DWS report number: P WMA 04/W100/00/9218/7

PREPARED FOR:

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

DIRECTORATE: NATIONAL WATER RESOURCE PLANNING

The Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns

Updated Reconciliation Strategy

FINAL
March 2021

FC/02711.cdr

P WMA 04/W100/00/9218/7

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

IMPLEMENTATION AND MAINTENANCE OF THE WATER RECONCILIATION STRATEGY FOR RICHARDS BAY AND SURROUNDING TOWNS

UPDATED RECONCILIATION STRATEGY

(FINAL)

MARCH 2021

COMPILED FOR:	COMPILED BY:
Department of Water and Sanitation Contact person: K Mandaza Private Bag X313, Pretoria 0001 South Africa Telephone: +27(0) 12 336 7670 Email: MandazaK@dws.gov.za	**BJ/iX/WRP Joint Venture** Contact person: C Seago Block 5, Green Park Estate, 27 George Storrar Drive, Pretoria Telephone: +27(0) 12 346 3496 Email: caryns@wrp.co.za

IMPLEMENTATION AND MAINTENANCE OF THE WATER RECONCILIATION STRATEGY FOR RICHARDS BAY AND SURROUNDING TOWNS

UPDATED RECONCILIATION STRATEGY

(FINAL)

MARCH 2021

This report is to be referred to in bibliographies as:

Department of Water and Sanitation, South Africa, March 2021. IMPLEMENTATION AND MAINTENANCE OF THE WATER RECONCILIATION STRATEGY FOR RICHARDS BAY AND SURROUNDING TOWNS: WATER RECONCILIATION STRATEGY. P WMA 04/W100/00/9218/7

LIST OF STUDY REPORTS

Report Name	Report Number	DWS Report Number
Inception	1	P WMA 04/W100/00/9118
Economic Growth and Demographic Analysis for the Richards Bay Reconciliation Strategy	2	P WMA 04/W100/00/9218
Water Requirements and Return Flows Report	3	P WMA 04/W100/00/9318
Water Conservation / Water Demand Management	4	P WMA 04/W100/00/9218/4
Water Resources	5	P WMA 04/W100/00/9218/5
Infrastructure and Cost Assessment	6	P WMA 04/W100/00/9218/5
Updated Reconciliation Strategy	**7**	**P WMA 04/W100/00/9218/7**
Executive Summary: Updated Reconciliation Strategy	8	

Title:	**Updated Reconciliation Strategy**
Authors:	**Study Team**
Project Name:	**Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns**
DWS Report No:	**P WMA 04/W100/00/9218/7**
Status of Report:	**Final**
First Issue:	**February 2021**

Consultants: **BJE/iX/WRP Joint Venture**

Approved for the Consultants by:

L.M.G. Louw
....

L Louw

Study Leader

DEPARTMENT OF WATER AND SANITATION

Directorate National Water Resource Planning

Approved for the Department of Water and Sanitation by:

KMandza
....

K Mandaza

Project Manager: National Water Resource Planning (East)

....

P Mlilo

Director: National Water Resource Planning

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

BJ	Black Jills Engineers Pty Ltd. (BJE)
CBA	Critical Biodiversity Areas
CoMLM	City of uMhlathuze Local Municipality
CoV	Coefficient of Variance
DWA	Department of Water Affairs (now DWS)
DWAF	Department of Water Affairs and Forestry (now DWS)
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
ESA	Ecological Support Areas
EWR	Ecological Water Requirement
FSC	Full Supply Capacity
HFY	Historic Firm Yield
IAPs	Invasive Alien Plants
IFR	Instream Flow Requirement
iX	iX Engineers Pty Ltd.
KCDM	King Cetshwayo District Municipality
KZN	KwaZulu-Natal
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MORFP	Mhlathuze Operating Rules and Future Phasing
MWAAS	Mhlathuze Water Availability Assessment Study
NMAR	Natural Mean Annual Runoff
NMMP	National Microbial Monitoring Programme
NWA	National Water Act
NWU	North-West University
PES	Present Ecological State
Per.	Percentile (%)
RBM	Richards Bay Minerals
RBWSS	Richards Bay Water Supply System
RDM	Resources Directed Measures
RI	Recurrance Interval
SFRA	Streamflow Reduction Activity
St. dev	Standard Deviation
TDS	Total dissolved salts
WRP	WRP Consulting Engineers Pty Ltd.
WR90	Water Resources Study 1990
WRPM	Water Resources Planning Model
WRYM	Water Resources Yield Model
WSS	Water Supply Scheme
WTW	Water Treatment Works

LIST OF UNITS AND SYMBOLS

ha	Hectare
l/c/d	Litres per Capita per Day
km^2	Square Kilometres
Mℓ/d	Mega Litres per Day
m^3/a	Cubic Metres per Annum
mcm/a	Million Cubic Metres per Annum
$m^3/ha/a$	Cubic Metres per Hectare per Annum
$m^3/km^2/a$	Cubic Metres per Square Kliometre per Annum
million m^3/a	Million Cubic Metre per Annum
m^3/s	Cubic Metres per Second
%	Percentage

EXECUTIVE SUMMARY

Introduction

The Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns (this Study) followed on from the *Reconciliation Strategy for Richards Bay and Surrounding Towns (DWS, 2015a)*. The overall objective of this Study was to systematically update and improve the Strategy (2015) in order for the Strategy (2015) to remain technically sound, economically feasible, as well as socially acceptable and sustainable. This report is the updated Reconciliation Strategy and is preceded by a number of supporting technical reports.

Study Area

The main focus of this Study was the Richards Bay Water Supply System (RBWSS). The RBWSS supplies water to the City of uMhlathuze Local Municipality (CoMLM), which comprises the towns of Richards Bay, Empangeni, Ngwelezane and Esikhaweni, as well as a number of rural villages. Furthermore, the RBWSS also supplies large well-developed industries, commercial areas and business centres within the Study Area. The RBWSS's supply area is within the Mhlathuze River Catchment, which is the major water resource. Water is, however, also sourced from various natural lakes within the Catchment such as Lake Nhlabane, Lake Mzingazi and Lake Cubhu. The Catchment also serves as the resource for agriculture, both irrigated and dryland, afforestation, as well as ecological requirements.

Background and Approach

This report provides the final updated Water Reconciliation Strategy prepared as a result of this Study. The original Strategy (DWS, 2015a) was used as a basis for the update. In addition to the update of the Strategy, part of the Study has included the monitoring of progress of implementation of the original Strategy interventions. This has been undertaken in the form of Strategy Steering Committee Meetings whereby responsible Institutions have provided feedback on progress.

Aspects Supporting Strategy Formulation

A number of detailed assessments have been undertaken as part of this Study in order to obtain the required information to update the Reconciliation Strategy. These Tasks have been documented in separate supporting reports covering:

- Demographics and Socio Economic Impacts;
- Water Requirements;
- Water Conservation and Water Demand Management;

- Water Resources; and
- Infrastructure and Cost Assessment.

The demographic assessment gathered information from various sources relating to current population estimates and future population growth. The growth considered aspects such as migration due to future job opportunities etc. Over the projection period (up till 2045) the realistic population growth estimates for the CoM LM were determined to be approximately 2.5% on an annual average.

Current water requirements for the various water user sectors were obtained and used as a basis to develop future water requirement projections. The results from the demographic assessment were used for the urban sector water requirement projections. Existing allocations were used for the irrigation sector, and no growth in these requirements were assumed. Landuse impacts resulting from afforestation and alien vegetation were obtained and included. The Environmental Flow Requirements Gazetted as part of the Compulsory License Process were also included. The following figure presents a breakdown of the water requirements per user sector.

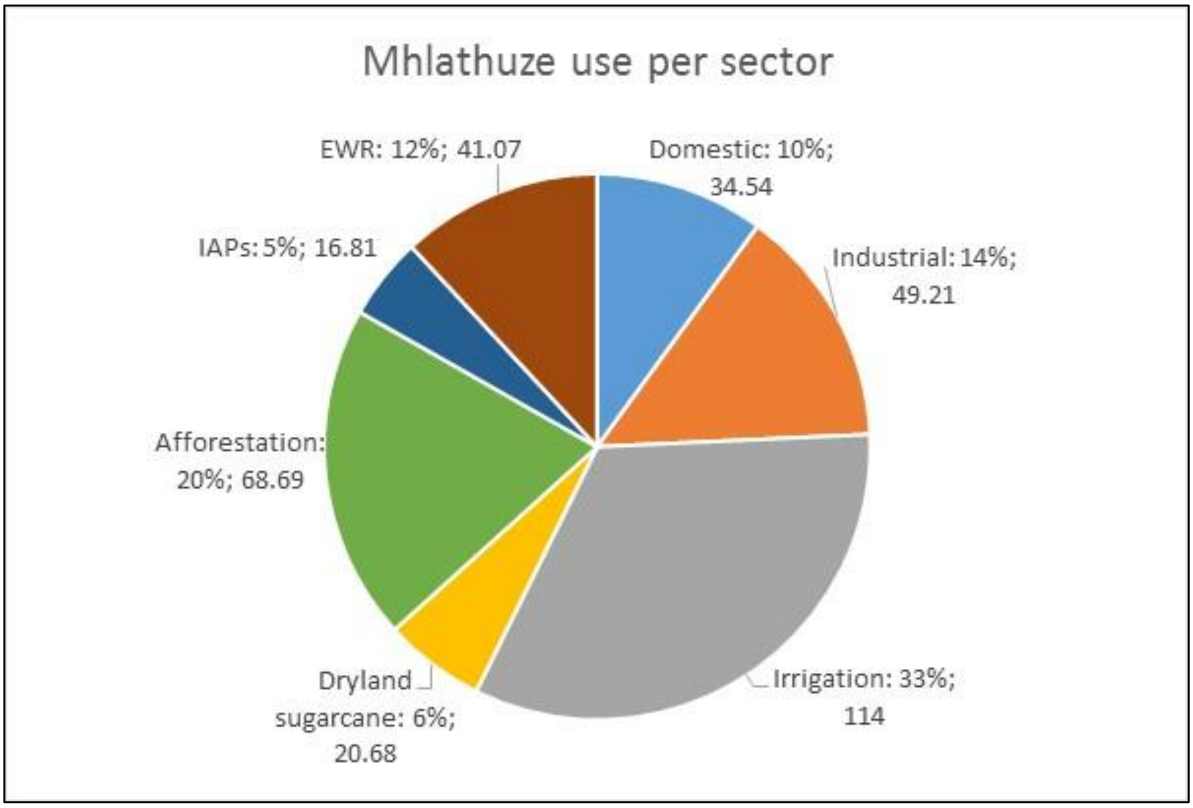


Figure 1: Water Use per use Sector (2017)

A detailed water conservation and water demand management assessment was undertaken, focusing on the urban sector. The results indicated that, on implementing a suitable plan including institutional, financial, social and technical components, the CoM could achieve a

10% saving on water losses and the KCDM could aim for a 15% saving for the smaller urban areas.

The water resources assessment included updating the DWS water resources simulation models with all the latest available information. Yield and scenario planning analyses were then undertaken. The results indicate that the existing water resources of the Mhlathize system are not sufficient to provide the users with their water at the required level of assurance from the year 2021 onwards.

The infrastructure assessment updated the costs of various intervention activities which are then ranked in terms of their Unit Reference Values. The results indicated the cheapest intervention would be to raise Goedertrouw Dam, with desalination of seawater being the most expensive intervention.

Water Balances

Individual water balances have been prepared for five different systems and sub-systems. The decision on differentiating between water balance areas involved grouping of users sharing similar water resources. The Strategy presents the current water balances for each of the systems, as well as future projected balances including intervention options. The water balance for the high growth scenario for the Mhlathuze System is presented in the following figure.

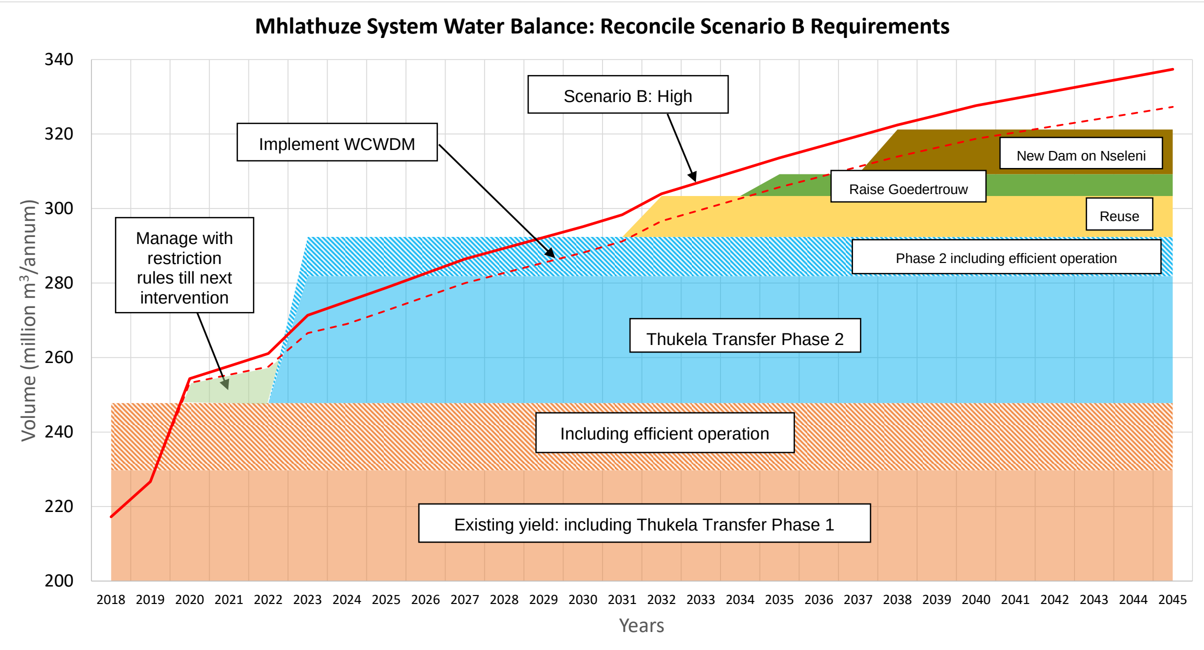


Figure 2: Water Balance: High water requirement projection scenario

Strategy Actions and Implementation Plan

Various Institutions and Organisations have been assigned responsibilities in order to implement the Strategy interventions. The following table provides a summary of the intervention action plan.

Intervention	Primary Responsibility	Target Date (priority)
WCWDM	Local Municipalities: City of Mhlathuze LM, KCDM,	High priority, implementation to continue/start immediately CoM: 10% savings, reduction in growth by 2025 KCDM: 15% savings, reduction in growth by 2025
Maintain existing Thukela Transfer scheme	MW DWS: RO: NWRI	Immediate and ongoing
Complete Thukela Transfer upgrade from Middeldrift	DWS: RO MW	High priority (December 2023)
Water Reuse	CoM LM	Medium priority level (2032)
Interim Restriction Rule to Benefit Priority (Primary) Users	DWS: Directorate Water Resources Planning Systems	Immediate and ongoing
Efficient system operation	DWS RO	Immediate and ongoing
Existing Dam Raising	DWS: OA	Low priority (2035)
New Dam Construction	MW	Low priority (dam construction) (2038) Medium priority (feasibility study)
Lower Thukela Transfer to KCDM	Umgeni Water	High priority
Remove alien vegetation	Department of Environmental Affairs, Mhlathuze CMF	Immediate and ongoing
Promote local Groundwater development	Municipalities	As and when required

1 INTRODUCTION

1.1 Background to this Study

The Department of Water and Sanitation (DWS) commissioned a study on the Water Reconciliation Strategy for Richards Bay and Surrounding Towns (2013-2015) to inform the planning and implementation of water resource management interventions necessary to reconcile future water requirements and water use patterns up to a period of thirty years until 2044.

For the Reconciliation Strategy for Richards Bay and Surrounding Towns (DWS, 2015a), referred to as the Strategy (2015) hereafter, to be implemented, and for the Strategy (2015) to remain relevant in order to properly fulfil its purpose into the future it has to be dynamic. Hence, the water balance has to be continuously monitored and the developed Strategy has to be regularly updated and maintained. This would ensure that planned intervention options to be implemented will also consider any changes, including climate change, that may have potential impacts on the projected water balance.

The DWS commissioned the Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns Study, referred to as this Study hereafter, to facilitate a process to maintain the relevance of the Strategy (2015).

1.2 Objectives of this Study

The overall objective of this Study was to systematically update and improve the Strategy (2015) in order for the Strategy (2015) to remain technically sound, economically feasible, as well as socially acceptable and sustainable. To assist with this, this Study was divided into a number of tasks, each focusing on various aspects that supported the updating of the Strategy (2015). Each Task had the objective to update information included in the Strategy (2015) and incorporate the updates into the updated Strategy.

This report provides the updated Reconciliation Strategy for Richards Bay and surrounding towns. The report summarises all the technical Tasks undertaken, the details thereof provided in separate stand alone documents (DWS 2018a, DWS 2018b, DWS 2019, DWS 2020a, DWS 2020b).

1.3 Study Area

The main focus of this Study was the Richards Bay Water Supply System (RBWSS). The RBWSS supplies water to the City of uMhlathuze Local Municipality (CoMLM), which comprises the towns of Richards Bay, Empangeni, Ngwelezane and Esikhaweni, as well as a number of rural villages. Furthermore, the RBWSS also supplies large well-developed industries, commercial areas and business centres within the Study Area. The RBWSS's supply area is within the Mhlathuze River Catchment, which is the major water resource. Water is, however, also sourced from various natural lakes within the Catchment such as Lake Nhlabane, Lake Mzingazi and Lake Cubhu. The Catchment also serves as the resource for agriculture, both irrigated and dryland, afforestation, as well as ecological requirements.

The Study Area includes the Mhlathuze River Catchment as illustrated in **Figure 1-1**. The Mhlathuze River Catchment receives inter-catchment transfers from the Umfolozi River and Thukela (Tugela) River Catchments and, as a result, these Catchments are also part of the Water Supply System/Study Area. Additional smaller towns not incorporated in the Strategy (2015), namely, Eshowe, Mtunzini, Melmoth, Gingindlovu and Amatikulu, were included in this Study. As a result of this, the catchments south of the Mhlathuze, namely the Mlalazi and Amatikulu were also considered as part of this Study.

