    - meeting floodplain requirements;
    - international obligations;

- current water uses.

Table 4-9: Projected (2040) domestic and industrial water demand projections

Town/Scheme	Quaternary	Projected Water Demand (x10^6m^3)					
		2015	2020	2025	2030	2035	2040
Kwanganase Water Supply Area	W45A	1.57	1.77	1.98	2.18	2.39	2.43
Mandlakhazi Water Supply Area	W45A	1.56	1.88	2.24	2.67	3.22	3.88
Transfer to Mkuze	W45A	30.00	30.00	30.00	30.00	30.00	30.00
Shemula Supply Area	W45B	5.55	5.90	7.15	7.84	8.46	8.58
Sub-total domestic demand		38.68	39.55	41.37	42.70	44.07	44.89

Table 4-10: Projected Irrigated agriculture water demand projections

Irrigation Activity	Quaternary	Projected Water Demand (x10^6m^3)					
		2015	2020	2025	2030	2035	2040
Cotton farming	W45B	0	15	30	45	60	60

4.3.5 Scenario LP1-4: Scenario 4 – Future water requirements with changes in operating rules

Scenario LP1-4 includes:

- future water requirements (2040) as in Scenario LP1-3;
- Reserve requirements (including the EWR and basic human needs);
- adjustment of the current operating rules of Pongolapoort Dam to release the natural flows and floods required for the EWR;
- curtailment of consumptive uses, if necessary based on the following curtailment rules:
  - irrigated agriculture as the lowest priority;
  - industrial sectors as the second lowest priority;
  - domestic use, for garden watering & washing vehicles as the third lowest priority.

4.3.6 Scenario LP1-5: Scenario 5 – Future water requirements with improved water use efficiency and changes in the operating rules

Scenario LP1-5 includes:

- Reserve requirements for LP1;
- future requirements as in Scenario LP1-4;
- adjustment of operating rules of Pongolapoort Dam as in Scenario LP1-4;
- improvement of irrigation and domestic water use efficiency levels.

4.3.7 Scenario LP1-6: - Scenario 6 – Future water requirements with improved water use efficiency levels and excluding flood releases for the Reserve

Scenario LP1-6 includes:

- Reserve requirements for LP1
- future requirements with improved water use efficiency levels as in Scenario LP1-5;
- adjustment of the floodplain release of 250 million m^3/a from Pongolapoort Dam over a period of 31 days, to natural flood patterns.

Floodplain releases will be part of the EWR flood requirements.

4.4 Development scenarios for EWR Site MK1 (Mkuze River at Mkuze Game Reserve 17445)

4.4.1 Overview

The EWR site is located at the outlet to quaternary catchment W31J, on the Mkuze River. The Mkuze River is unregulated with the major infrastructure being the irrigation canals that supply the Mkuze Irrigation Scheme by run-of-river abstraction. The scenario developed therefore is based on the restrictive management of the abstractions for the current and projected consumptive water uses in the river reach.

4.4.2 Baseline Scenario (Scenario MK1-1) – Baseline demands without the EWR flows

Scenario MK1-1 includes the following:

- baseline (2011) consumptive use for the process water for the mining of Enyati Anthracite Mine and the process water for the Bernice Coke Plant (Table 4-11);
- baseline (2011) consumptive use of the Mkuze Falls and Railway Valley irrigation scheme (Table 4-12);
- return flows from the domestic users of Mkuze and Ubombo Schemes, which are supplied water from the Pongola system

Table 4-11: Baseline (2011) domestic and industrial water demand

Town/Scheme	Quaternary	Registered use (2011) x10^6m^3
Mkuze Ubombo Water Supply Scheme	W31A to W31H	2.77
Enyati Anthracite + Bennies Coke plant	W31A	-
Sub-total domestic demand		2.77

Table 4-12: Baseline (2011) afforestation, alien vegetation and irrigated agriculture

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Irrigation demand (2011) / Registered use (x10^6m^3)
W31A	370	27.00	22.40	3.22	85%	77.00
W31B	304	30.50	5.80	3.22	85%	
W31C	172	14.50	0.90			
W31D	295	41.30	12.50	1.56	85%	
W31E	334		2.00	20.00	85%	
W31F	583	0.60	3.20	5.00	85%	
W31G	520		2.20	6.00	85%	
W31H	323		1.80	16.00	85%	

4.4.3 Scenario MK1-2: Scenario 2 – Baseline scenario with the EWR flows

Scenario MK1-2 includes:

- Reserve (including the EWR and basic human needs) as priority use;
- baseline consumptive use as provided in Scenario MK1-1, curtailed if necessary, based on the following curtailment rules:
    - eliminating inefficiencies, including reducing agricultural requirements but ensuring current level of production as first stage;
    - Further curtailment of agricultural requirements as second stage;
- providing the return flows from the domestic water use as this is a transfer from the Pongola River system.

4.4.4 Scenario MK1-3: Scenario 3 – Future requirements without the EWR flows and improved operating rules

Scenario MK1-3 includes:

- future projected (2040) consumptive water requirements (Table 4-13);
- marginal increase in return flows from the Mkuze and the Ubombo.

Table 4-13. Future water requirements

Town/Scheme	Quaternary	Projected Water Demand ($x10^6m^3$)					
		2015	2020	2025	2030	2035	2040
Bernice Coke Plant	W31A	1,65	2,38	2,38	2,38	2,38	2,38
Enyathi Anathracite Mine	W31A	0,68	1,42	1,42	1,42	1,85	1,85
Leeuw Mining Exploration	W31A	0,93	0,93	0,93	0,93	0,93	0,93
Total industrial demand		3,26	4,73	4,73	4,73	5,16	5,16
Mandlakazi Scheme*	W31H	3,02	3,64	4,18	4,80	5,25	5,74

**This is inflow from the Pongola system*

4.4.5 Scenario MK1-4: Scenario 4 – Future water requirements without the EWR flows and improved consumptive use

Scenario MK1-4 includes:

- increase in return flows as a result of growth in domestic sector;
- 2040 level of requirements in the industrial, mining and agricultural sectors, with:
    - improved water use efficiency.

4.4.6 Scenario MK1-5: Scenario 5 – Future water requirements with the EWR flows and improved consumptive use

Scenario MK1-5, will include:

- 2040 water demands as provided in Scenario MK1-3
- Increase in return flows as a result of growth in demands
- Improved water use efficiency
- Including the EWR as priority use

4.5 Development scenarios for EWR Site BM1 (Black Mfolozi at Ekuhlengeni 701HU/0)

4.5.1 Overview

The EWR site is located at the outlet to quaternary catchment W22C, on the Black Mfolozi River. It is just downstream of the outlets from quaternary catchments W22A and W22B. This is upstream of most current and proposed developments. There are major developments planned with respect to the abstraction of consumptive water from the Black Mfolozi River, but these are located downstream of this EWR site.

4.5.2 Scenario BM1-1: Scenario 1 – Baseline without the EWR flows

Scenario BM1-1 includes:

- baseline consumptive water use by the Khambi supply scheme, which supplies the rural communities upstream of the EWR site (Table 4-14);
- baseline extent of afforestation, alien vegetation and irrigated agriculture (Table 4-15).

The resultant flows at the EWR site will be compared with the EWRs to determine whether these are being met.

Table 4-14: Scenario BM1-1: Domestic and industrial water demand

Town/Scheme	Quaternary	Current use (2011) $x10^6m^3$
Khambi Supply Area	W22A	0.13
Sub-total domestic demand		0.13

Table 4-15: Baseline (2011) afforestation, alien vegetation and irrigated-agriculture areas

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Irrigation demand (2011) / Registered use ($x10^6m^3$)
W22A	239	36.3	1.4	2.16	85%	0.34
W22B	332	5.1	1.0	5.76	85%	0.28
W22C	186	3.0	1.4	4.64	85%	0.04

4.5.3 Scenario BM1-2: Scenario 2 - Baseline with the EWR and curtailment of current consumptive uses where necessary

Scenario BM1-2 includes:

- the Reserve at EWR BM1 (including the EWR and Basic Human Needs) as the priority "consumptive use";
- water use as for Scenario BM1-1, but with existing consumptive uses curtailed where necessary based on the following curtailment rules:
    - run-of-river abstraction for irrigation agriculture upstream of the EWR site will be curtailed by first removing the current irrigation inefficiencies based on the crop water requirements;
    - levels of service provision to domestic water users will be the next use to be curtailed.

4.5.4 Scenario BM1-3: Scenario 3 – Future water requirements without the EWR under current water use practices and operating rules

Scenario BM1-3 includes:

- 2030 water use by the Khambi supply scheme, which supplies the rural communities upstream of the EWR site (Table 4-16).
- 2040 level of run-of-river abstractions by agriculture and the effect of commercial forestry in the headwaters of the Black Mfolozi River;

According to DWA (2011e) future water requirements for the Khambi Water supply Area can be met from run-of-river abstraction from the Black Mfolozi River. There is no water resource infrastructure upstream of the EWR Site BM1, which can be used to manage releases.

Table 4-16: Domestic water demand projections

Town/Scheme	Quaternary	Projected Water Demand (x$10^6 m^3$)					
		2015	2020	2025	2030	2035	2040
Khambi Water Supply Area	W22A	0.16	0.18	0.21	0.24	0.27	0.31

4.5.5 Scenario BM1-4: Scenario 4: Future water requirements without EWR but with improvements in water use practices

Scenario BM1-4 includes:

- water use as for Scenario BM1-3 reduced based on improved water use efficiencies and demand management.

4.5.6 Scenario BM1-5: Scenario 5: Future water requirements with improvements in water use practices and with EWR

Scenario BM1-5 includes:

- the Reserve at EWR BM1 (including the EWR and Basic Human Needs) as the priority "consumptive use";
- water use as for Scenario BM1-4.

4.6 Development scenarios for extrapolated node in lower Black Mfolozi (Black Mfolozi at Stedham 867GU/0)

4.6.1 Scenario BM2-1: Scenario 1 – Baseline without the EWR under current operating rules and water use practices

Scenario BM2-1 includes:

- baseline consumptive water use by the Nongoma and Ceza supply schemes (Table 4-17) DWA (2011f and 2011g);
- baseline extent of afforestation, alien vegetation and irrigated agriculture (Table 4-18).