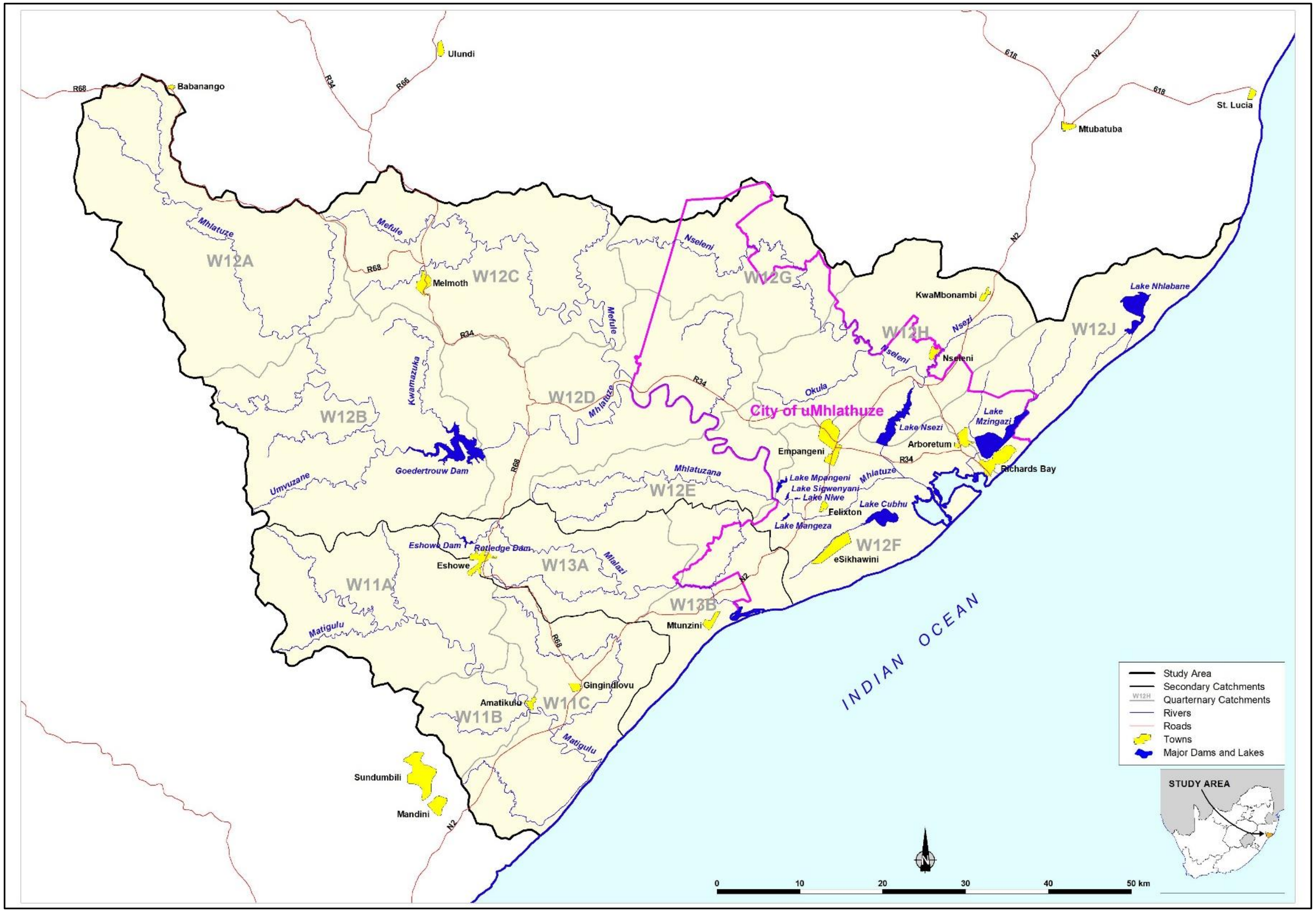


Figure 1-1: Locality map of the Study Area

1.4 Purpose and Structure of this Report

This report presents the updated water reconciliation strategy for the Richards Bay and surrounding towns located in the Mhlathuze, Mlalazi and Amatikulu catchments. The purpose of this report was to:

- Summarise the information obtained and assessed as part of preceding detailed Technical Reports produced as part of this Study.
- Present the current water balance status in terms of existing resources and water requirements.
- Determine future intervention options in order to augment the existing water resources.
- Present water balances comparing future water requirement projections with intervention options implemented on a timeline.
- Assign responsibility for implementation of actions to various applicable institutions.

The report is structured as follows:

- **Section 1** provides a formal overview of the Study Area, this strategy and the purpose and structure of this report.
- **Section 2** presents an overview of the current water use and projected water requirements.
- **Section 3** provides a summary of the Water Conservation and Water Demand Management assessment undertaken.
- **Section 4** presents the water resources availability from the catchments included in the Study Area.
- **Section 5** provides the current water balances included existing water resources only.
- **Section 6** provides an overview of the various options to increase water supply or decrease water requirements available to the Study Area.
- **Section 7** presents a reconciliation of water requirements and intervention options in the form of water balance plots.
- **Section 8** provides and implementation action plan including the assignment of responsibility to various Institutions.
- **Section 9** presents recommendations for further work relating specifically to the future update and enhancement of the Strategy.
- Section **10** indicates the study references.

2 CURRENT WATER USE AND PROJECTED WATER REQUIREMENTS

2.1 Demographics and Population Projections

A detailed demographic assessment was carried out and is documented in DWS, 2018a, one of the preceding technical reports to this Strategy.

Two population growth scenarios were developed, namely a realistic growth and a high growth scenario. Historical evidence shows that the smaller settlements in the surrounding Local Municipalities are not growing at the same rate as larger towns such as Richards Bay within the CoMLM. Past Demographic Studies typically required low and high population growth scenarios to be developed. The approach taken in this study was to develop a realistic and a high population projection scenario.

Furthermore, each Water Supply Scheme (WSS) has various varying factors that affect each WSS's individual characteristics. The following demographic development determinants were taken into account:

- Migration;
- Mortality;
- Fertility, and
- HIV/AIDS.

There are indications that there is significant migration of people from rural communities in search of the perceived job opportunities in urban centres. These people settle within low income settlements in and around these urban centres. This trend is evident in rural Nkandla, Middledrift and Mthonjaneni signaling declines in population growth rates, and in some cases negative growth. A decline in agriculture as a source of living has left many working age-group adults with fewer options in the rural communities, resulting in them choosing to migrate to nearby settlements surrounding major towns such as Esikhaweni east and west. These trends place enormous pressure on the already over-extended, and under-supplied social services (e.g. schools, clinics), as well as on the existing infrastructure and services (e.g. water, sanitation, electricity, etc.). Population growth projections therefore need to consider in-migration, in order to estimate what this could entail for future population distribution and resource requirements (e.g. for water, sanitation, etc.).

The CoMLM is experiencing rapid population growth as a result of migration into the area in search of a better life and job opportunities. Very limited information is available pertaining to migration patterns at local level (municipal level). It is, however, also a fact that a lack of sufficient job opportunities to accommodate an economically active population, together with past apartheid policies of influx control, has entrenched a migratory labour pattern in the area as is the case in the rest of South Africa.

According to StatsSA, the South African infant mortality rate for 2017 is estimated at 32,8 per 1 000 live births. The estimated overall HIV prevalence rate is approximately 12,6% amongst the South African population. Furthermore, the total number of people living with HIV in South Africa was estimated to be approximately 7,06 million in 2017 and an estimated 18% of people aged between 15 to 49 years in South Africa are HIV positive.

This health pattern is also evident from Census information, which indicates a discrepancy in the gender structure. Male absenteeism is higher in many rural areas, but some females also form part of the migrant labour pattern, although substantially less than males. Life expectancy of South Africans at birth for 2017 is estimated at 61,2 years for males and 66,7 years for females.

The above-mentioned demographic trends influencing population growth have been taken into account for both the realistic and high growth scenarios designed for the CoMLM and the other five LMs within the Broader Study Area.

The projected population growth forecasts depict population growth within each one of the WSSs supply areas, within the Study Area, over a slightly more than 20-year period. This was arrived at after careful consideration of factors within each one of the WSSs (DWS, 2018a). The projected population figures for each of the WSSs until 2040 for the realistic and high growth scenarios are given respectively in **Table 2-1** and **Table 2-2**.

The average growth per five year interval, from 2010 to 2040, for all the WSSs within the CoMLM is an approximate 40,000 to 50,000 additional people per five year interval for the realistic and high population growth scenarios respectively. The combined population within all of the WSSs supply areas, within the CoMLM, is projected to increase from a base of 351,260 people in 2016 to 547,130 people for the realistic population growth scenario, and to 592,740 people for the high growth population scenario, in 2040.

The locations of the Water Supply Schemes within the CoMLM are presented in **Figure 2-1.**

Table 2-1: Projected Population Figures for the CoMLM from 2016 to 2040 for the Realistic Growth Scenario

Water Supply Scheme	Population Figures						
	2016	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
Richards Bay	47 940	50 482	53 131	60 265	68 230	77 105	86 977
Meer En See	9 732	9 888	10 038	10 405	10 604	10 604	10 604
Empangeni	24 181	25 512	26 902	30 638	34 804	39 436	44 574
Felixton	1 099	1 128	1 155	1 217	1 283	1 352	1 426
Esikhaweni East	126 444	130 419	134 437	144 814	155 761	167 293	179 424
Esikhaweni West	38 119	40 694	43 164	49 292	55 558	61 882	68 195
Ngwelezane	61 245	64 025	66 638	72 919	79 083	85 079	90 868
Nseleni	42 500	44 585	46 552	51 305	56 002	60 599	65 062
Total	**351 260**	**366 734**	**382 017**	**420 856**	**461 323**	**503 350**	**547 130**

Table 2-2: Projected Population Figures for the CoMLM from 2016 to 2040 for the Higher Growth Scenario

Water Supply Scheme	Population Figures						
	2016	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
Richards Bay	47 940	50 508	53 213	60 628	69 076	78 701	89 667
Meer En See	9 732	9 888	10 046	10 439	10 661	10 729	10 750
Empangeni	24 181	25 526	26 945	30 829	35 249	40 276	45 990
Felixton	1 099	1 131	1 164	1 247	1 335	1 430	1 532
Esikhaweni East	126 444	130 460	134 603	145 547	157 319	169 978	183 585
Esikhaweni West	38 119	40 985	44 067	52 355	61 676	72 074	83 580
Ngwelezane	61 245	64 338	67 586	75 981	84 924	94 608	105 058
Nseleni	42 500	44 820	47 267	53 386	59 683	66 099	72 579
Total	**351 260**	**367 656**	**384 893**	**430 411**	**479 924**	**533 895**	**592 740**

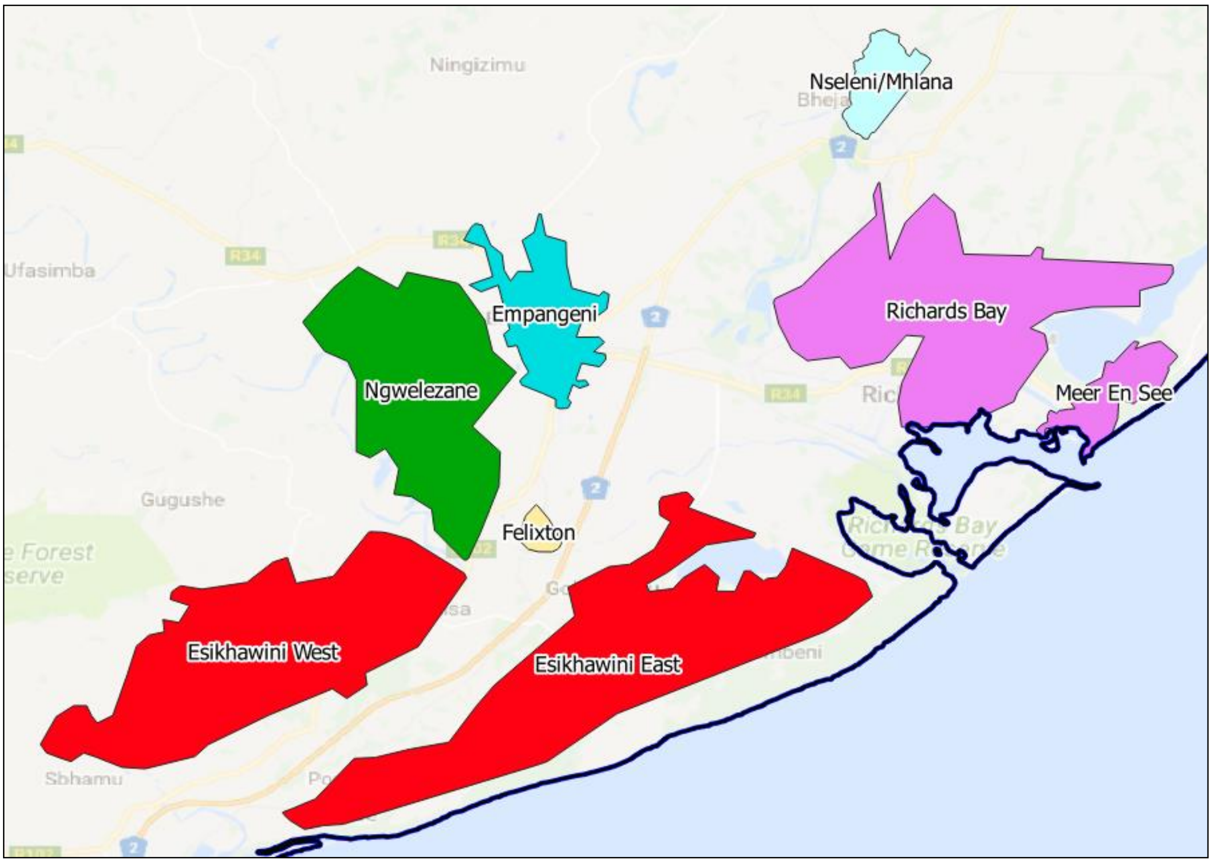


Figure 2-1: Map of urban demand centres in the RBWSS

The population projections for the smaller towns included in the Study, which are located outside of the CoMLM, are given in **Table 2-3** and **Table 2-4**.

Table 2-3: Projected Population Figures for the Realistic Population Growth Scenario within the Broader Study Area

Area/Town	Population Figures						
	2016	2018	2020	2025	2030	2035	2040
Other Towns in the Broader Study Area							
Eshowe Town	9 386	9 593	9 804	10 353	10 933	11 546	12 192
Gingindlovu Town	1 153	1 171	1 189	1 236	1 284	1 335	1 387
Mtunzini Town	2 266	2 307	2 349	2 456	2 568	2 686	2 808
Melmoth Town	8 252	8 434	8 620	9 102	9 612	10 151	10 719
Amatikulu Town	536	545	553	576	600	624	650
Totals Towns	**21 593**	**22 050**	**22 515**	**23 723**	**24 997**	**26 342**	**27 756**

Table 2-4: Projected Population Figures for the High Population Growth Scenario within the Broader Study Area

Area/Town	Population Figures						
	2016	2018	2020	2025	2030	2035	2040
Other Towns in the Broader Study Area							
Eshowe town	9 386	9 622	9 864	10 496	11 169	11 885	12 646
Gingindlovu town	1 153	1 172	1 190	1 239	1 289	1 341	1 396
Mtunzini town	2 266	2 325	2 386	2 545	2 715	2 896	3 089
Melmoth town	8 252	8 451	8 655	9 187	9 752	10 351	10 987
Amatikulu	536	546	555	580	607	634	663
Total Towns	**21 593**	**22 116**	**22 650**	**24 047**	**25 532**	**27 107**	**28 781**

2.2 Urban Water Requirements (DWS, 2018b)

The definition of the urban water use sector includes water requirements for both residential and light industrial purposes. The CoMLM consists of the main urban demand centres of Richards Bay, Empangeni, Esikhaweni (east and west), Ngwelezane and Nseleni.

Population growth estimations and the related economic growth characteristics within the study area formed the basis for the calculation of the domestic water requirement calculations. An increase in service levels over time was introduced resulting in an increase in the per capita water uses, specifically in those areas with currently low service levels.

An in depth assessment took place for each demand centre which included obtaining the following information:

- Actual use prior to development of Strategy (2015) for years 2008 – 2013.
- Strategy (2015) low medium and high projections from 2013 onwards.
- Actual use for years 2013 to 2017 (these incorporated drought years).
- Allocated/licensed water available.
- Updated high and moderate projections.

Figure 2-2 to **Figure 2-6** provide graphical representations of the information obtained for each urban demand centre. In all cases, the anticipated growth will start to exceed the allocations allowed for in the near future.

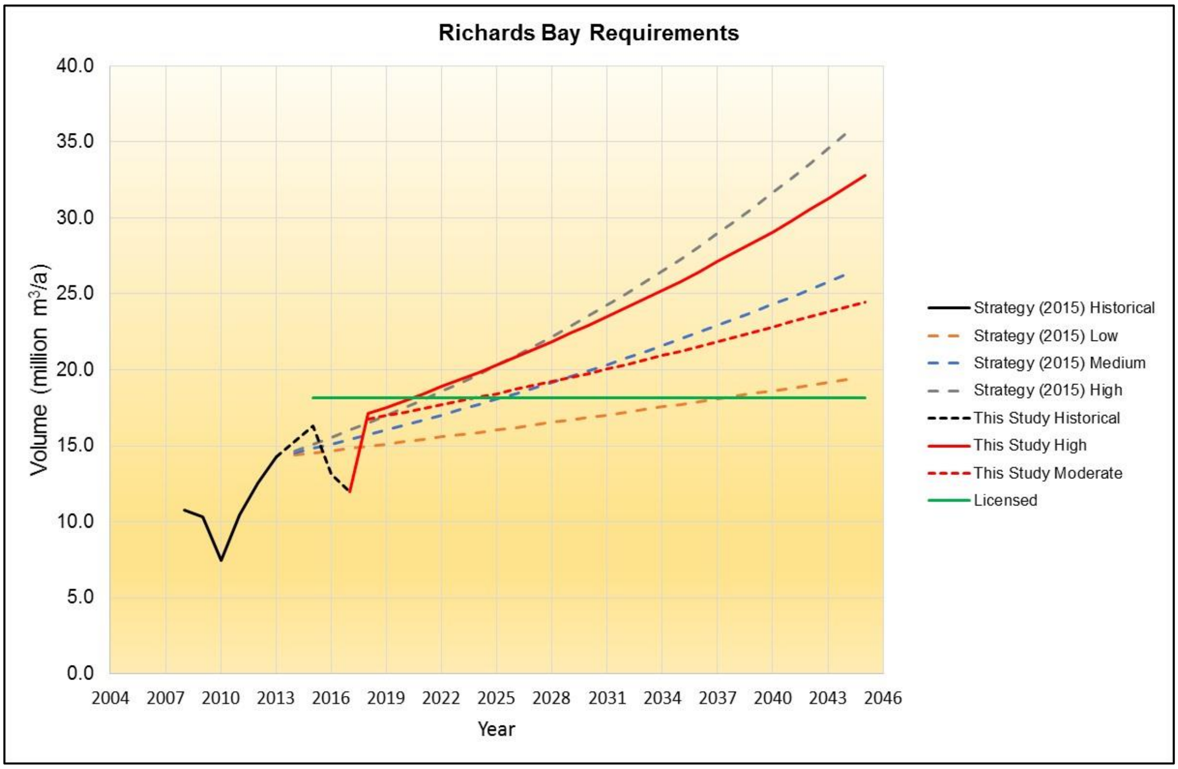


Figure 2-2: Water requirements of Richards Bay

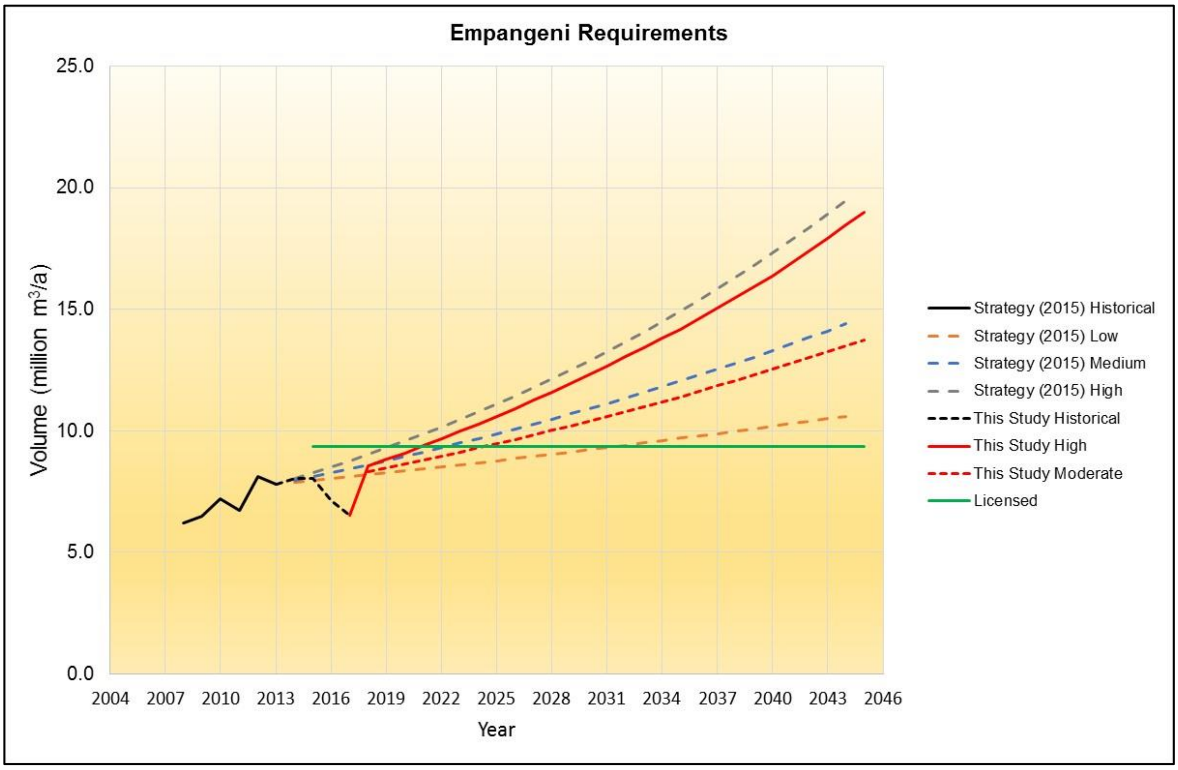


Figure 2-3: Water requirements of Empangeni

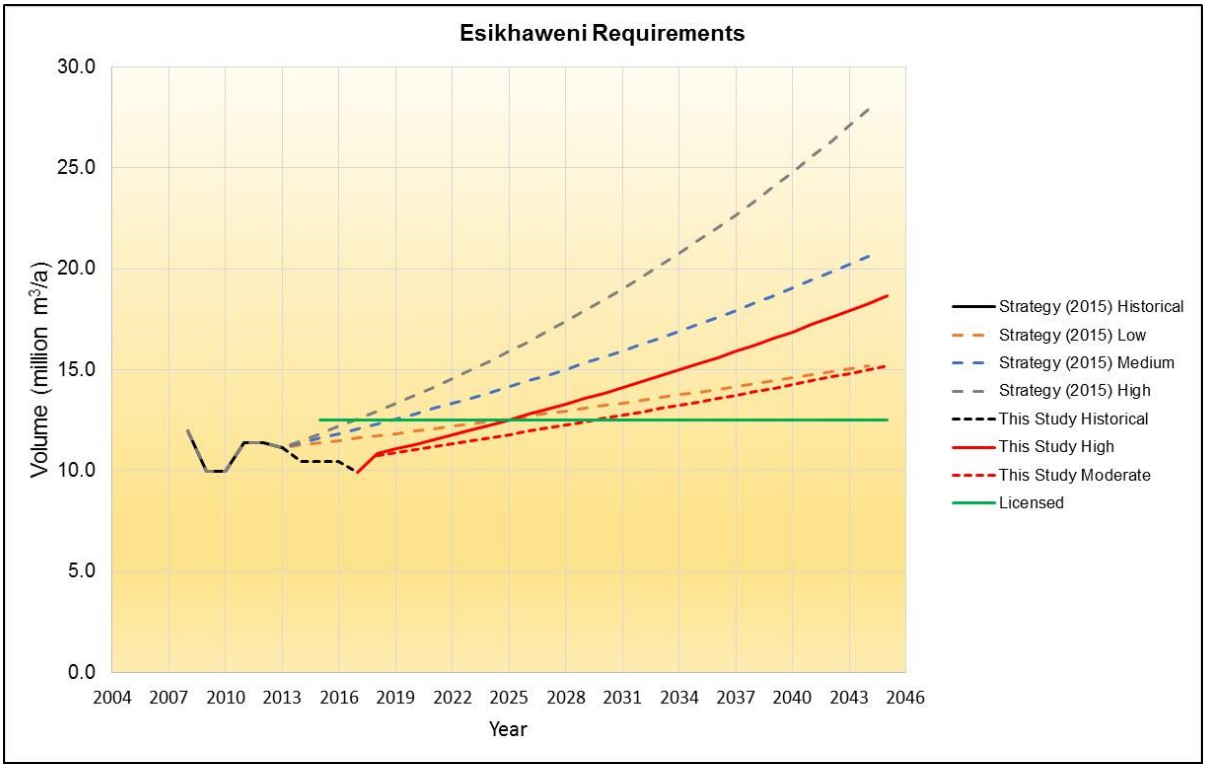


Figure 2-4: Water requirements of Esikhaweni

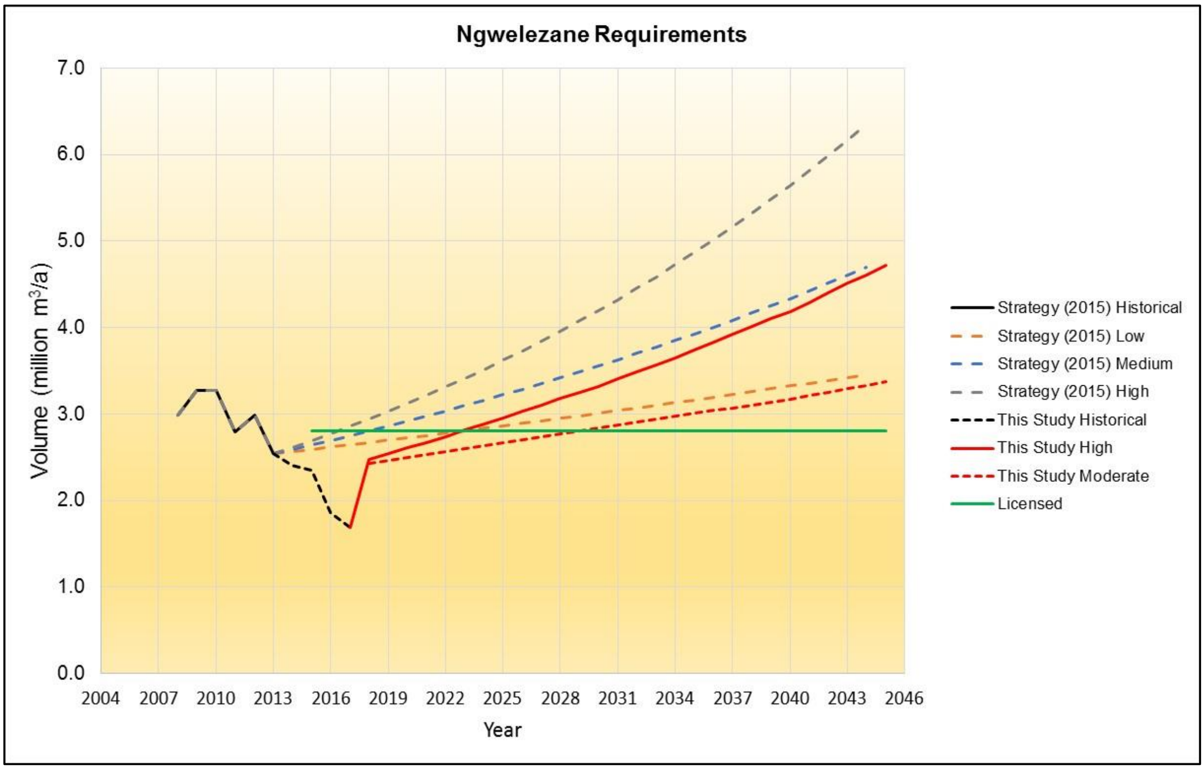


Figure 2-5: Water requirements of Ngwelezane

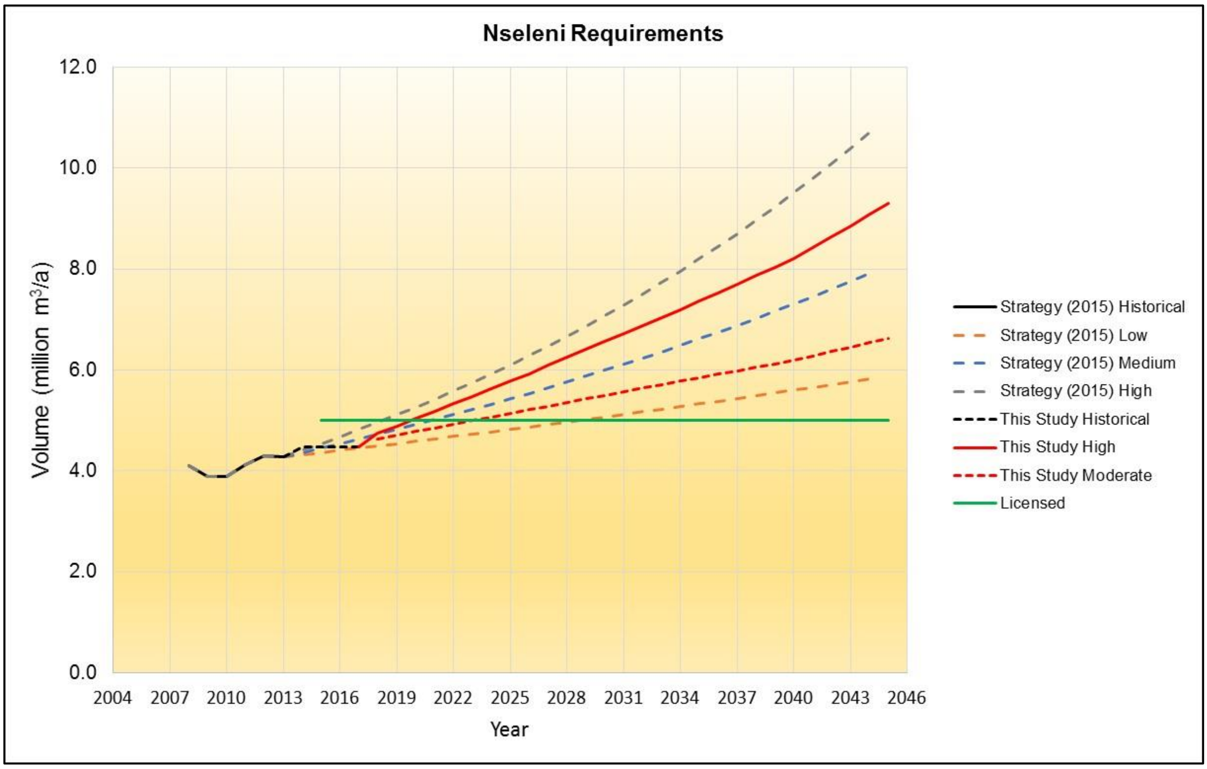


Figure 2-6: Water requirements of Nseleni

Figure 2-7 provides a locality map of the additional surrounding towns included in the Strategy update. The growth in water requirements for these towns are provided in **Table 2-5**.

Table 2-5: Future water requirements for surrounding towns

Town	Growth Scenario	2016	2020	2025	2030	2035	2040	2045	Compounded Growth (%)
		million m^3/a							
Eshowe	Moderate	2.08	2.15	2.24	2.33	2.43	2.53	2.64	0.82
	High	2.08	2.23	2.43	2.64	2.85	3.07	3.33	1.64
Gingindlovu (incl. Amatikulu)	Moderate	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.57
	High	0.33	0.34	0.36	0.37	0.39	0.41	0.43	0.93
Melmoth	Moderate	0.86	0.89	0.92	0.96	1.00	1.05	1.09	0.82
	High	0.86	0.92	1.00	1.09	1.17	1.26	1.36	1.59
Mtunzini	Moderate	0.46	0.47	0.49	0.50	0.52	0.54	0.56	0.67
	High	0.46	0.49	0.52	0.56	0.60	0.65	0.70	1.43

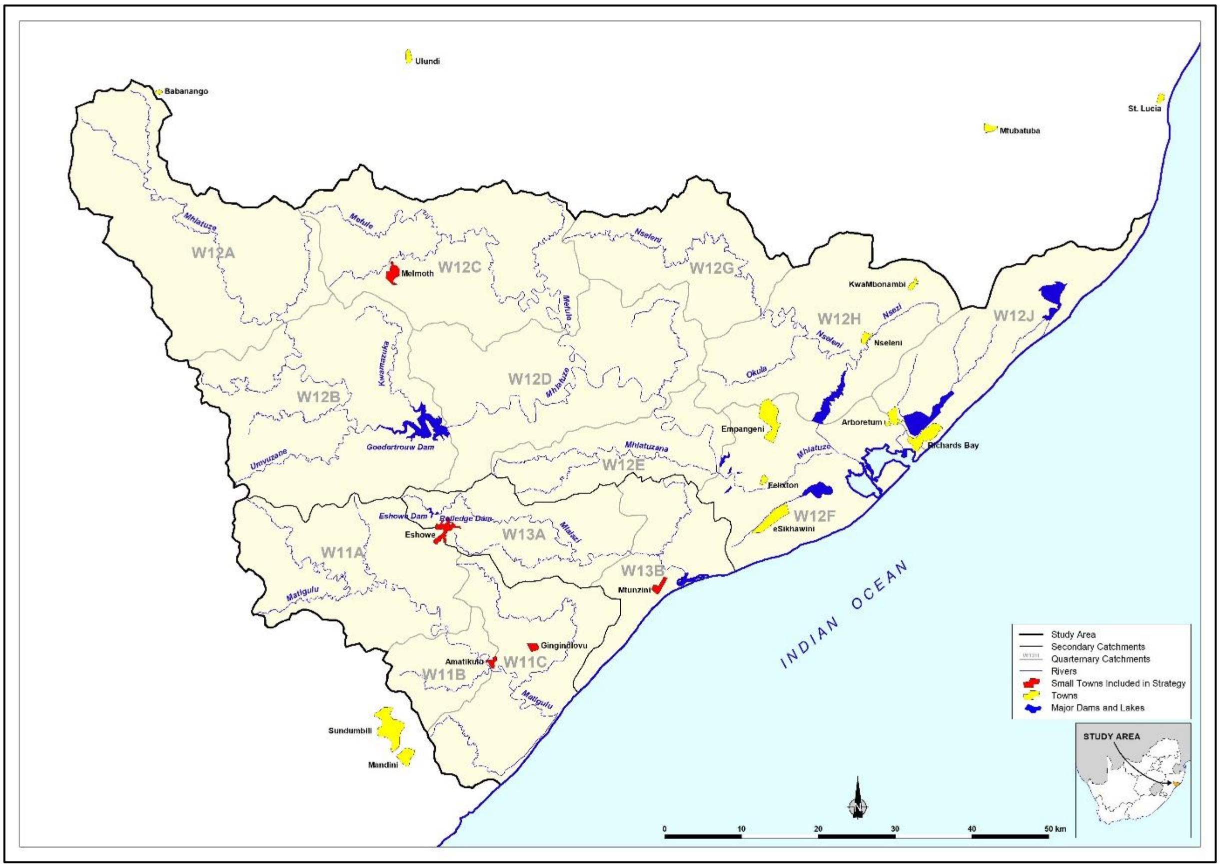


Figure 2-7: Surrounding Towns included incorporated into Reconciliation Strategy

Table 2-6 provides a summary of the domestic requirements (high growth scenario) of users located in the study area for five year intervals in the planning horizon up till 2045. Over and above the indicated urban users, allocations have been provided for additional abstractions (new licenses) for rural users throughout the catchment during the Compulsory licensing process. These will be taken up over the years; and are grouped together in the Table under the title “new users”.

Table 2-6: Urban and industrial projected water requirements per year indicated

Demand	Requirement (Mm^3/annum)					
	2018	2025	2030	2035	2040	2045
Richards Bay	17.12	20.3	22.91	25.79	29.06	32.78
Nseleni	4.74	5.78	6.56	7.37	8.2	9.3
Ngwelezane	2.47	2.95	3.32	3.74	4.18	4.72
Esikhaweni	10.86	12.51	13.84	15.29	16.87	18.65
Empangeni	8.55	10.57	12.29	14.19	16.36	18.97
Goedertrouw direct (Phobane WTW)	1.39	11.16	13.95	13.95	13.95	13.95
Eshowe	2.23	2.43	2.64	2.85	3.07	3.33

Demand	Requirement (Mm³/annum)					
	2018	2025	2030	2035	2040	2045
Mtunzini	0.49	0.52	0.56	0.60	0.65	0.70
Gingindlovu	0.34	0.36	0.37	0.39	0.41	0.43
Melmoth	0.92	1.00	1.09	1.17	1.26	1.36
New Users	0.77	6.12	7.65	7.65	7.65	7.65
Total	**49.88**	**73.70**	**85.18**	**92.99**	**101.66**	**111.84**

Table 2-7 provides a summary of the projected return flow increases for the moderate and high growth in water requirement projection scenarios.