Table 4-17: Domestic and industrial water demands

Town/Scheme	Quaternary	Current use (2011) x10^6m^3
Ceza Water Supply Scheme	W22F	-
Nongoma (Vuna) Water Supply Scheme	W22F	1.59
Sub-total domestic demand		1.59

Table 4-18: Afforestation, alien vegetation and irrigation

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Irrigation demand (2011) / Registered use (x10^6m^3)
W22A	239	36.30	1.40	2.16	85%	2.69
W22B	332	5.10	1.10	5.76	85%	
W22C	186	3.00	1.40	4.64	85%	
W22D	197		0.80	2.72	85%	
W22E	385	58.10	2.10			0.42
W22F	312		1.70			

4.6.2 Scenario BM2-2: Scenario 2 – Baseline with the EWR flows and current operating rules

Scenario BM2-2 includes:

- the Reserve at EWR BM2 (including the EWR and Basic Human Needs) as the priority "consumptive use";
- water use as for Scenario BM2-1, but with existing consumptive uses curtailed where necessary based on the following curtailment rules:
    - run-of-river abstraction for irrigation agriculture upstream of the EWR site will be curtailed by first removing the current irrigation inefficiencies based on the crop water requirements;
    - The area under forestry will be curtailed in order to improve the stream flow particularly the base flows.
    - levels of service provision to domestic water users will be the next use to be curtailed.

4.6.3 Scenario BM2-3: Scenario 3 – Future water requirements under current water use practices and operating rules without the EWR

Scenario BM2-3 includes:

- 2040 water use by the Nongoma and Ceza supply schemes (Table 4-19).
- 2040 level of run-of-river abstractions by agriculture and the effect of commercial forestry in the upper catchment of the Black Mfolozi River;
- Raising of Vukwana Dam to act as the OCS for the next 10 years. High flows will be pumped from the Black Mfolozi River and stored in the Dam.

Table 4-19: Domestic and industrial water demand projections

Town/Scheme	Quaternary	Projected Water Demand ($x10^6m^3$)					
		2015	2020	2025	2030	2035	2040
Ceza Water Supply Scheme	W45A	4.60	4.88	5.89	6.49	7.03	7.13
Nongoma (Vuna) Water Supply Scheme	W45A	6.70	7.11	8.56	9.45	10.25	10.39
Sub-total domestic demand		11.30	11.99	14.45	15.94	17.28	17.52

4.6.4 Scenario BM2-4: Scenario 4 – Scenario 3 with changes to the current operating rules of the Vukwana

Scenario BM2-4 includes:

- 2040 water use as contained in Scenario BM2-3
- new operating rules for Vukwana Dam to regulate releases/abstractions during drought and normal conditions in order to avoid complete failure of supply
- the proposed off channel storage to supply the Usutu scheme with a total volume of 25 million m^3 based on pumping high flows from the Black Mfolozi River. This demand will come on 10 years from current.

4.6.5 Scenario BM2-5: Scenario 5 – Scenario 4 with improved water use practices and the Vukwana Dam being the OCS

Scenario BM2-5 will include:

- 2040 water use as contained in Scenario BM2-3, with improved water efficiency.
    - The high systems losses in the Nongoma estimated at 42% of system input volume will be reduced to 20%.
- Utilisation of Vukwana Dam as the OCS.

4.6.6 Scenario BM2-6: Scenario 6 – Scenario 5 with proposed new off channel storage

Scenario BM2-6 will include:

- Demands and improved efficiencies and water use practices as in Scenario BM2-5
- The proposed 25 million m^3 dam will function as the new storage for the Usutu Regional Scheme
- Improved water use practices and releases from Vuna and Vukwana Dam to contribute to the flows

4.7 Development scenarios for EWR Site WM1 (White Mfolozi River at Langgewacht 235 GU)

4.7.1 Overview

The White Mfolozi River is high regulated with the EWR flows having to be managed through releases from the dams upstream of the catchment. The EWR site is located at the outlet to quaternary catchment W21H, on the White Mfolozi River, which is upstream of Ulundi scheme.

4.7.2 Scenario WM1-1: Scenario 1- Baseline under current development level and without the EWR flows

Scenario WM1-1 includes:

- baseline (2011) consumptive use for irrigated agriculture, commercial forestry (Table 4-20) and domestic water (Table 4-21) supply under current water use practices;
- current operating rules of Klipfontein, Grootgewaad and Bloemveld Dams (Table 4-22).

Table 4-20: Baseline (2011) afforestation, alien vegetation and irrigated agriculture

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Irrigation demand (2011) / Registered use ($x10^6m^3$)
W21A	340	47.90	0.90	0.24	85%	
W21B	580	20.20	1.00			
W21C	370					
W21D	469		0.90			
W21E	416		1.00			
W21F	243		0.90	0.32	85%	
W21G	563	6.80	2.70			
W21H	433	0.70	2.20			

Table 4-21: Baseline (2011) domestic and industrial water demand

Town/Scheme	Quaternary	Current use (2011) x$10^6 m^3$
Vryheid scheme	W21A	7.51-
Emondlo Mvuzini & Purim schemes	W21A	5.17
Mpungamhlope scheme	W21H	0.79
Ulundi/Nkonjeni scheme	W21K	8.57
Sub-total domestic demand		20.56