Table 2-7: Projected future return flow volumes

Centre	Growth Scenario	2018	2020	2025	2030	2035	2040	2045
		million m³/a						
Richards Bay	Moderate	7.99	8.21	8.79	9.43	10.12	10.89	11.68
	High	8.17	8.57	9.69	10.93	12.30	13.87	15.64
Empangeni	Moderate	3.01	3.12	3.41	3.74	4.11	4.52	4.96
	High	3.08	3.28	3.81	4.43	5.12	5.90	6.84
Esikhaweni	Moderate	2.24	2.32	2.54	2.79	3.06	3.36	3.69
	High	2.91	3.04	3.36	3.72	4.10	4.53	5.01
Ngwelezane	Moderate	0.72	0.74	0.80	0.85	0.90	0.94	1.00
	High	0.74	0.78	0.88	0.99	1.11	1.25	1.41
Nseleni	Moderate	0.31	0.32	0.35	0.37	0.39	0.42	0.44
	High	0.32	0.34	0.39	0.44	0.49	0.55	0.62
Eshowe	Moderate	0.37	0.38	0.39	0.41	0.43	0.44	0.46
	High	0.38	0.39	0.43	0.46	0.50	0.54	0.59
Gingindlovu	Moderate	0.45	0.45	0.46	0.48	0.49	0.51	0.52
	High	0.45	0.46	0.48	0.50	0.53	0.55	0.58
Melmoth	Moderate	0.28	0.28	0.30	0.31	0.32	0.34	0.35
	High	0.29	0.29	0.32	0.35	0.37	0.40	0.44
Mtunzini	Moderate	0.09	0.09	0.10	0.10	0.10	0.11	0.11
	High	0.09	0.10	0.10	0.11	0.12	0.13	0.14

2.3 Bulk Industrial and Mining Water Use

The main bulk industrial water users sharing the resources of the Study Area are as follows:

- **Mondi** processes pulp and paper, which is used to make a number of products such as Baycel and a premier grade bleached hardwood pulp. These processes require large amounts of potable water. Effluent that is recycled for process purposes has to be treated to a high standard. Mondi is supplied with water by Mhlathuze Water from Lake Nsezi.

- **Foskor** produces fertiliser, sulphuric and phosphoric acid. Foskor makes use of potable and clarified (semi-purified) water. The clarified water is supplied from the Nsezi WTW by MW and the potable water supplied from the Mzingazi WTW by the CoMLM.
- The **Hillside (South 32) Aluminium smelter**, which produces ingots is supplied by potable water from Mzingazi WTW. South 32 has its own desalination plant which supplies an average of 2 Mℓ/day (0.73 million m^3/annum).
- The **Bayside Aluminium** smelters process Aluminium. They are supplied with potable water from the Mzingazi WTW by the CoMLM. The plant was planned to close down due to low commodity prices in 2016. This, however, did not materialise, and the plant is still operating.
- The **Richards Bay Coal Terminal** and harbour are supplied with potable water from the Mzingazi WTW. Furthermore, the RBCT also has an effective storm water reuse plan, which drastically reduced the water requirements from the RBWSS in recent years.
- **Tongaat Hulett Sugar Mill** was constructed in 1970 and processes harvested sugarcane from the surrounding area. Water is abstracted from the Mhlathuze River and is treated at the Tongaat Hulett WTW.
- **Mpact Felixton**, previously Mondi Felixton, is a paper mill in the town of Felixton which demerged from the Mondi Group in 2011. A major portion of the raw material for the paper mill manufacturing process is obtained from the nearby Tongaat Hulett Sugar Mill bagasse, a dry pulpy residue left after the extraction of juice from the sugarcane.
- The **Industrial Development Zone** (IDZ) is an industrial estate in Richards Bay, which consists of various phases to be implemented in future. The current focus is on Phase 1F.
- The **Richards Bay Minerals** mines sand dunes in Richards Bay for heavy minerals, including Ilmenite. Zircon and Rutile. Their mining operations consist of two areas; namely the Tsand/Zulti North area, which is to the North of Richards Bay, and Zulti South area, which is close to eSikhaweni. The Zulti South area is not yet active.
- **Tronox** mines dunes to the South of Richards Bay for heavy minerals, such as Ilmenite and Zircon. Rutile is mined at Tronox's Fairbreeze Mine, south of

Mtunzini. Tronox has a heavy minerals refinery and smelter plant North-West of Empangeni. The central processing plant receives water from the Nsezi WTW. Water for the mining operation is abstracted at the Mhlathuze Weir. It was initially envisaged that water would be obtained from the Thukela transfer from Mandini, however, this has not yet materialised.

Figure 2-8 to **Figure 2-16** provides the graphical representations of the bulk urban and industrial sector users. The graphs are presented in a similar format to the individual urban demand centre plots.

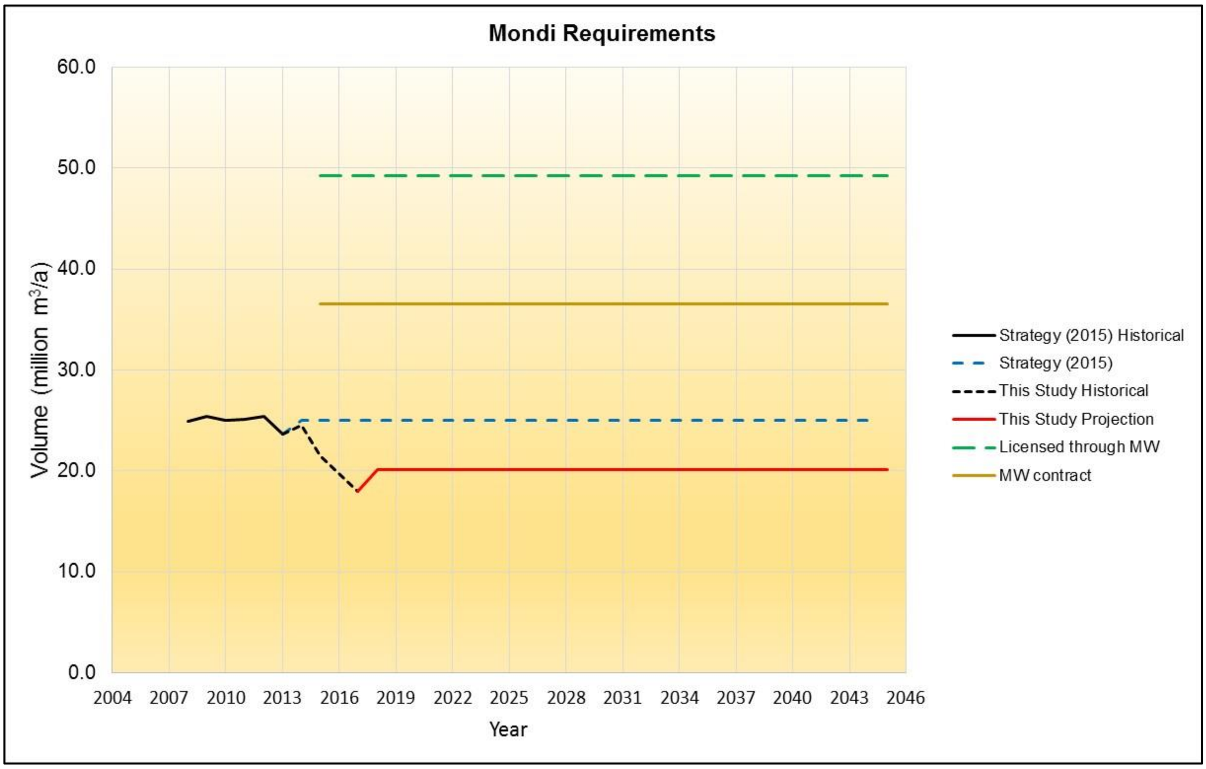


Figure 2-8: Water requirements of Mondi

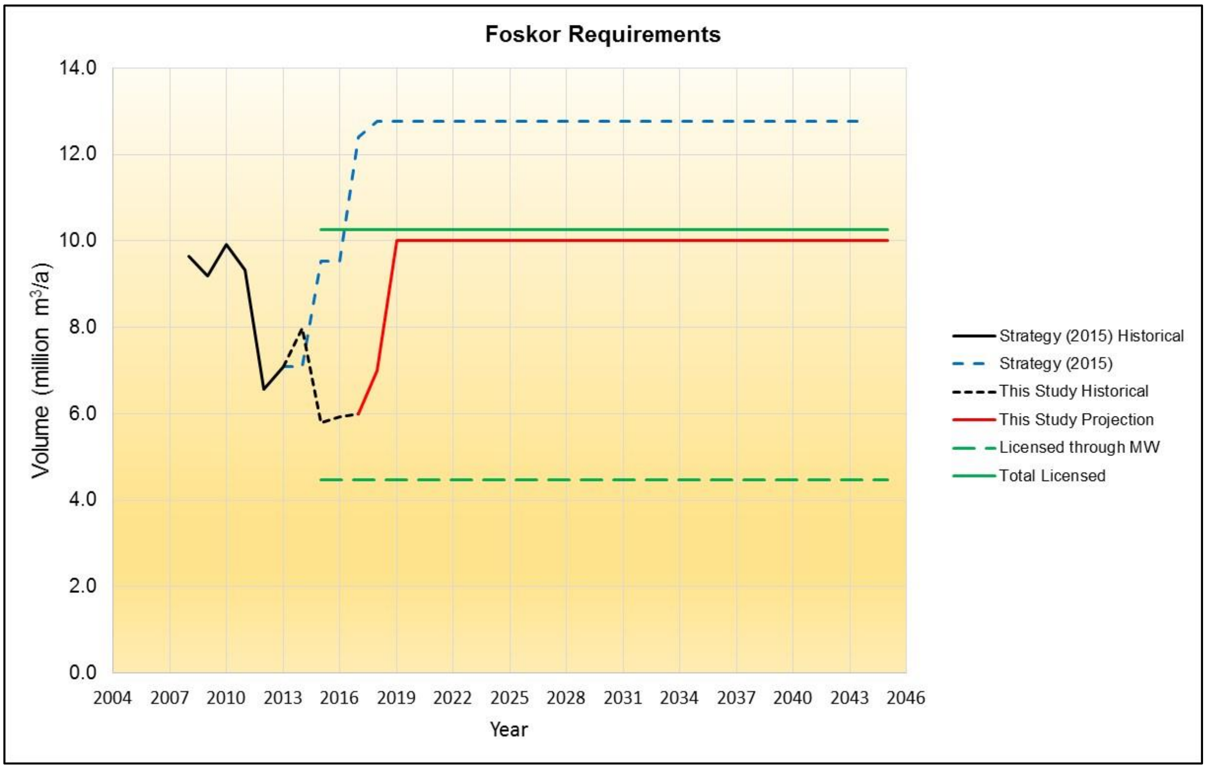


Figure 2-9: Water requirements of Foskor

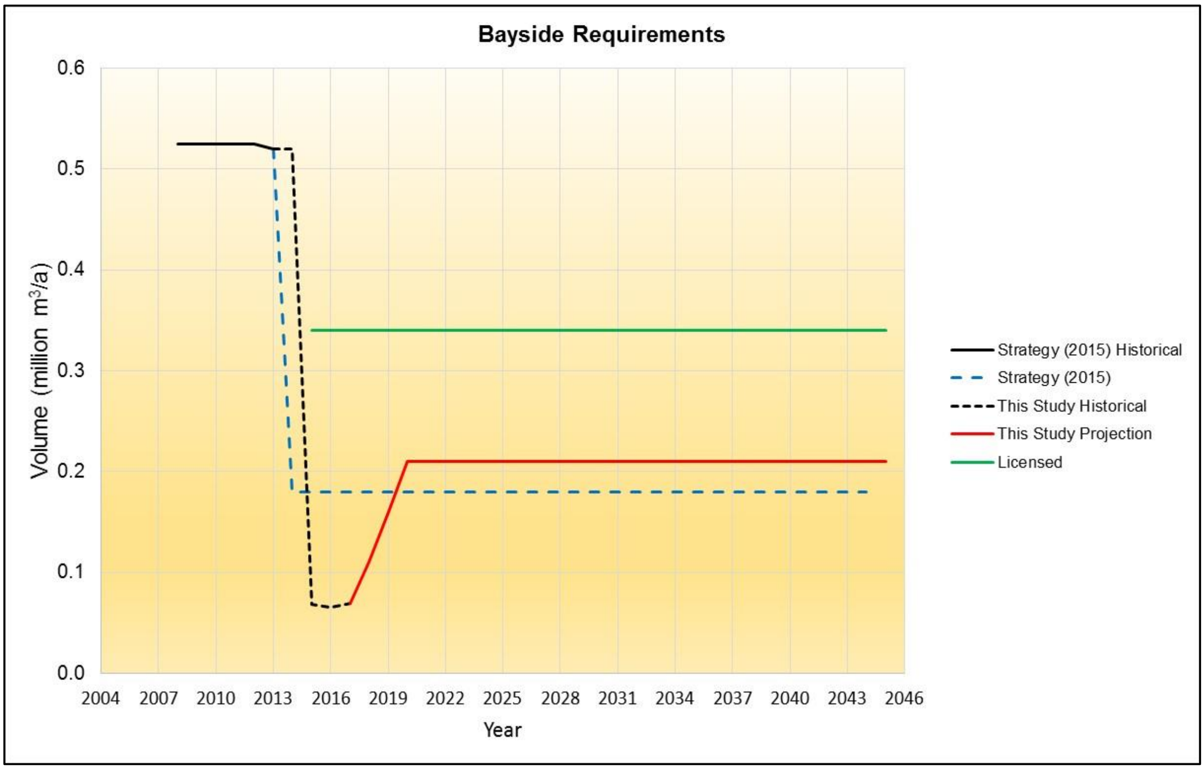


Figure 2-10: Water requirements of Bayside Aluminium

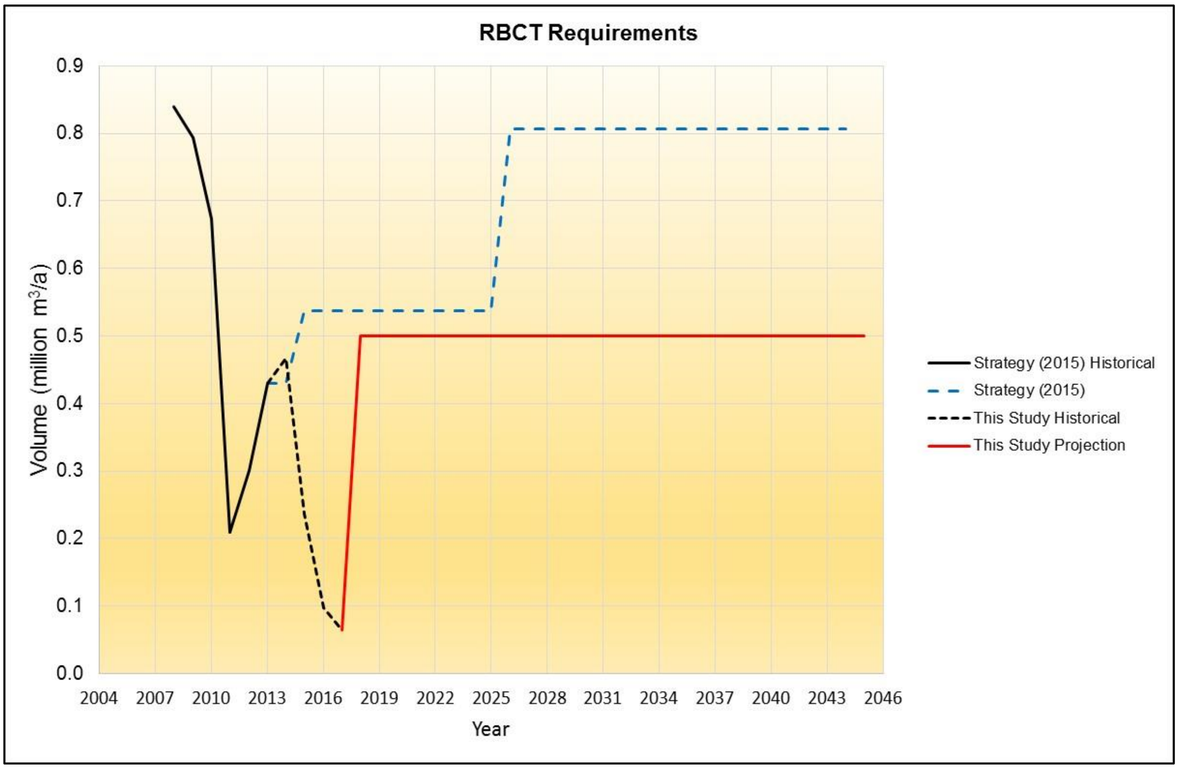


Figure 2-11: Water requirements of the RBCT

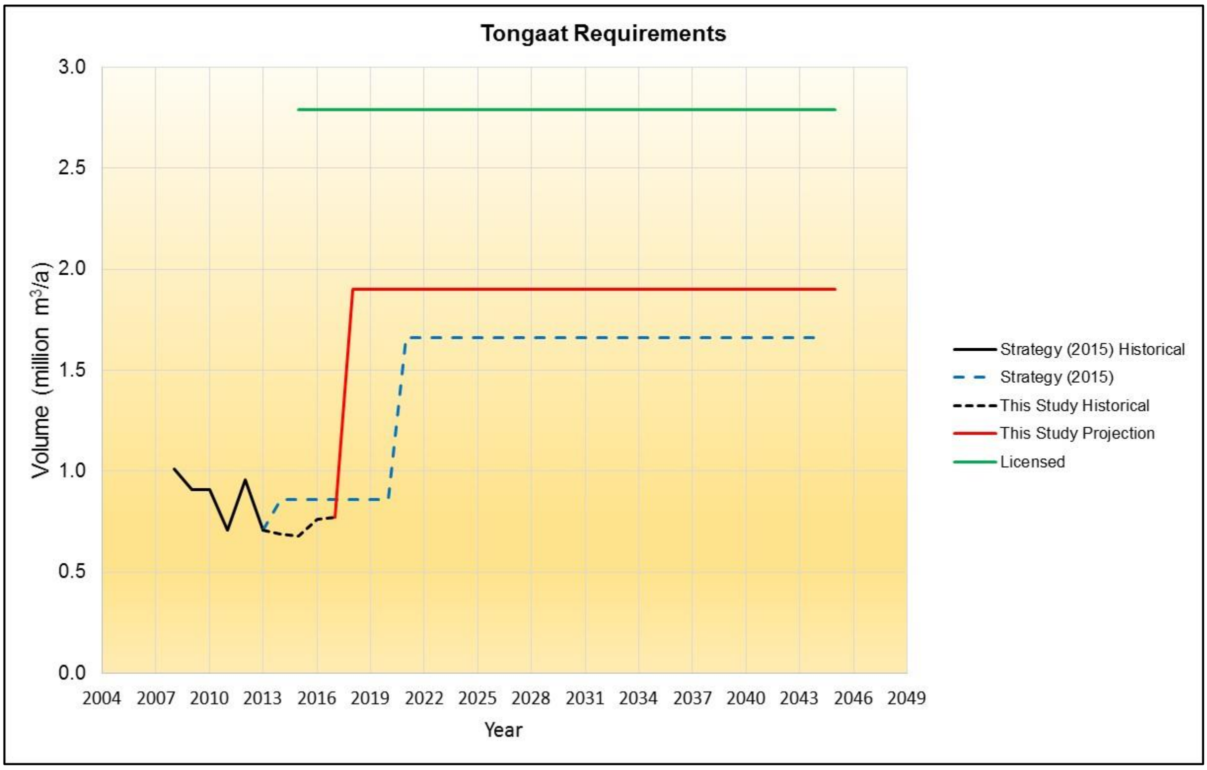


Figure 2-12: Water requirements of the Tongaat Hulett Sugar Mill

Figure 2-13: Water requirements of Mpact Felixton

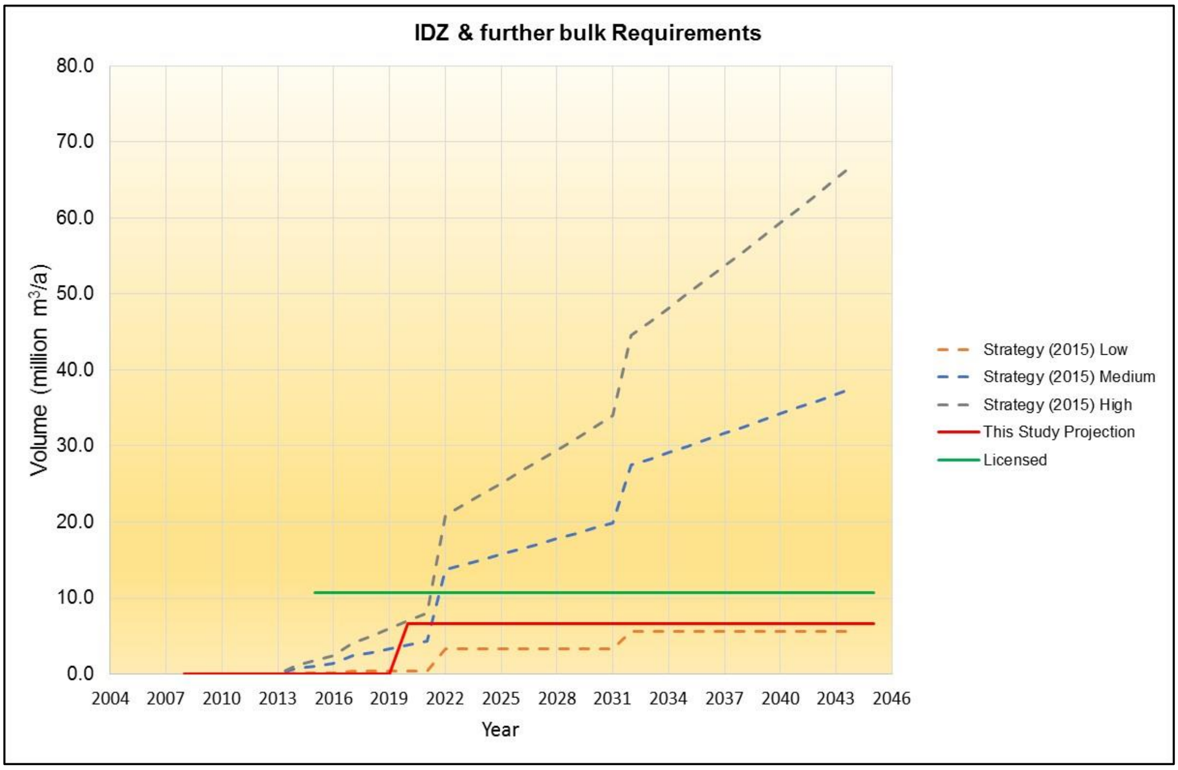


Figure 2-14: Water requirements of the IDZ

Figure 2-15: Water requirements of RBM

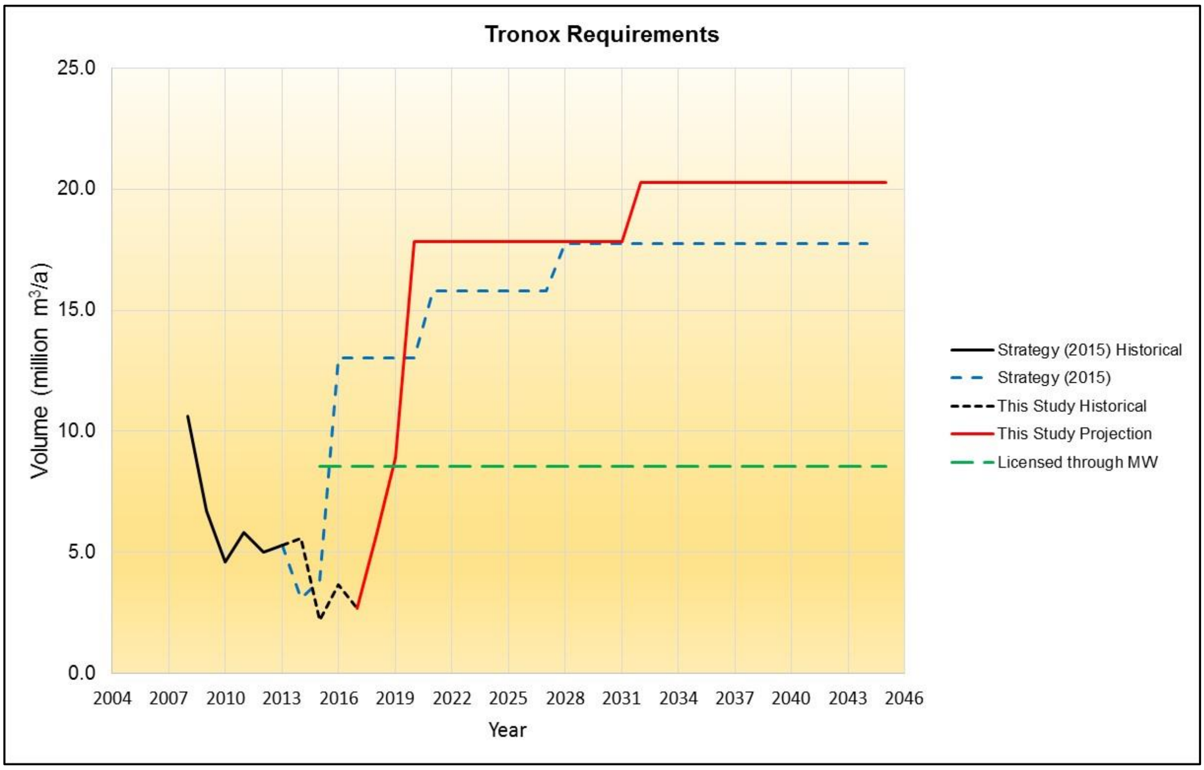


Figure 2-16: Water requirements of Tronox

Demand	Requirement (Mm^3/annum)					
	2018	2025	2030	2035	2040	2045
RBM smelter	5.6	8.1	8.1	8.1	8.1	8.1
RBM ponds	14.4	20.7	20.7	20.7	20.7	20.7
Foskor potable	4	5.6	5.6	5.6	5.6	5.6
Foskor clarified	3	4.4	4.4	4.4	4.4	4.4
Tronox	5.80	17.83	17.83	20.26	20.26	20.26
Mondi	20.1	20.1	20.1	20.1	20.1	20.1
Bayside	0.11	0.21	0.21	0.21	0.21	0.21
Mpact	2.48	2.48	2.48	2.48	2.48	2.48
Tongaat	1.9	1.9	1.9	1.9	1.9	1.9
Small Industry	0.03	0.03	0.03	0.03	0.03	0.03
IDZ	0.00	6.57	6.57	6.57	6.57	6.57
Total	**57.42**	**87.92**	**87.92**	**90.35**	**90.35**	**90.35**

2.4 Agricultural Water Requirements

2.4.1 Irrigation

Irrigation is a significant user of water in the study area. Sugarcane is the most commonly found crop grown in the Mhlathuze catchment, followed by citrus. Various irrigation Boards are located along the river, all sharing the water resources of the Goedertrouw Dam as indicated in **Figure 2-17**. The total water allocated to the irrigation Sector is summarsed in **Table 2-8**..

The final volume allocated to the irrigation sector is 128.59 million m^3/annum. This allocation is a combination of 124.41 million m^3/annum (Table C) and 4.18 million m^3/annum (Table A: Existing Licenses) as indicated in the Government Gazette (DWS, 2015c).

Table 2-8: Summary of Final Allocation Schedule for irrigation (DWS, 2015b)

Location	Allocation (million m^3/a)
1) Heatonville	43.62
2) Lower Mhlathuze	7.73
3) Mfuli	5.55
4) Nkwaleni	57.00
5) Other-irrigation	8.93
c) Existing licenses under NWA	4.18
b) Applications for new water uses	1.54
Total	**128.54***

* slight difference in total, possibly due to rounding errors

Some of these applicants are diffuse irrigators, meaning that they obtain their water from tributaries. While their use is considered when determining the available water resources of the catchment, they do not specifically form part of the water balance of the main catchment requirements. Furthermore, these users do not form part of an Irrigation Board. Only the Irrigation Boards indicated in **Table 2-8** (Heatonville, Lower Mhlathuze, Mfuli and Nkwaleni) are dependent on the Goedertrouw Dam for their water. Therefore, the volume allocated to irrigation forming part of the water balance is 113.9 million m^3/annum.

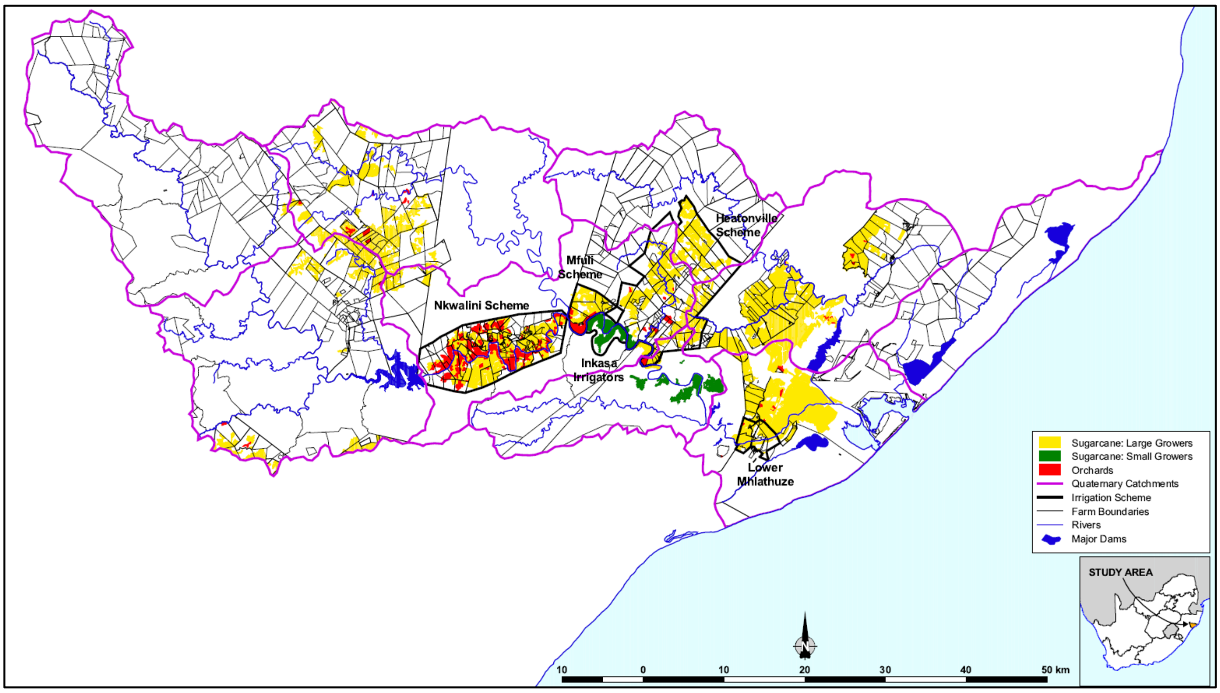


Figure 2-17: Locality of irrigation

2.4.2 Dryland Sugarcane

Though not officially declared a Stream Flow Reduction Activity (SFRA) the extent of dryland sugarcane is large in the Mhlathuze, Amatikulu and Mlalazi catchments, and it is therefore important to consider the impacts thereof. The Mhlathuze Water Availability Study (MWAAS) (DWAF, 2009) carried out a detailed landuse assessment, and this information is included in the water resources models used for undertaking analyses. The areas and estimated volumes used by dryland sugarcane are summarized in **Table 2-9**.

Table 2-9: Summary of dryland sugarcane in the Mhlathuze Catchment

Quaternary	Existing area (km^2)	Existing use average (million m^3/a)
W12A	1	0
W12B	36	2.28
W12C	32	2.61

Quaternary	Existing area (km^2)	Existing use average (million m^3/a)
W12D	16	1.53
W12E	18	1.96
W12F	85	6.65
W12G	3	0.25
W12H	73	5.4
W12J	0	0
Total	**264**	**20.68**

2.4.3 Afforestation

An extensive investigation into the status of existing afforestation in the Mhlathuze Catchment was undertaken during the MWAAS (DWAF, 2009). Subsequently after Validation, Verification and the determination of the existing lawful use, Compulsory Licensing finalized allocated areas and volumes for afforestation (indicated in the Gazette as SFRAs, (DWS, 2015c). No further afforestation will be allowed for in the future. A summary of the information available on afforestation is provided in **Table 2-10**. This provides the afforested areas and estimated volumes used the Mhlathuze Catchment (W12) affecting the RBWSS.

Table 2-10: Summary of afforestation in the Mhlathuze Catchment

Quaternary	Allocated area (ha)	Allocated use average (million m^3/a)
W12A	15884	11.96
W12B	4306	3.09
W12C	7780	5.66
W12D	720	0.65
W12E	0	0.00
W12F	2803	2.50
W12G	0	0.00
W12H	12348	13.69
W12J	12131	20.57
Total	**55 971**	**58.12**

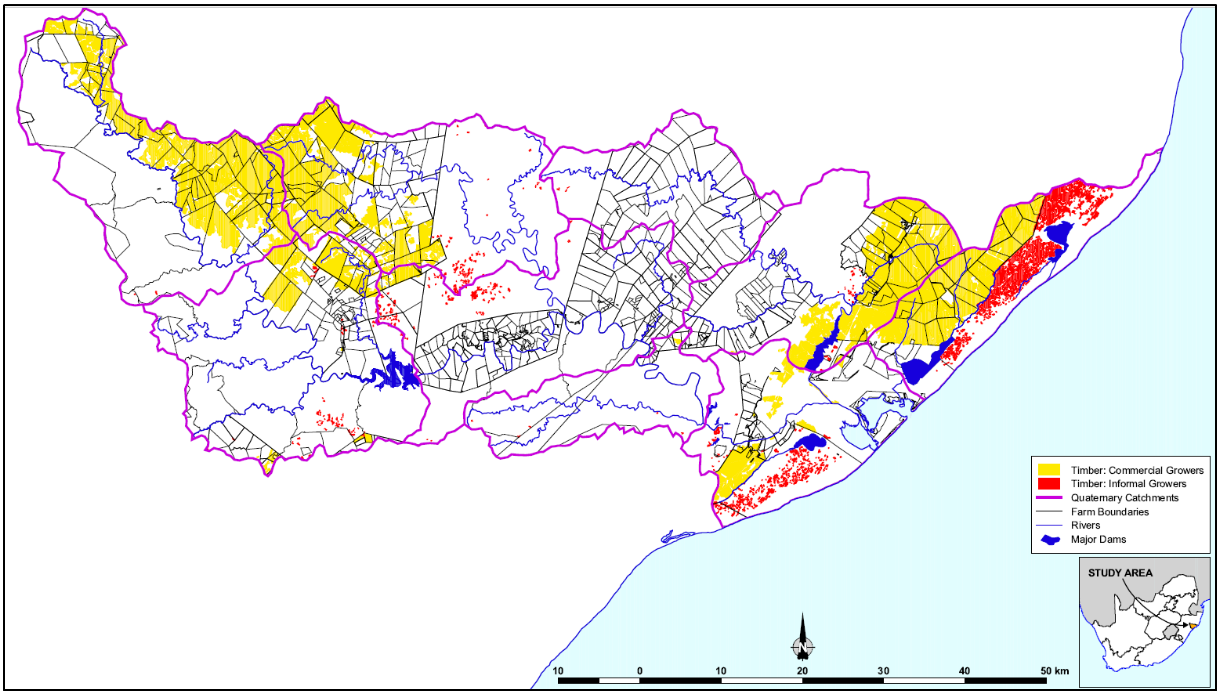


Figure 2-18: Locality of afforestation

2.4.4 Return Flows from the Agriculture Sector

Return flows from irrigated agriculture are not measured in the Study Area. The MWAAS assumption of approximately 15% of the irrigation requirements return into the Mhlathuze system as return flows was used in this Study.

2.5 Environmental Water Requirements and International Obligations

A reserve determination process was first undertaken in the Study Area as part of the Mhlathuze Operating Rules and Future Phasing Study (DWAF, 2001). The MWAAS subsequently updated and extended the hydrology of the Mhlathuze Catchment, and the originally determined Ecological Water Requirements (EWRs) were then scaled in order to reflect the adjusted hydrology. These scaled EWRs were “signed off” as the preliminary reserves applicable to the catchment in May 2012 (DWA, 2012c).

The preliminary reserve was considered during Compulsory Licensing. During Compulsory Licensing, a closer review of the “signed off” preliminary reserves indicated that some errors had occurred in developing the EWRs. These errors were as a result of incorrect scaling of hydrological data sets and the incorrect positioning of the EWR sites. These errors were rectified prior to the Compulsory Licensing analyses, and the correct EWRs were incorporated and analysed.

The resulting Gazette (DWS, 2015c) included a summary of the correct reserve requirements, which is shown in **Table 2-11**. The table presents the average flows at each of the EWR sites over the historical record period.

No further work relating to the EWRs has been undertaken since these flows were Gazetted, and these have therefore been used as part of this Study. The DWS still needs to undertake a Classification Study before the final EWRs for the Mhlathuze Catchment can be determined. The DWS recently called for proposals for Service Providers to undertake the Determination of Water Resource Classes and Associated Resource Quality Objectives in the Usuthu and Mhlathuze Catchments, however, the Study has not yet commenced.