Table 4-22: Major dams in the catchment

Dam Name	Year Built	Full Supply Capacity (million m^3/a)	Quaternary Catchment	Natural MAR (million m^3/a) (WR90)	Historical Firm Yield (million m^3/a)[1]	Historical Firm Yield (million m^3/a)[2]
Klipfontein	1983	18.09	W21A	49.10	16.603	16.20
Bloemveld	1969	2.73	W21A	9.82	1.07	1.03
Grootgewacht	1948	1.14	W21A	4.91	0.61	0.60
Mvunyana	1970s	2.87	W21D	13.08	3.96	3.96

4.7.3 Scenario WM1-2: Scenario 2 - Baseline with the EWR flows with changes to the current operating rules

Scenario WM1-2 includes:

- baseline (2011) consumptive water use requirements (Table 4-20 and Table 4-21);
- changing the operating rules between Klipfontein Dam and Ulundi weir to maximise system yield; including:
    - 50% of the water requirements for Emondlo scheme will be sourced directly from Klipfontein Dam through a pipeline from the intake works.
    - The rest of the water requirements of Emondlo will continue to be sourced from the Mvunyana Dam. However the reduction in yield of the dam due to siltation should be taken into account
    - Releases for the EWR from Klipfontein Dam with the exception of the floods should be modelled.

4.7.4 Scenario WM1-3: Scenario 3 - Baseline with releases for the EWR with changes to the current operating rules and Emondlo supplied directly from Klipfontein Dam and Ulundi releases not being made

Scenario WM1-3 includes:

- baseline (2011) consumptive use (Table 4-20 and Table 4-21);
- changes to operating practices and rules; which include:
    - the Ulundi demands are provided by means of a pipeline from Klipfontein Dam in order to reduce the river losses;
    - the total current demand for eMondlo, Purin and Mvuzini are supplied by a pipeline from the Klipfontein Dam intake works
    - no abstractions are made from the Mvunyana Dam;
- removal of current allocation for Gluckstadt irrigation (not utilising allocation). The Glucksdat irrigation scheme is located in W22B and has an allocation of approximately 2.5 million m^3.

4.7.5 Scenario WM1-4: Scenario 4 – Future water requirements under current operating rules and water use practices and no resource development

Scenario WM1-4 includes the following:

- project future (2040) water requirements (Table 4-23); the irrigation water requirements as indicated Table 4.2o are not expected to grow. The Gluckstadt irrigation scheme is envisaged to be operational using 2.5 million m3.
- current operating rules and practices, based on the drought operating rules developed for the dams in the White Mfolozi.

Table 4-23: Domestic and industrial water demand projections (2040)

Town/Scheme	Quaternary	Demand (2011) / Registered use ($x10^6m^3$)	Projected Water Demand ($x10^6m^3$)					
			2015	2020	2025	2030	2035	2040
Vryheid scheme	W21A		9.38	11.43	13.84	16.72	20.20	24.40
Emondlo scheme	W21A		4.47	5.29	6.20	7.25	8.48	9.91
Mpungamhlope scheme	W21H		0.96	1.15	1.36	1.61	1.91	2.26
Ulundi/Nkonjeni scheme	W21K		10.68	12.93	15.51	18.44	21.92	26.07
Sub-total domestic demand			25.49	30.80	36.91	44.02	52.51	62.64

4.7.6 Scenario WM1-5: Scenario 5 – Future water requirements with improved operating rules and water use practices and resource development

Scenario WM1-5 includes the following:

- projected demands as in Scenario WM1-4;
- intervention measures to meet with projected demands, which include:
    - an additional 0.2 million m^3 which can be drawn from Bloemveld Dam without a significant increase in the risk of supply failure;
    - raising of Klipfontein Dam wall by 4m to provide a storage which increases the storage of the dam by an additional 15 million m^3. ;
    - the minimum pumping level for Vryheid at Klipfontein Dam can be lowered to the dead storage level;
    - the scheduling of releases from Klipfontein Dam can be improved in order to reduce the river losses in the system along the White Mfolozi River;
    - a new off-channel dam located at: Latitude: 28°15'33.14"S and Longitude: 31° 8'13.61"E can be developed to a storage capacity between 40 million m^3;
    - abstraction works at the OCS to supply water to Ulundi scheme.

4.7.7 Scenario WM1-6: Scenario 6 – Future water requirements with improved current operating rules and water use practices and resource development

Scenario WM1-6 includes:

- future (2040) projected water requirements (Table 4-23), with improved water use efficiency, excluding the Gluckstadt irrigation allocation;

- water-resource development to meet future demands as in Scenario WM1-5 which is the OCS as discussed in the previous scenario.

4.8 Development scenarios for EWR Site MA1 (Matigulu River at Endondakusuka/Umlalazi)

4.8.1 Overview

The Matigulu River is unregulated with the major infrastructure being the pumping infrastructure from the river to supply the irrigators by run-of-river abstraction. The EWR site is located at the outlet to quaternary catchment W11B, on the Matigulu River close to the outlet from quaternary catchment W11A. The scenarios developed therefore are based on the restrictive management of the abstractions for the current and projected consumptive water uses in the river reach.

4.8.2 Baseline Scenario (Scenario MA1-1) – Baseline demands without the EWR flows

Scenario MA1-1 includes:

- baseline (2011) consumptive domestic water use by the Gingindlovu scheme and to a limited extent Eshowe schemes (Table 4-24).
- baseline (2011) consumptive use by irrigators as well as the commercial forestry and industry (Table 4-25);

Table 4-24: Baseline domestic and industrial water demand

Town/Scheme	Quaternary	Registered use (2011) x$10^6 m^3$
Part of Eshowe Water Supply Scheme	W11A, B, C	0.06
Catherine Booth Hospital	W11A	0.01
Gingindlovu Water Supply Scheme	W11C	0.38
Sub-total domestic demand		1.59

Table 4-25: Baseline afforestation, alien vegetation and irrigated agriculture

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Irrigation demand (2011) / Registered use ($x10^6m^3$)
W11A	445	8.90	45.40	12.00	85%	
W11B	127		6.40	6.40	85%	
W11C	382	13.20	25.80			7.20

4.8.3 Scenario MA1-2: Scenario 2 – Future requirements without the EWR flows

Scenario MA1-2, includes:

- projected future (2040) domestic and industrial water requirements (Table 4-26);
- baseline (2011) water use for irrigated agriculture (not expected to grow) (Table 4-25).

Table 4-26: Domestic and industrial water demand projections (2040)

Town/Scheme	Quaternary	Demand (2011) / Registered use ($x10^6m^3$)	Projected Water Demand ($x10^6m^3$)					
			2015	2020	2025	2030	2035	2040
Part of Eshowe Water Supply Scheme	W11A W11B W11C	0.06	0.07	0.08	0.09	0.09	0.10	0.11
Catherine Booth Hospital	W11A	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Gingindlovu Water Supply Scheme	W11C	0.38	0.43	0.49	0.54	0.59	0.64	0.70
Sub-total domestic demand		0.45	0.51	0.58	0.64	0.70	0.76	0.83

4.8.4 Scenario MA1-3: Scenario 3 – Future water requirements with the EWR flows and improved consumptive use

Scenario MA1-3 includes:

- Reserve (including the EWR and basic human needs);
- projected future (2040) domestic and industrial water requirements (Table 4-26); with
    - Improved water use efficiency.

4.9 Development scenarios for EWR Site NS1 (Nseleni River at Mhlana 16922/0)

4.9.1 Overview

The upper Nseleni River is unregulated with the major infrastructure being the pumping infrastructure from the river to supply the irrigators by run-of-river abstraction. The EWR site is located at the outlet to quaternary catchment W12H, in the headwaters of the Nseleni River, a tributary of the Mhlathuze River. There are no major developments currently and planned in the future. Therefore the scenarios developed are based on maintaining the pristine nature of the upper Nseleni with consumptive water uses in the lower river reach.

4.9.2 Scenario NS1-1 – Baseline demands without the EWR flows

Scenario NS1-1 includes:

- baseline (2011) consumptive uses by irrigated agriculture and commercial forestry (Table 4-27).

Table 4-27: Afforestation, alien vegetation and irrigation

Quaternary catchment	Catchment Area (km^2)	Afforestation (km^2)	Alien vegetation (km^2)	Irrigation (km^2)	Irrigation efficiency (%)	Irrigation demand (2011) / Registered use ($x10^6m^3$)
W12G	326		21.20			7.20
W12H	485	134.40	35.70	21.92	85%	21.58

4.9.3 Scenario NS1-2: Scenario 2 – Baseline with the EWR flows and current operating rules

Scenario NS1-2 includes:

- Reserve requirements (including the EWR and basic human needs) as a priority use;
- baseline consumptive use, which will be curtailed where necessary based on the following curtailment rules:
    - run-of-river abstraction for irrigation agriculture will be curtailed by first removing the current irrigation inefficiencies based on the crop water requirements.
    - the area under forestry will be curtailed in order to improve the stream flow particularly the base flows;
- higher level of service provision for the domestic sector.

5 SCENARIOS FOR THE ESTUARIES

5.1 Overview

In order to determine the impact on the estuaries, development scenarios were designed based on the potential development options immediately upstream of each of the main estuaries. Development further upstream have been taken into consideration in the scenarios for the River EWRs, where available.

5.2 St Lucia Lake – Mfolozi River

5.2.1 Overview

The Mfolozi River system is currently unregulated with the demands upstream of the St Lucia dependent on run of river abstraction. Notwithstanding the limitations on the available yield from run of river abstraction, the following scenarios are envisaged which may impact on the St Lucia Lake.

5.2.2 Scenario LMF 1-1. Scenario 1 Base case demands without the EWR

Scenario LMF1-1 includes:

- The current demands upstream of St Lucia in the Mfolozi River (Table 5-1).