Table 2-11: EWR summary according to Gazette No. 38599

EWR Site	Position	Volume (million m^3/a)
1	W12A Outlet	16.97
2	Downstream Goedertrouw Outlet of W12B	41.07
4	W12C Outlet	7.06
5	W12D downstream of Mhlathuze-Mfuli Confluence	32.61
6	W12D Outlet	31.81
7	W12E Outlet, not including Mhlathuzana river contribution	32.19
8	Upstream of Mhlathuze-Nsezi Confluence	37.19
9	W12G Outlet	3.40
10	W12H Outlet	10.22
11	Mhlathuze Mouth	10.85
12	W12J2 Mouth	0.76

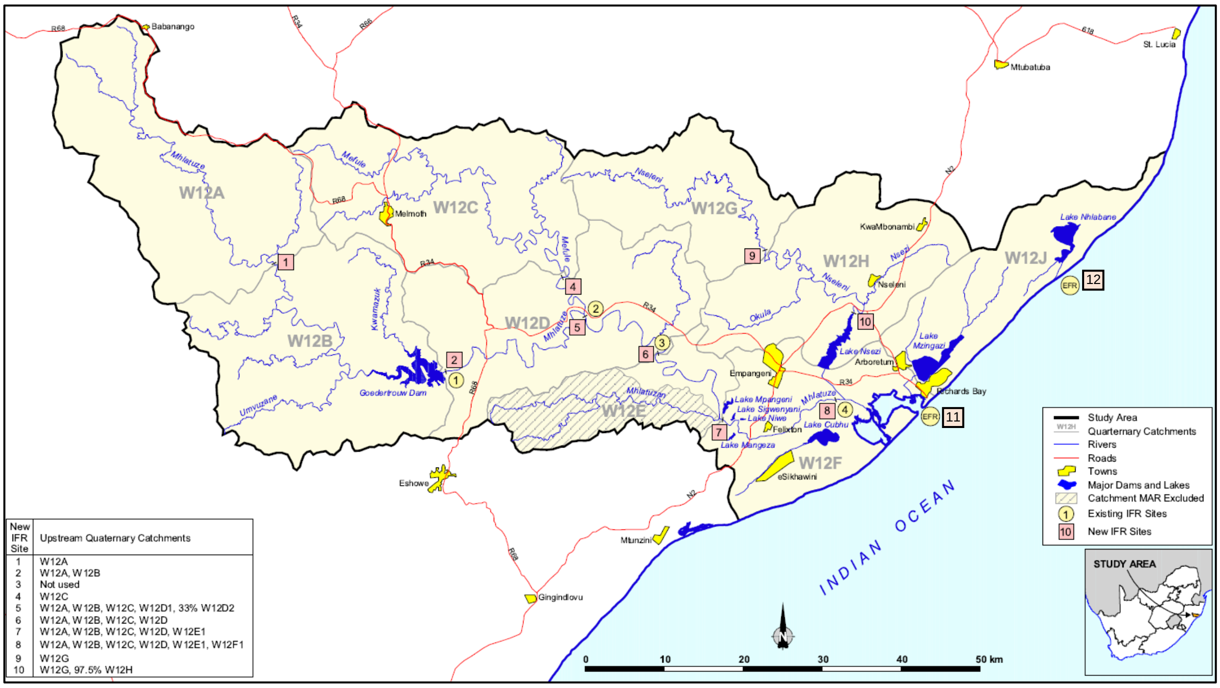


Figure 2-19: EWR Site locations

2.6 Alien Invasive Plants

Invasive Alien Plants (IAPs) can cause a significant reduction in runoff, especially if these plants are riparian. No further information relating to the extent and use of IAPs in the catchment was available, and therefore the MWAAS data in assumed in this Study. The IAP Survey Dataset from 2010 was reviewed, differences in area distribution were found, which are summarised in **Table 2-12** (ARC, 2010). The total IAP area for the two sources of information is very similar and only differs by 5 km^2 in total. The water requirements for the condensed IAP Survey were not derived.

Table 2-12: Summary of IAPs in the Mhlathuze Catchment

Quaternary	Condensed IAP area (km^2) MWAAS (2006)	MWAAS water use average (million m^3/a)	Condensed IAP survey area (km^2) (2010)
W12A	18	2.01	33.3
W12B	21	2.5	31.8
W12C	10	0.65	30.0
W12D	12	0.97	23.7
W12E	10	1.43	4.1
W12F	41	5.99	0
W12G	4	0	0
W12H	11	1.42	13.3
W12J	13	1.84	8.9
Total	**140**	**16.81**	**145.1**

2.7 Inter-catchment transfers

An inter-catchment transfer occurs when water is transferred across a catchment divide from one catchment to a user in a neighbouring catchment. Some inter-catchment transfers occur within the Study area and some from catchments outside the study area. These are summarized in **Table 2-13**.

Table 2-13: Summary of transfers and infrastructure capacities

Details	Capacity
Thukela (Middledrift) existing transfer and increase capacity as per emergency intervention. Enters Umvuzane River upstream of Goedertrouw Dam	1.08 m^3/s till December 2023, thereafter 2.16 m^3/s. This is 1.2 m^3/s and 2.4 m^3/s less 10% for losses and outages
Secondary supply from Mhlathuze weir to Esikhaweni WTW, to be used when Lake Cubhu drops below maintenance level	Maximum capacity 15000 m^3/day, 0.173 m^3/s
Mhlathuze weir directly to Tronox	Maximum capacity 48000 m^3/day, 0.565 m^3/s
Mhlathuze weir to Lake Nsezi/Nsezi WTW	Maximum capacity 3.5 m^3/s
Secondary supply from Nsezi WTW to Richards Bay, to be used when Lake Mzingazi drops below maintenance level and Mzingazi WTW shuts down	Maximum capacity 48840 m^3/day, 0.555 m^3/s
Transfer from Umfolozi to RBM	Maximum capacity 2 m^3/s

2.8 Water use per sector summary

Accurate water requirement projections are an important part of a Reconciliation Strategy. The required size and implementation dates of future interventions are directly related to the growth in future water requirements. Historical use information was obtained and updated for all the major users in the Study Area. Two updated future requirement projections were determined, namely a high growth and a moderate growth projection. The high growth projection is based on future high population and the LOS increases in the urban sector, individual discussions of future water requirements in the bulk industrial sector as well as updated allocations in the irrigation sector. The moderate growth projection is based on future realistic population increases, however, no change in the LOS and increase in light industrial and commercial uses is accounted for. The bulk industrial and irrigation sector future requirements are identical to the high growth scenario. Generally, all the Stakeholders were forthcoming with their information and understood the need to provide accurate information for future planning.

The overall perspective of the water requirements of the RBWSS is presented in **Figure 2-20**. The graph includes the historical use from 2008 until 2017. The impact of reduced use over the drought period experienced is evident. Furthermore, the graph also includes the Strategy (2015) low, medium and high projection scenarios. These scenarios were based on broad assumptions, and it is believed that the updated projections resulting from this Study have been determined using a more systematic approach. The graph also presents the updated allocations provided to users dependant on the water resources supplying the RBWSS.

The updated future projection initially grows steeply which is partly as a result of the past few years of slower growth due to the drought. Many bulk water users have specific plans to increase use over the next few years. The projection slope then evens off and finishes slightly higher than the 2015 Strategy's medium projection scenario in 2045. It is expected that the high projection will exceed the allocated volume in 2032.

Figure 2-21 provides an overall summary of the water use per sector of the catchment. Irrigation is the highest water user, followed by afforestation.

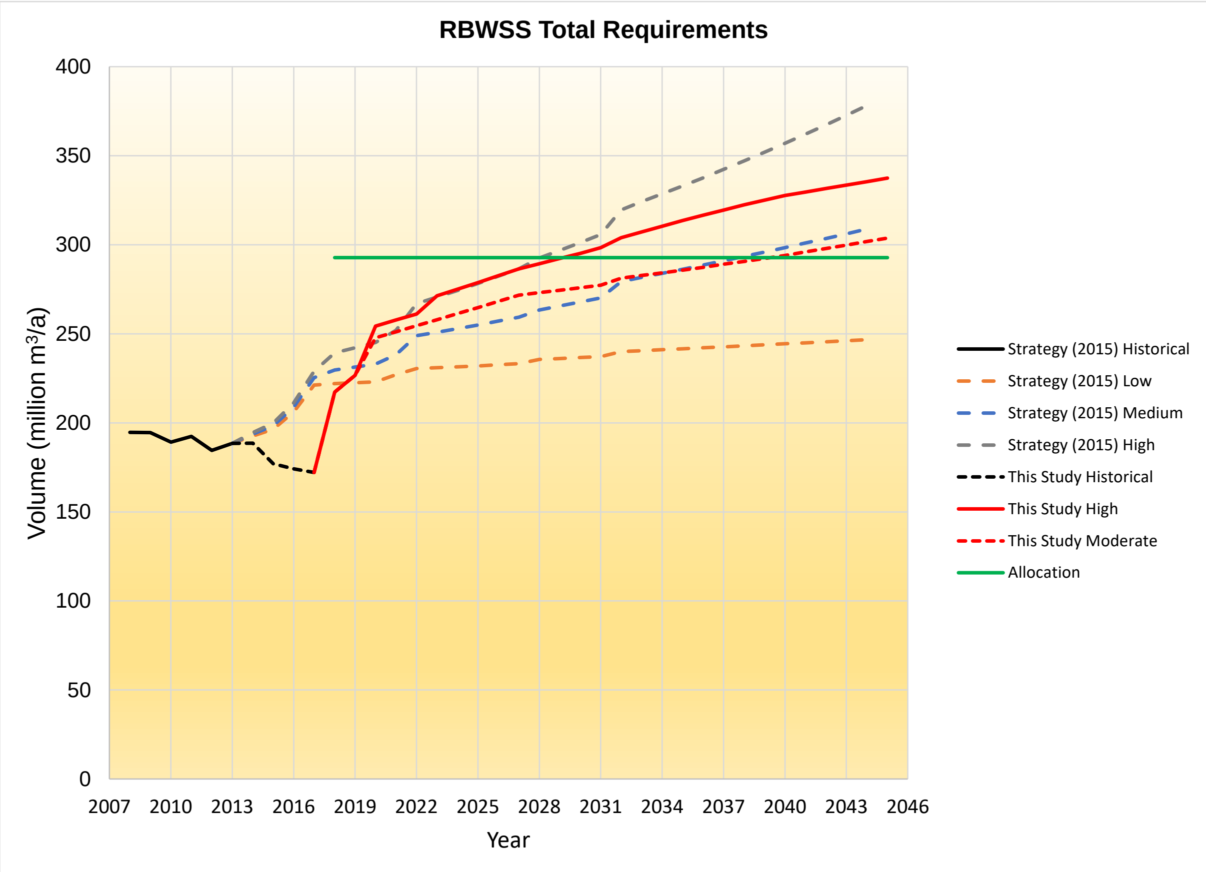


Figure 2-20: RBWSS total water requirements

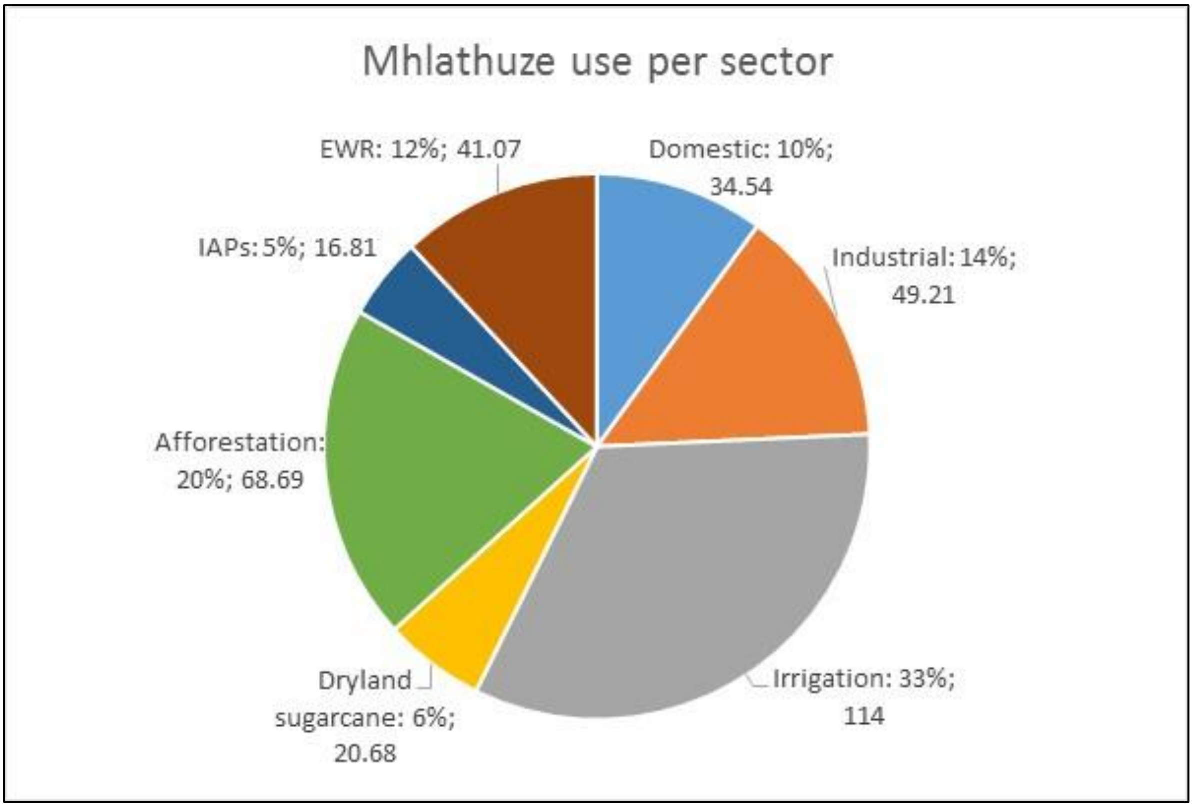


Figure 2-21: Water use per sector in the Mhlathuze Catchment (2017)

Four water requirement scenarios were selected for water balance purposes which are presented in **Section 5**. The details of the users included are presented in **Appendix B**. The scenarios are described as follows and presented graphically in **Figure 2-22.**

- Scenario A: High water requirement growth projection (based on high population growth and increased level of service) excluding additional new users (not yet licensed).
- Scenario B: Scenario A plus new users (Eskom, transfer to Mtubatuba / Mpukunyoni and IDZ) as well as increased Phobane WTW capacity accounted for.
- Scenario C: Scenario A less estimated savings made by WCWDM
- Scenario D: Scenario A plus increased Phobane WTW capacity accounted for.

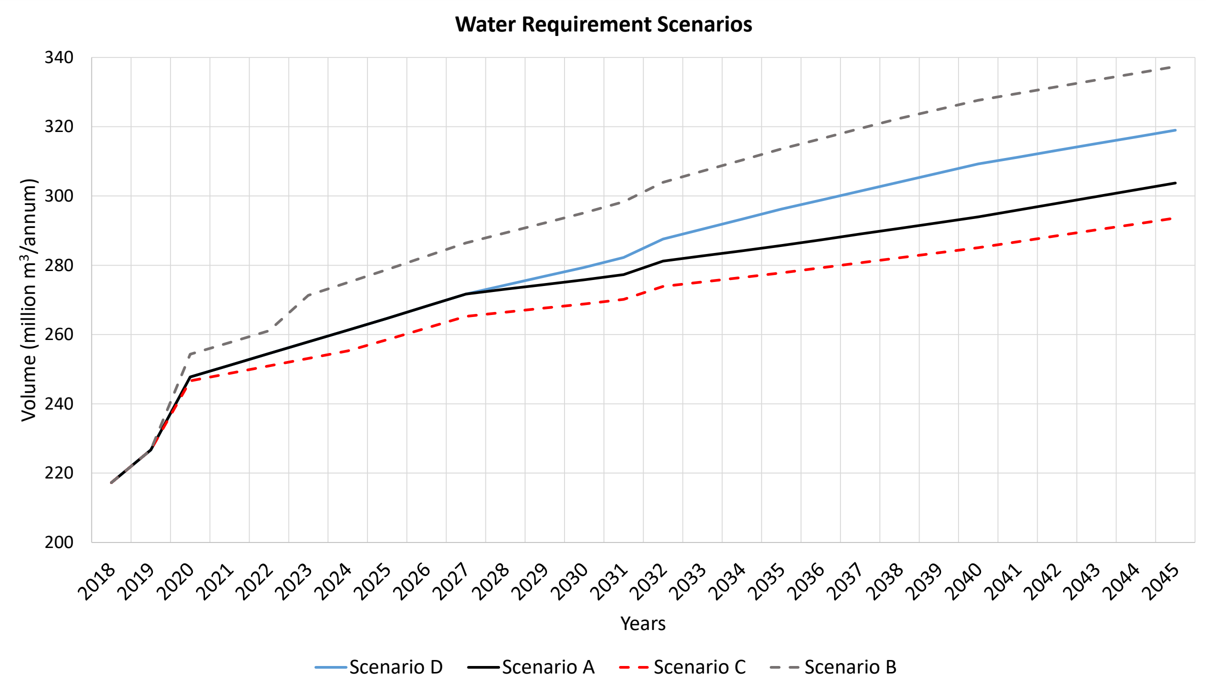


Figure 2-22: Final water requirement projection scenarios included in water balances

3 WATER CONSERVATION AND WATER DEMAND MANAGEMENT

A detailed Water Conservation Water Demand Management assessment was done and is documented in DWS, 2019, one of the preceding technical reports to this Strategy.

3.1 Background and Approach

The WCWDM assessment was undertaken in the stepped approach:

- **Status quo assessment:** Review the status quo of the municipalities concerning their institutional, financial, legal, social and technical pillars. The assessments were undertaken to gain a complete understanding of the existing municipal water business, their operations and current key challenges.
- **Assessment Overview of Individual Demand Centres**: To allow for the concise assessment of the water situation, the individual demand centres the individual LM's were assessed and visited to gather information and to gain a better understanding of the status quo. The WCWDM key performance indicators (KPI's) were assessed for each demand centre.
- **Strategy**: Based on the results of the assessments a WCWDM strategy was developed, which was broken down into institutional, financial, social and technical strategy components.
- **Business Plan**: A business plan (targets and budgets) was developed for the CoMLM and the assumptions were documented.

3.2 Water Loss and NRW Reduction Targets

The realistic and optimistic targets resulting from WCWDM intervention implementation for the CoMLM are summarised in **Table 3-1**

Table 3-1: Summary of CoMLM realistic and optimistic targets

Indicator	Current Value	Realistic Target value 10% Reduction	Optimistic Target Value 20% Reduction
System Input volume (million m^3/a)	39,15	34.89	32.23
System Input volume (Mℓ / day)	107,19	95.54	88.24
Billed Authorised Consumption (million m^3/a)	30,00	24.32	23.89
Unbilled Authorised Consumption (million m^3/a)	1,95	4.52	4.47
Water Losses (million m^3/a)	7,20	6.06	3.87
Non-revenue Water (million m^3/a)	9,15	10.57	8.34
% Non-revenue water	43%	30%	26%

Indicator	Current Value	Realistic Target value 10% Reduction	Optimistic Target Value 20% Reduction
% Water Losses	24%	17%	12%
Input Volume (litres / capita / day)	277	246	228
Input Volume (m^3 / household / month)	35	31	29
Authorised Consumption (litres / capita / day)	226	204	200
Authorised Consumption (m^3 / household / month)	29	26	26

If the above targets could be achieved, the future realistic water balance for the municipality is shown in **Figure 3-1**

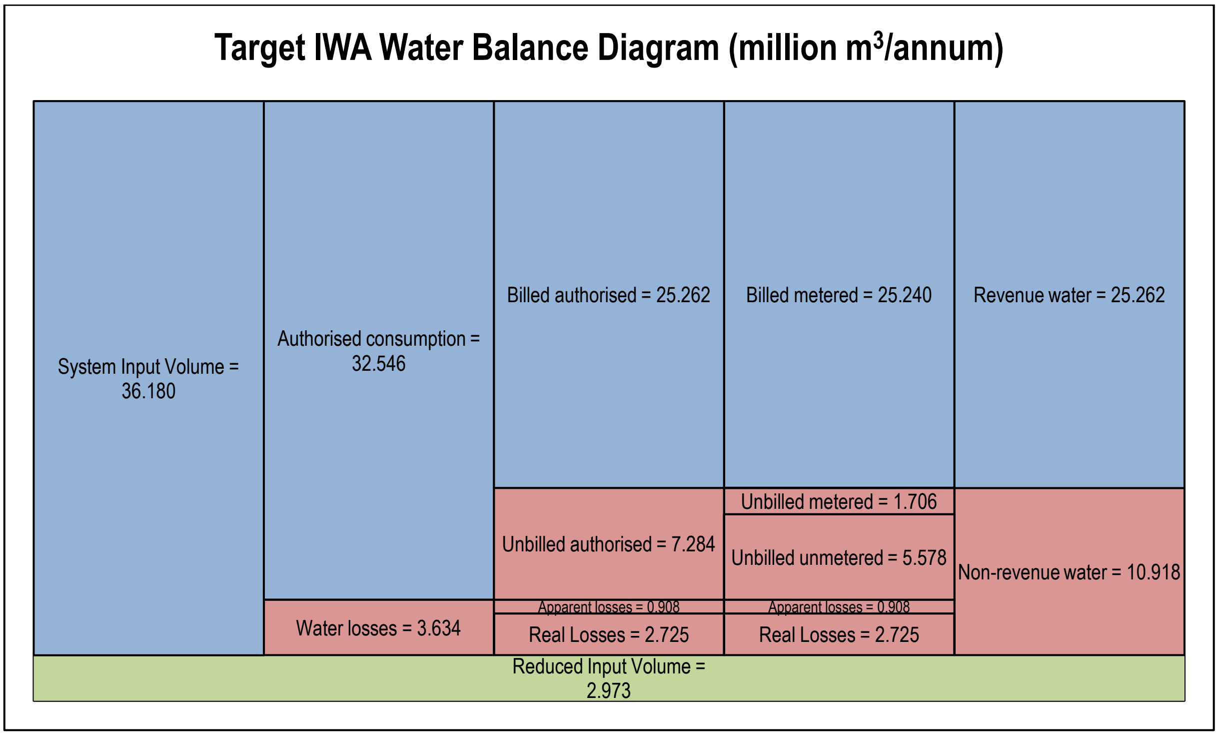


Figure 3-1: Target Water Balance for CoMLM

The targets are based on a 10% reduction in total demand and 20% increase in billed consumption. It is recommended that water tariffs are increased by 10% per annum for 5 years to promote water use efficiency and increase revenue.

The recommendations for WCWDM measures are based on the findings of the various analyses undertaken. The assessments include recommendations on interventions, estimated costs, and priorities for the period of five years and the WCWDM budget summary is presented in **Table 3-2**.

The budget shows that approximately R 60 million per annum is required over the next five years to address WCWDM.

Table 3-2: CoM WCWDM Budget Summary

Interventions	Type	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Institutional	Capex	100 000	300 000	0	0	0	400 000
	Opex	375 000	375 000	375 000	375 000	375 000	1 875 000
	Sub Total	475 000	675 000	375 000	375 000	375 000	2 275 000
Financial	Capex	200 000	200 000	0	0	0	400 000
	Opex	19 139 840	19 139 840	19 139 840	19 139 840	19 139 840	95 699 200
	Sub Total	19 339 840	19 339 840	19 139 840	19 139 840	19 139 840	96 099 200
Social	Capex	3369 952	3 369 952	2 219 952	2 219 952	2 219 952	13 399 760
	Opex	5 859 880	5 859 880	5 859 880	5 859 880	5 859 880	5 859 880
	Sub Total	9 229 832	9 229 832	8 079 832	8 079 832	8 079 832	42 600 160
Technical	Capex	19 321 360	23 757 200	17 202 200	16 524 700	16 524 700	93 330 160
	Opex	17 527 445	17 527 445	17 527 445	17 527 445	17 527 445	87 637 275
	Sub Total	36 848 816	41 284 655	34 729 655	34 052 155	34 052 155	180 967 435
Total		65 893 487	70 529 327	62 324 327	61 646 827	61 646 827	322 040 795

3.2.1 Unit reference values

Unit reference values for demand centres are summarised in **Table 3-3** the unit reference values have been discounted over 20 years at 6%; 8% and 10%.

Table 3-3: Summary of Unit Reference Values

Discount rate	Total discounted cost (R)	Total realistic discounted saving (m^3)	URV Rand / m^3	Total optimistic discounted saving (m^3)	URV Rand / m^3
6%	R 998 596 013	57 767 795	R 17.29	77 046 514	R 12.96
8%	R 783 094 519	43 892 336	R 17.84	58 540 429	R 13.38
10%	R 638 479 066	34 655 726	R 18.42	46 221 306	R 13.81

3.3 Conclusion and Recommendations (WCWDM)

Based on the findings of the municipal water sector, it is clear that there is significant scope for WCWDM in the study area. WCWDM will result in both a reduction of NRW and the total system input volume. A serious concern however, is the pervasive limitation in institutional capacity and technical skills to embark on WCWDM programmes in the municipality.

- WCWDM interventions should focus on the following interventions:
- Reduce the high water losses and inefficiencies with set targets and timelines;
- KCDM and CoMLM should improve service delivery, as this will minimise informal and unauthorised connections in some areas;

- Develop and implement an operation and maintenance plan, if an existing plan is not in place;
- Install bulk meters to measure supply from the zones and districts;
- Maintain satisfactory operating pressures and install control valves in areas experiencing high pressures to ensure that operating pressures do not exceed the DWS regulation of 9 bar;
- Properly investigate the status of the service level for drinking water and sanitation in order to assess the situation and formulate recommendations for future improvements of servicing the entire area;
- Investigate the situation of water supply infrastructure on the base of new data in order to assess properly which investments in the refurbishment of the system are required;
- Provide training technical staff and for meter readers and perform monthly audits to eliminate estimates and other inaccuracies; and
- Embark on community awareness programmes that promote the value of water wise gardening.

4 WATER RESOURCE AVAILABILITY

4.1 Surface Water Hydrology

Surface water runoff contributes to water resources availability, however, runoff should not be confused with the yield of a catchment. Runoff represents the amount of water that could potentially be captured in water storage infrastructure and then converted into yield. Runoff varies on an annual basis and is dependent on rainfall, which is highly variable. It can therefore not be translated into the amount of water available for users required at a high level of assurance.

Surface water runoff is the main source of water for users within the Mhlathuze catchments. The total surface water runoff under natural conditions is summarized in **Table 4-1**. The quinary catchment delineations were maintained since the original MWAAS hydrology subdivisions. **Figure 4-1** presents a map of the catchments and sub-catchment delineations. In total, there are 24 sub-catchments. The Mean Annual Runoffs provided in the Table are as per the MWAAS Study (DWAF, 2009) and cover the time period 1920 to 2004.

Table 4-1: Surface water runoff per tertiary catchment

Major River	Tertiary Catchment	Quaternary Catchment	Quinary Catchments	Contributing Area (km^2)	MWAAS MAR (Mm^3/annum)
Mhlathuze	W12	W12A	W12A1	624	64.81
		W12B	W12B1	657	91.88
		W12C	W12C1	227	26.88
			W12C2	344	23.92
		W12D	W12D1	278	29.33
			W12D2	293	29.02
		W12E	W12E1	76	8.81
			W12E2	172	23.13
		W12F	W12F1	177	40.55
			W12F2	71	18.04
			W12F3	101	25.02
		W12G	W12G1	326	26.77
		W12H	W12H1	485	61.93
		W12J	W12J1	110	52.47
			W12J2	168	33.18
Amatigulu	W11	W11A	W11A1	445	55.17
		W11B	W11B1	127	17.53
		W11C	W11C1	102	14.98
			W11C2	109	22.03
			W11C3	172	31.47
			W13A1	36	9.60*

Major River	Tertiary Catchment	Quaternary Catchment	Quinary Catchments	Contributing Area (km^2)	MWAAS MAR (Mm^3/annum)
Mlalazi	W13	W13A	W13A2	166	44.69*
			W13A3	74	20.24*
		W13B	W13B1	171	44.80
Umfolozi	W21				571.88

Note *: This hydrology was updated as part of the Development of Operating Rules for Water Supply and Drought Management for Stand-Alone Dams and Schemes: Eastern Cluster: The Eshowe Water Supply Scheme: Rutledge and Eshlazi Dams Study (DWS, 2016), and therefore superseded the MWAAS hydrology.

It is important to note that some portions of the catchment do not contribute to any runoff, and therefore the catchment areas presented in **Table 4-1** above do not reflect the total catchment areas but rather the contributing catchment areas.

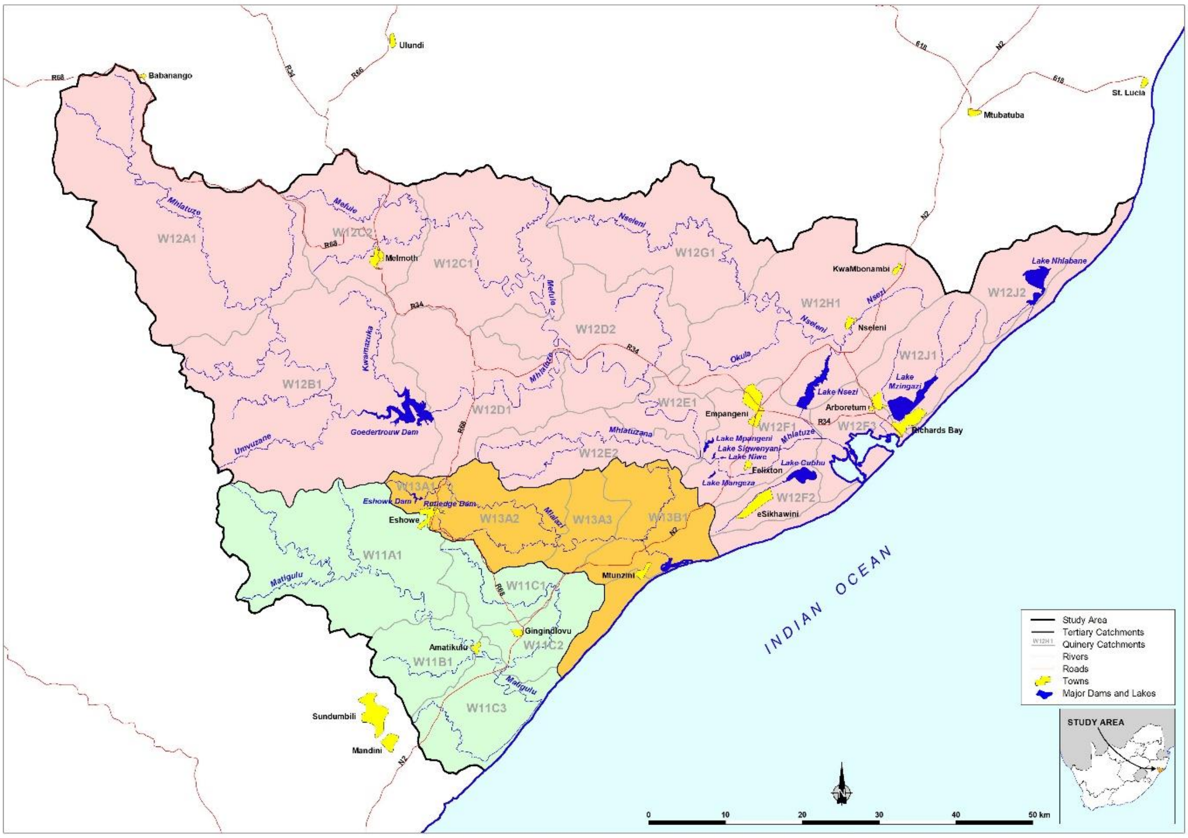


Figure 4-1: Catchment Study Area showing quinary sub-catchments

4.2 Regulating Storage Structures

Table 4-2 provides a summary of the large storage reservoirs and lakes simulated explicitly in the Study Area.

Table 4-2: Summary of Lakes and Dams in Study Area

Quaternary Catchment	Details	Full capacity (million m^3)	Minimum Capacity associated with Lake maintenance level* (million m^3)
W12B	Goedertrouw Dam	301.26	1.2
W12H	Lake Nsezi	4.95	0.02
W12F	Lake Cubhu	6.09	2.46
W12J	Lake Nhlabane	39.7	17.1
W12J	Lake Mzingazi	37.6	16.9
W13A	Eshowe & Rutledge Dam	1.12	0.09

Note *: This level is to protect the Lake from an environmental perspective, and the Lake should not be drawn lower than this level except in extreme emergencies.

4.3 Water Availability (Yield)

The Water Resources Yield Model (WRYM) developed by the DWS and applied countrywide was applied in previous studies to carry out long term historical and stochastic yield analysis as well as short term analysis to determine the yield available for a range of initial dam storages. A brief description of the terminology relating to the yield analyses is as follows:

- Historic Firm Yield: The maximum volume of water that can be abstracted from a resource over the historical observed time period (1920-2004) such that the resource is able to provide the abstracted volume in full each and every year.
- Long Term Yield at various Recurrence Intervals: 201 natural hydrological time series' (known as stochastic sequences) of 85 year record length are analysed in order to determine the system behavior under different hydrological conditions. The analyses allow for some sequences to fail (not supply the abstraction in full) and the results are quoted in assurance of supply depending on how many sequences fail.
- Short Term Yield at various Recurrence Intervals: 501 natural hydrological time series' (known as stochastic sequences) of 5 year record length are analysed in order to determine the system behavior under different hydrological conditions. In this case the resource's starting storage condition is considered as additional yield is available when the resource is fuller compared with when it starts lower.

More information on yield analyses as well as additional terminology such as assurance of supply, recurrence interval etc. can be found in Basson *et. al*, 1994.

4.3.1 Mhlathuze System

Detailed yield analyses were undertaken during the MWAAS and subsequent further analyses took place during the Support of Compulsory Licensing. No further updates to the WRYM took place as part of this study as the WRPM was used for the water availability assessment. The required yield inputs to the WRPM in the form of the short term curves had already been undertaken, and it was not necessary to revisit these. This sub-section provides a summary of the yields of the system.

The water availability in the Mhlathuze system is determined as a system yield (which also includes the groundwater contribution) and not just the yield of the Goedertrouw Dam and relevant Lake resources added together. This is because of the large amount of tributary runoff that occurs between the Goedertrouw Dam and the point of abstractions of the various users. In order to determine the yield, the individual abstractions at their relative locations are withdrawn from the system and combined together in a single yield node. The excess yield (over and above the total use) is abstracted from the point in the system representing the Mhlathuze weir.

Using this approach, the historic firm yield (HFY) determined for the Mhlathuze system in the MWAAS, including the current available transfer from the Thukela was determined to be 245 million m^3/a.

The long term stochastic yields obtained from the MWAAS are presented in **Table 4-3** with the curve presented in **Figure 4-2**.

Table 4-3: Long Term Stochastic Yields: Mhlathuze System

Stochastic firm yield at levels of assurance in supply (M m^3/annum)			
99.5 %	**99.0 %**	**98.0 %**	**95.0 %**
1:200 years	**1:100 years**	**1:50 years**	**1:20 years**
243.3	251.6	260.0	272.3

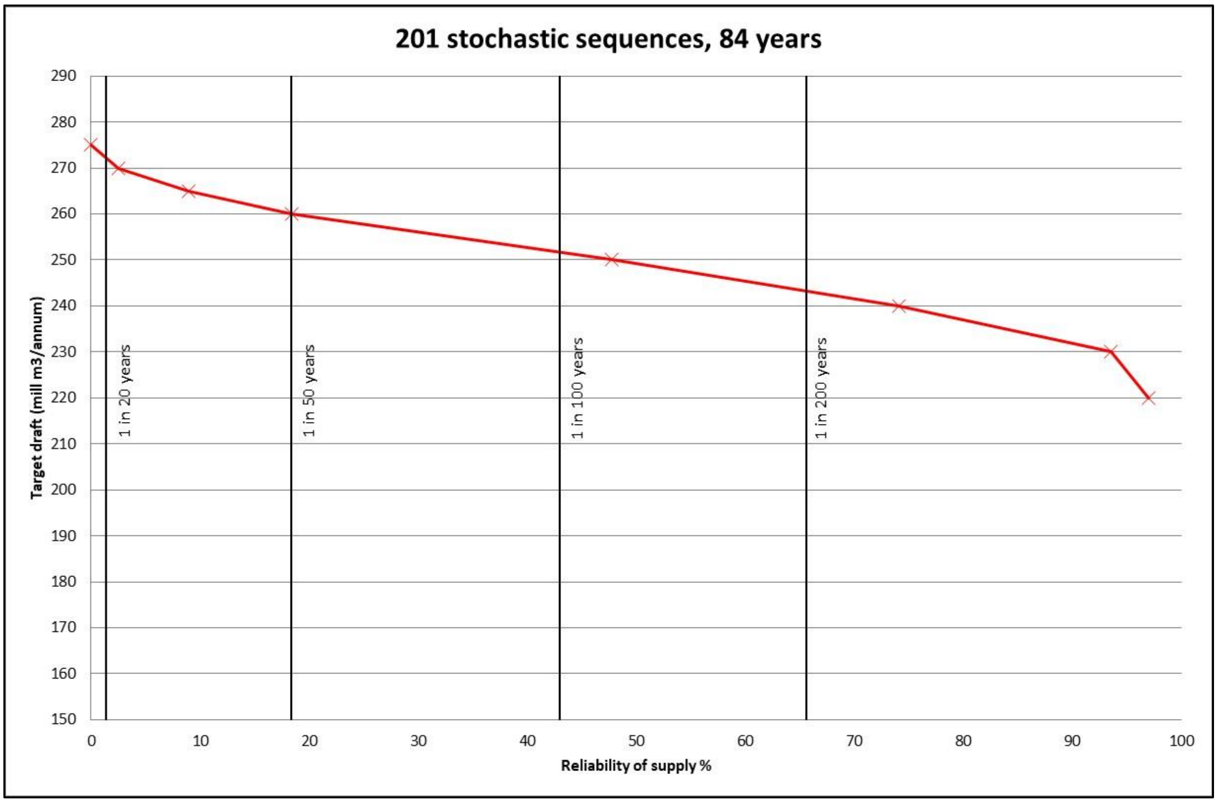


Figure 4-2: Long Term Stochastic Firm Yield: Mhlathuze System

The short term stochastic yields of the Mhlathuze and Mfolozi systems ate various starting storages are presented in **Table 4-4** and **Table 4-5** and represented graphically in **Figure 4-3** and **Figure 4-4**.