Table 5-1: Lower Mfolozi current water requirements

Catchment	Water User	Quaternary catchment	Current demand (2011) / Registered use
Mfolozi	Mtubatuba scheme	W23A	4.35
	Mpukunyoni scheme	W23D	3.09
	Richards Bay Mineral	W23D	11.00
	Total Domestic & Industrial demand		14.09
	Mandlakazi Scheme		
	Irrigation	W23A	0.52
		W23B	2.02
		W23C	7.97
		W23D	28.22
			38.73
	Afforestation	W23A	0.20
		W23B	2.69
		W23C	7.85
		W23D	4.42
			15.16

5.2.3 Scenario LMF1: Sc LMF1-2 – Base case with the EWR flows and curtailment of forestry

Scenario LMF1-2 will include:

- Demands as in Scenario LMF1-1
- Removal of commercial forestry in buffer zones, based on land cover data

5.2.4 Scenario LMF: Sc LMF1-3 – Base case with forestry removed

Scenario LMF1-3 includes:

- Demands as in LMF1-1
- Removal of commercial forestry (covering approx. 15.16 million m^3/a)

5.2.5 Scenario LMF: Sc LMF1-4 – Future water requirements without the EWR flows and improved consumptive use

Scenario LMF1-4 will include:

- 2040 water demands (Table 5-2), with improved water use efficiency
- development of OCS of 7.5 million m^3 capacity in W23A. High flows will be pumped during the rainfall periods for use during the dry flow periods

Table 5-2: Demand forecast for the lower Mfolozi River system

Catchment	Water User	Quaternary catchment	Current demand (2011) / use	2015	2020	2025	2030	2035	2040
Hluhluwe	Hluhluwe scheme	W32F	3.09	4.51	4.93	5.31	5.58	5.79	6.02
Mfolozi	Mtubatuba scheme	W23A	4.35	6.71	7.91	9.10	10.50	11.83	13.21
	Mpukunyoni scheme	W23D	3.09	3.47	3.70	3.94	4.14	4.30	4.46
	Richards Bay Mineral	W23D	11.00	11.25	11.50	11.76	12.02	12.29	12.57
	Total Domestic & Industrial demand		14.09	21.43	23.11	24.80	26.66	28.43	30.24
	Irrigation	W23A	0.52						
		W23B	2.02						
		W23C	7.97						
		W23D	28.22						
			38.73						
	Afforestation	W23A	0.20						
		W23B	2.69						
		W23C	7.85						
		W23D	4.42						
			15.16						

5.2.6 Scenario LMF: Sc LMF1-5 – Future water requirements with the EWR flows and improved consumptive use

Scenario LMF1-5 will include:

- The scenario for LMF1-4, with
- EWR requirements for the Black and White Mfolozi Rivers imposed

5.2.7 Scenario LMF: Sc LMF1-6 – Future water requirements met from Lake Nsezi

Scenario LMF1-6 will include:

- 2040 domestic demands (Table 5-3) to be supplied from Lake Nsezi, resulting in significant return flows

Table 5-3: Future return flows with supply from Lake Nsezi

Catchment	Water User	Quaternary catchment	Current demand (2011) / use	2015	2020	2025	2030	2035	2040
Mfolozi	Mtubatuba scheme	W23A	4.35	6.71	1.98	2.28	2.62	2.96	3.30
	Mpukunyoni scheme	W23D	3.09	3.47	0.93	0.98	1.03	1.07	1.12

5.2.8 Scenario LMF: Sc LMF1-7 – Future water requirements for Richards Bay met from Mfolozi River

Scenario LMF1-7 will include:

- 2040 water demands as per Scenario LMF1-4, with
- demands for Richards Bay sourced from the Lower Mfolozi
- possibility of developing a larger OCS to supply both Mtubatuba and Richards Bay.

5.2.9 Scenario LMF: Sc LMF1-8 – Future water requirements for Richards Bay met from Mfolozi River and including the EWR

Scenario LMf1-8 will include:

- Scenario for LMF1-7, with
- EWR for the Black and White Mfolozi Rivers included.

5.3 St Lucia Lake – Hluhluwe River

5.3.1 Overview

No EWR site was identified for the Hluhluwe River catchment. However because the Hluhluwe River flows into St Lucia Lake it will have an impact on the functioning of the lake. There are demands in the Hluhluwe River that need to be taken into account when assessing St Lucia Lake and these are discussed in the following sections including future demand scenarios.

5.3.2 Scenario HH1-1 Base case demands without the EWR

Scenario HH1-1 includes:

- Current demands (Table 5-4)
- Current operating rules of the Hluhluwe Dam

Table 5-4: Base demand in the Hluhluwe River catchment

Catchment	Water User	Quaternary catchment	Current demand (2011) / Registered use
Hluhluwe	Hluhluwe scheme	W32F	3.09
	Irrigation	W32C	2.83
		W32D	-
		W32E	-
		W32F	11.21
		W32H	0.02
			14.06
	Afforestation	W32C	0.16
		W32D	0.02
		W32E	0.01
		W32F	0.79
		W32H	7.55
			8.53

5.3.3 Scenario HH1-2 -Base case demands with forestry curtailment

Scenario HH1-2 will include:

- Current demands as in Table 5-4
- Removal of commercial forestry
- Inclusion of drought operating rules for the Hluhluwe Dam to prevent failure.

5.3.4 Scenario HH1-3- Base case (2011) based on releases limited to the outlet works capacity

Scenario HH1-3 includes:

- The scenario HH1-2, with
- Releases from Hluhluwe Dam for EWR/needs of estuary limited to the capacity of the outlet works

5.3.5 Scenario HH1-4 –Future water requirements including commercial forestry

- Scenario HH1-4 includes:
- Table 5-5), met from transfers from the Mfolozi River to supplement allocation from the Dam
- Improved water use efficiency of the projected consumptive use

Table 5-5: Demand forecast for the Hluhluwe River system

Catchment	Water User	Quaternary catchment	Current demand (2011) / Registered use	2015	2020	2025	2030	2035	2040
Hluhluwe	Hluhluwe scheme	W32F	3.09	4.51	4.93	5.31	5.58	5.79	6.02
				-	-	-	-	-	-
	Irrigation	W32C	2.83						
		W32D	-						
		W32E	-						
		W32F	11.21						
		W32H	0.02						
			14.06						
	Afforestation	W32C	0.16						
		W32D	0.02						
		W32E	0.01						
		W32F	0.79						
		W32H	7.55						
			8.53						

5.3.6 Scenario HH 1-5: Future water requirements met from the Hluhluwe River catchment

Scenario HH1-5 includes:

- 2040 water demands (Table 5-5), met from the Hluhluwe Dam with
- curtailment of commercial forestry

5.4 St Lucia Lake – Additional scenarios

The following scenarios were elaborated upon and investigated as a result of data emanating from the Reconciliation Study Project.

5.4.1 Scenario 1: - Full Development in the Mfolozi River System without significant development in the Hluhluwe and

5.4.1.1 Scenario 1(a) – Development of an in-channel dam in the Mfolozi River

There is potential that Richards Bay future demand may come from the Mfolozi River system. There are two options. The first proposed development is the Kwesibomvu Dam which is an in-channel earthfill dam on the Mfolozi River about 7 km upstream of the N2 road bridge that would transfer water to Nsezi WTW and provide a regional water supply to Mtubatuba and other small towns in the area. The yield of the dam will be 66.6 million m^3/a or 182.5 Ml/d being dammed upstream of Lake St Lucia.

The demands upstream of the proposed development as provided in the scenarios for the Black and White Mfolozi River system will not have a significant impact on Lake St Lucia with the in-channel dam development.

At the same time the current demands from the Hluhluwe system (Table 5-4) will be abstracted. The major demands are for irrigation agriculture from Hluhluwe River and some commercial forestry. The growing demand is however domestic water. Because of the constraints in the available yield, this is impacting on the water availability for agriculture.

A hydrological analysis of the flows into St Lucia Lake from the Hluhluwe after these abstractions are taken out of the river system will be conducted to determine the flow regime into the lake. This should be done taking into account the current operating rules of Hluhluwe Dam.

5.4.1.2 Scenario 1(b): - Development of an off channel storage dam

The second scenario that is the most feasible option is the development of an off-channel storage dam. This involves pumping from a weir in the Mfolozi River about 4 km upstream of the Kwesibomvu Dam site to an off-channel earthfill dam at the Nkatha Pan. The scheme would transfer water to Nsezi WTW and provide a regional water supply to Mtubatuba and other small towns. Different rates of pumping from the Mfolozi River to the dam were investigated, as well as different storage capacities.

The least cost option from a financial perspective is pumping 2.5 m^3/s of the highflows to Nkatha Pan from a weir in the Mfolozi River. This will provide a yield of 155 Ml/d. This can supply Richards Bay as

well as Mtubatuba supply areas. The demands upstream of the proposed development as provided in the scenarios for the Black and White Mfolozi River system will need to be considered in the scenario because of the off-channel storage.

However because the Hluhluwe River flows into St Lucia Lake it will have an impact on the functioning of the lake. There are demands in the Hluhluwe River that need to be taken into account when assessing St Lucia Lake as discussed in scenario 1(a) above.

5.4.1.3 Scenario 2(a) – On channel dam in Mfolozi with the Hluhluwe future demands

Scenario 2(a) will be modelled based on the future envisaged growth in the domestic water of the Hluhluwe catchment which may impact on the St Lucia Lake as indicated in Table 5-5 while the Mfolozi River system the in-channel dam is developed as discussed in scenario 1(a).

The improved water use efficiency of the projected consumptive use will be used in the hydrological analysis.

5.4.1.4 Scenario 2(b)

The scenario 2(b) will be the off-channel storage dam at Nkatha Pan taking into account the future water requirements as provided in Table 5-2 above for the lower Mfolozi River system. This also includes the Hluhluwe River system demands as provided in Table 5-5.

5.4.1.5 Scenario 3

Scenario 3 is the scenario where no storage development takes place in the lower Mfolozi River. Instead the future water demands of the Mtubatuba are supplied from Lake Nsezi. This will increase the return flow in the lower Mfolozi and have a positive impact on the base flows of the Lower Mfolozi River system.

5.5 Kosi Bay

5.5.1 Overview

The water resources supplying Kosi bay is from the large sand aquifer in the W70 catchment. This is also the only source of water supply for the domestic sector in the catchment. Domestic water requirements have been growing and are expected to grow because of the envisaged development in the area. Any abstractions from groundwater will have an impact on Kosi Bay. Therefore scenarios have been developed in order to determine the impact on the Kosi Bay system.

5.5.2 Scenario KB1-1: Base case demands without the EWR

Scenario KB1-1 includes:

- Current demands from groundwater (Table 5-6)

Table 5-6: Base demand in the Kosi Bay area catchment

Water User	Quaternary catchment	Current demand (2011) / Registered use
Kwanganase scheme	W70A	1.39
Pelindaba scheme		0.31
Ekhanyizeni scheme		0.22
Total		1.91

5.5.3 Scenario KB1–2 –Future water requirements met from groundwater

Scenario KB1-2 includes:

- 2040 demands for domestic water requirements (Table 5-7).

Table 5-7: Future water requirements for Kosi Bay

Water User	Quaternary catchment	Current demand (2011) / use	2015	2020	2025	2030	2035	2040
Kwanganase scheme	W70A	1.39	1.88	2.19	2.40	2.63	2.85	2.89
Pelindaba scheme		0.31	0.36	0.43	0.48	0.54	0.59	0.67
Ekhanyizeni scheme		0.22	0.27	0.30	0.32	0.33	0.35	0.50
Total		1.91	1.96	2.00	2.05	2.09	2.14	2.19

5.6 Lake Sibayi

5.6.1 Overview

There are commercial forests surrounding Lake Sibayi, including groundwater abstraction for domestic supply to Mseleni and Mbazwana areas. Mseleni also directly abstracts from Lake Sibayi. The impact of the current and future developments in the area on the Lake, need to be evaluated.

5.6.2 Scenario LS1-1: Base case demands without the EWR

Scenario LS1-1 includes:

- Current demands from groundwater and direct abstraction from the Lake (Table 5-8)

Table 5-8: Base demand in the Lake Sibayi area catchment

Water User	Quaternary catchment	Current demand (2011) / Registered use
Mbazwana scheme	W70A	0.74
Mseleni scheme		0.59
Sub-total domestic demands		1.33
Irrigation	W70A	0.11
Afforestation	W70A	11.86

5.6.3 Scenario LS1-2: Base case demands with illegal commercial forests removed

Scenario LS1-2 includes:

- Current demands
- Removal of illegal commercial forests

5.6.4 Scenario LS1-3: Future water requirements met from groundwater

Scenario LS1-3 includes:

- 2040 water demands for the domestic sector (Table 5-9)

Table 5-9: Future water requirements for Lake Sibayi

Water User	Quaternary catchment	Current demand (2011) / Registered use	2015	2020	2025	2030	2035	2040
Mbazwana scheme	W70A	0.74	1.38	1.47	1.58	1.76	1.94	2.13
Mseleni scheme		0.59	0.73	0.78	0.83	0.88	0.93	0.98
Sub-total domestic demands		1.33	1.36	1.39	1.42	1.45	1.49	1.52
Irrigation	W70A	0.11						
Afforestation	W70A	11.86						

5.7 Other estuaries

There are neither significant current demands nor planned major developments immediately upstream of the rest of the estuaries in the Mhlathuze River that form part of the EWR determination. These include Amatikulu/Nyoni and the Mlalazi. In the case of the Amatikulu/Nyoni, the scenarios developed for the river system connecting to these estuaries are applicable.

In the case of the Mlalazi estuaries, the town of Eshowe is supplied from the Mhlathuze River system and not from the Mlalazi River. Therefore the impact on the estuary would be increased flows due to return flows into the Mlalazi River catchment.

6 REFERENCES

1) Department of Water Affars (DWA), 2011a, Gert Sibande District Municipality: First Order Reconciliation Strategy for Piet Retief Water Supply Scheme Area – Mkhondo Local Municipality
2) Department of Water Affars (DWA), 2011b, Zululand District Municipality: First Order Reconciliation Strategy for Greater Paulpietersburg Water Supply Scheme Area – eDumbe Local Municipality
3) Department of Water Affars (DWA), 2011c, Zululand District Municipality: First Order Reconciliation Strategy for Simdlangentsha West Regional Water Supply Scheme Area – eDumbe Local Municipality
4) Department of Water Affars (DWA), 2011d, Umkhanyakude District Municipality: First Stage Reconciliation Strategy for Jozini-Malobeni Water Supply Scheme Area
5) Department of Water Affars (DWA), 2011e, Umkhanyakude District Municipality: First Stage Reconciliation Strategy for Mhuze Ubombo Water Supply Scheme Area– Jozini Local Municipality
6) Department of Water Affars (DWA), 2011f, Zululand District Municipality: First Stage Reconciliation Strategy for Greater Nongoma (vuna) Water Supply Scheme Area - Nongoma Local Municipality
7) Department of Water Affars (DWA), 2011g, Zululand District Municipality: First Stage Reconciliation Strategy for the Usuthu (Ceza) Regional Water Supply Scheme Area - Ulundi Local Municipality
8) Department of Water Affars (DWA), 2011h, Uthungulu District Municipality: First Stage Reconciliation Strategy for Eshowe Water Supply Scheme Area – Umlalazi Local Municipality
9) Department of Water Affars (DWA), 2011j, Uthungulu District Municipality: First Stage Reconciliation Strategy for Gingindlovu Water Supply Scheme Area – Umlalazi Local Municipality
10) Department of Water Affars (DWA), 2011k, Uthungulu District Municipality: First Stage Reconciliation Strategy for Mhlana Somopho Water Supply Scheme Area – Mbonambi Local Municipality
11) Department of Water Affars (DWA), 2011m, City Of Umhlathuze Local Municipality: First Order Reconciliation Strategy for Richards Bay
12) Department of Water Affars (DWA), 2013, Continuation of Reconciliation Strategies for All Towns in the Eastern Region, Background and Issues Document on the Water Supply Situation in the White Mfolozi River
13) Water Research Commission, 2008, Water Resources of South Africa, 2005 Study (WR2005).
14) Google Earth, 2013, Image Land Sat