Table 4-4: Short term characteristics: Mhlathuze system

	Yield Mm^3/annum at indicated RI $^{(2)}$					
Starting storage (as % of live FSC$^{(1)}$)	1:200	1:100	1:50	1:20	1:10	1:4
100%	207.33	214.00	227.44	250.46	269.27	297.76
80%	192.48	202.43	217.12	239.02	261.36	295.86
60%	174.18	184.10	198.77	224.01	247.87	289.51
40%	145.33	158.56	170.54	193.71	226.94	270.59
20%	101.50	114.83	126.15	153.84	179.65	212.59
10%	78.39	87.67	95.95	107.61	132.34	164.74

Note: (1) Live full supply capacity (FSC) of Dam.

(2) Recurrence interval of failure, in years.

Table 4-5: Short term characteristics: Mfolozi system

	Yield Mm³/annum at indicated RI					
Starting storage (as % of live FSC)	**1:200**	**1:100**	**1:50**	**1:20**	**1:10**	**1:4**
100%	34.36	35.42	38.33	39.60	39.86	40.42
80%	26.60	28.60	30.33	34.55	38.17	39.79
60%	17.60	19.40	21.21	24.19	28.22	38.15
40%	7.24	8.01	10.01	13.60	16.10	25.29
20%	1.57	1.71	1.80	2.77	5.99	13.64
10%	0.74	0.85	0.96	1.54	3.10	11.15

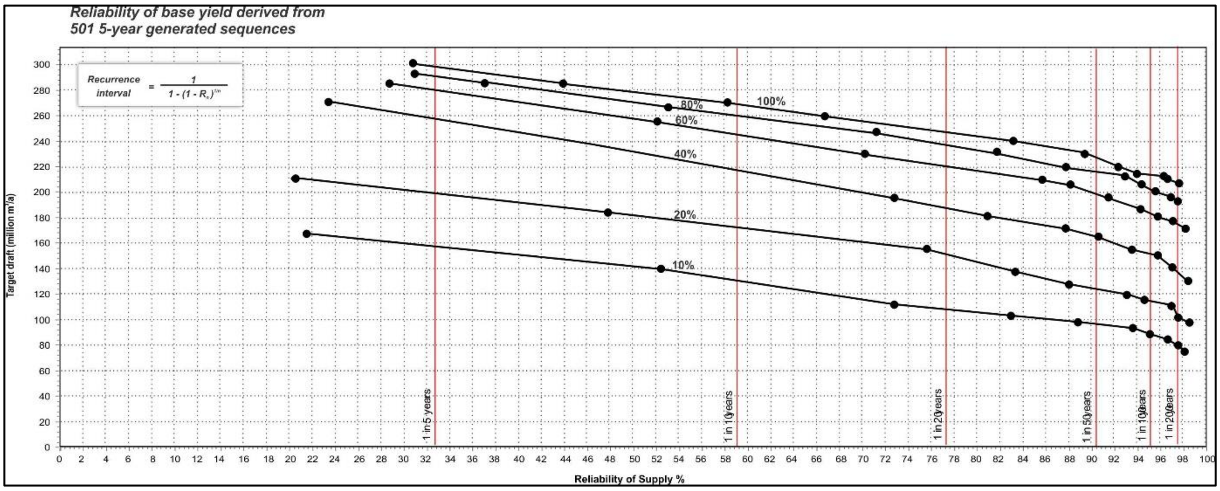


Figure 4-3: Short Term yields: Mhlathuze system

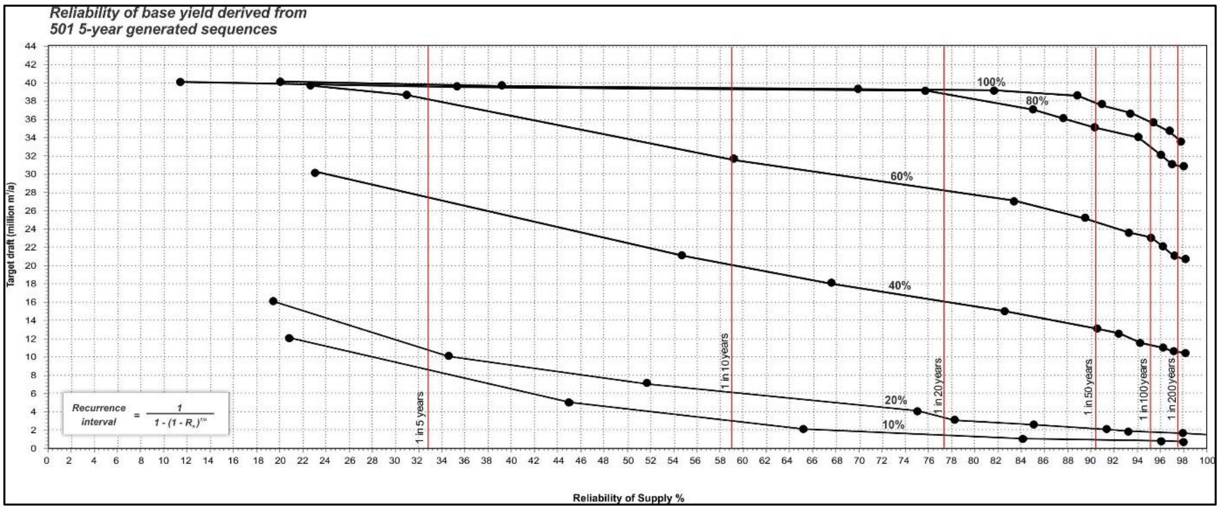


Figure 4-4: Short Term yields: Mfolozi system

4.3.2 Surrounding Towns

The Eshowe WSS obtains its raw water from local dams, Rutledge Dam and Eshlazi Dam, in the Mlalazi River. The system also receives supplementary water from the Goedertrouw Dam in the Mhlathuze River. The Rutledge and Eshlazi (also referred to as Eshowe) dams which supply Eshowe are situated in the upper reaches of the quaternary catchment W13A, namely quinary catchment W13A1, see locality in **Figure 4-1**.

A detailed hydrological, yield and operating rules assessment was carried out as part of the Stand Alone Dams Study (Eastern Cluster) (DWS, 2016). The HFY determined for the combined two dams is 1.29 million m^3/annum. The long term stochastic yields are presented in **Table 4-6** and the associated yield curve in **Figure 4-5.**

Table 4-6: Long Term Stochastic Yields: Combined Eshlazi and Rutledge Dams

Stochastic firm yield at levels of assurance in supply (Mm^3/annum)		
99.0 %	**98.0 %**	**95.0 %**
1:100 years	**1:50 years**	**1:20 years**
1.58	1.77	2.0

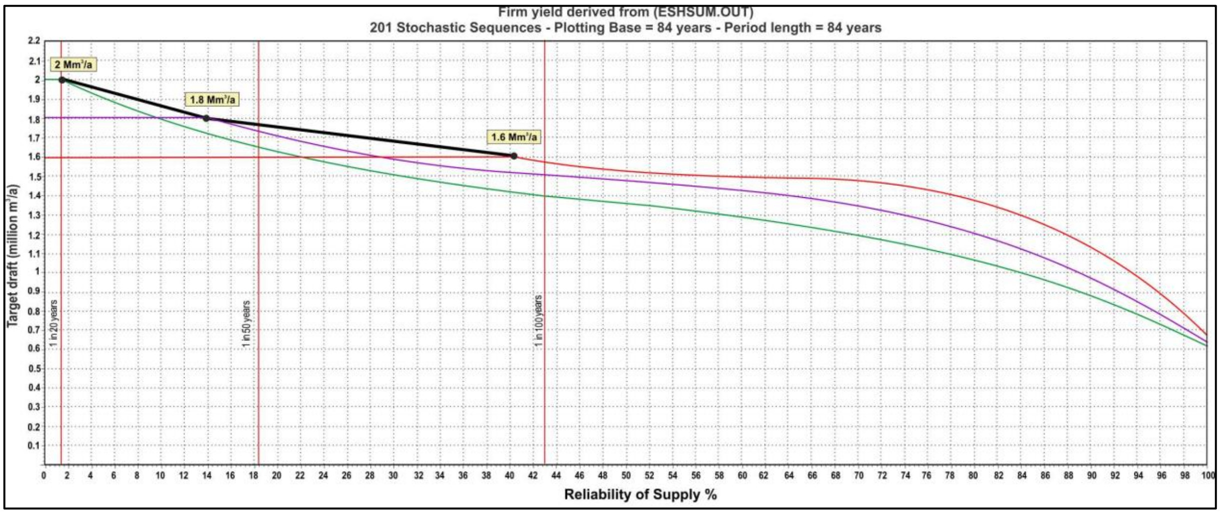


Figure 4-5: Long Term Yield Curve: Combined Eshlazi and Rutledge Dams

The short term yields for the combined dams are presented in **Table 4-7**.

Table 4-7: Short term characteristics: Combined Eshlazi and Rutledge Dams

	Yield Mill m^3/annum at indicated RI [(2)]				
Starting storage (as % of live FSC[(1)])	**1:200**	**1:100**	**1:50**	**1:20**	**1:10**
100%	1.53	1.66	1.81	2.08	2.33
80%	1.50	1.60	1.78	2.02	2.30
60%	1.35	1.48	1.64	1.87	2.11
40%	1.15	1.25	1.40	1.50	1.78
5%	0.80	0.84	0.90	1.10	1.28

Note: (1) Live full supply capacity (FSC) of Dam.

(2) Recurrence interval of failure, in years.

Information for the remaining three surrounding towns included in this Study at a Desktop Level Assessment was sourced from the Reconciliation Strategies prepared for each town as part of the All Towns Strategy Study (DWA, 2011a,b,d).

The main source of supply for Gingindlovu Water Supply Scheme is the Matigulu River and Msunduzi River which is a tributary of the Matigulu River. The Gingindlovu Town therefore relies on run of river for its water resources. The Reconciliation Strategy concluded that “During low flow periods the amount of run-off is sufficient to meet the three month peak summer annualised demand of the Gingindlovu WTW, as well as for other water uses, particularly irrigation agriculture.” However, it is noted that no water resources analyses took place as part of the study and the conclusion was drawn by comparing average natural flows (from WR90) at the abstraction point.

The main source of supply for the Mtunzini Water Supply Scheme, is the Ntuze River, a tributary of the Mlalazi River and bulk water purchase from CoMLM. The KCDM has a service level agreement for the municipality to supply Mtunzini with bulk water supply. The Reconciliation Strategy stated that “The Mtunzini Water Supply Scheme has a registered water use of 0.5 million m^3/a, from the Ntuze River. The treated bulk water supply infrastructure from the CoMLM, can deliver on average 1.0 Ml/d (0.37 million m^3/a). Therefore the total water available is 0.87 million m^3/a.”

The main source of supply for the Melmoth Water Supply Scheme is the Mfulazane River, a tributary of the Mfule River. The Reconciliation Strategy concluded that “during low flow periods the run-off at the abstraction point is not sufficient to meet the three month peak summer annualised demand of Melmoth WTW abstraction requirements. This is the reason why boreholes were drilled to supplement the surface water supplies, particularly during low flow periods". Again, however, water resources analyses were not undertaken and the conclusions were drawn using WR90 hydrological flows.

4.4 Groundwater Availability

4.4.1 Coastal Lakes

The Yield Analysis Report of the Richards Bay Reconciliation Strategy (DWS, 2015d) found that the confidence in the estimated lake yields presented was very low, as only the surface water component of these yields has historically been taken into account in the modelling. Groundwater contributions to the lakes could not be quantified with an acceptable level of confidence to be included in the lakes' yields estimation. However, this conclusion was based on the findings of the hydrology in the MORFP study. It recommended that in order to improve this assessment in future, the monitoring and quantifying of the groundwater contribution be included, as well as the interaction between groundwater and surface water. Yields for the lakes could then be determined at a more acceptable level of confidence.

The Mhlathuze Water Availability Assessment Study (MWAAS) (DWAF, 2009) subsequent to the MORFP study, had developed a lake water balance model linked to the Pitman Model to simulate lake levels and groundwater inflows and outflows to the lakes. The model did incorporate groundwater inflow to lakes at a coarse level with limited calibration based on existing reports. It simulated and calibrated lake water levels and discharge at existing gauging stations for Lake Mzingazi, however, Lakes Nhlabane and Cubhu were not calibrated. These are the lakes with significant groundwater interaction.

This model incorporated abstractions from the lakes until 2004 and was calibrated against lake water levels reported by Kelbe and Germishuyse (2001) and discharge at the DWS gauging station at the outlet of Lake Mzingazi only. From this model, a time series of groundwater inflows into the lakes was derived for all three lakes.

The MWAAS identified a need to incorporate groundwater interactions from the groundwater lake module into the WRYM to determine a combined system yield. In this study, the Pitman model and the Lake model were updated with revised afforestation estimates and additional lake water level data for calibration and were used to generate both surface water and groundwater inflow and outflow estimates for all three lakes.

On the KwaZulu-Natal coastal plain in the vicinity of Richards Bay, groundwater interacts with a system of lakes. The coastal lakes are lakes Mzingazi, Nhlabane, Nsezi, Cubhu and Mangeza (**Figure 1-1**). The hydrology of the lakes is influenced by the regional groundwater system through baseflow into adjacent streams flowing into the lakes, and for some lakes, by direct seepage from the aquifers into the lakes.

Three types of lake systems exist that function in different manners. The coastal lakes (i) are situated in a topographically flat region with a shallow water table, while the lakes further inland along the Mhlathuze Valley are small water bodies that are formed through the damming of tributaries by sandbars along the flood plain. These off-channel lakes (ii) reside under different geological conditions. They formed in the incised river channels where there are shallow soils and limited groundwater interaction. The third type of lakes are combination lakes (iii) that are fed by rivers and groundwater but are dominated by the stream network.

Although surface water processes dominate the flow regime in Lakes Nsezi and Mangeza, a strong interaction also exists between the local aquifers and these lakes, since they are also fed by baseflow from rivers. Lake Nsezi is controlled by the Nseleni River and lies on the edge of the Zululand Coastal Plain. Lake Mangeza formed as a result of a drowning river valley and is situated at the confluence of the Mangeza and Mhlatuze rivers.

The hydrology of the coastal lakes (i), in particular, is influenced by the groundwater system through baseflow from inflowing rivers and direct seepage from the aquifers into the lakes. The coastal lakes that are controlled by subsurface conditions include Lake Nhlabane, Lake Mzingazi and Lake Cubhu, which are characterised by a very shallow water table intersected by the lakes. They are therefore very sensitive to landuse and large-scale groundwater abstraction that may impact on the water table.

The coastal lakes Cubhu, Mzingazi and Nhlabane are extensions of the local groundwater and have a strong interaction with the aquifer, hence determining their yield requires accounting for surface and groundwater inflows and outflows to the lakes. These are the lakes investigated in this report in terms of the groundwater contribution and its influence on their yields.

Table 4-8 provides a summary of the previous natural MARs as determined during the MWAAS for the lake catchments compared with the newly determined MARs resulting from the enhanced groundwater interaction Task undertaken as part of this Study.

Table 4-8: Summary of results

Lake	Quinary	MAR (MWAAS) (Mm^3/a)	This Study			Comparison
			MAR Groundwater (net) (Mm^3/a)	MAR Surface portion (Mm^3/a)	Total MAR (Mm^3/a)	
Mzingazi	W12J1	52.47	12.45	39.98	52.43	Total MAR almost identical, remain with MWAAS
Nhlabane	W12J2	33.18	4.69	25.71	30.40	New MAR lower, adjust to new hydrology for water resources analyses
Cubhu	W12F2	18.04	3.49	18.09	21.58	New MAR higher, remain with MWAAS to be conservative given lack of observed data for validation purposes

Yield is not only dependent on MAR, but is highly influenced by the time period of low flows, ie. the number of sequential months of low flows. It is evident that the MAR for Lake Nhlabane resulting from this Task is less than 10% lower than that from the MWAAS. The updated hydrology was used in the water resources scenarios assessment, however, it was found that it did not have an impact on the results.

Further analyses was undertaken in order to determine the portion of yield contributed to by the groundwater on the coastal lake catchments. This was found to be 11.1 million m^3/annum.

4.4.2 Additional Groundwater

As part of the development of the Reconciliation Strategy (DWS, 2015a), a detailed assessment of groundwater resources was undertaken in order to determine whether groundwater would be a realistic future intervention option. It was concluded that, despite the high density of boreholes located predominantly in and around the western portion of the CoMLM, the majority of boreholes were identified to be very low yielding with blow yields in the range of 0 l/sec to 0.5 l/sec. Furthermore, it was stated that the yield of the groundwater schemes are so limited, that they cannot practically be considered for bulk water supply. Local use should rather be encouraged.

A detailed assessment was undertaken as part of this Study (DWS, 2020a) in order to determine whether the Strategy (DWS, 2015) conclusion was valid. The outcome was concluded that the previous conclusion is a realistic assessment of the yield potential of the aquifer. It would require 50-60 production boreholes to provide 1.5 Mm^3/a. This is not viable for bulk water supply, however, the range of yields 23-300 m^3/d per borehole suggests the aquifer is suitable for local stand-alone water supply.

Aquifer yield

Aquifer yield is a measure of the available groundwater resources, excluding an assessment of whether they can be economically abstracted. Data was collected on Harvest Potential, Exploitation Potential, and recharge from GRAII (**Table 4-9**).

Table 4-9: Groundwater resources

	Harvest Potential	**Recharge**	**Exploitation Potential**	**Aquifer recharge**	**Potable fraction**	**Baseflow**	**Abstraction (WARMS)**	**Stress index**
	Mm^3/a	**Mm^3/a**	**Mm^3/a**	**Mm^3/a**		**Mm^3/a**	**Mm^3/a**	
W11A	34.583	43.639	12.226	12.796	0.94	39.271	0.259	0.02
W11B	5.396	12.292	4.506	3.731	0.20	10.980	0.000	0.00
W11C	8.655	40.400	17.241	10.653	0.83	37.143	0.092	0.01
W12A	21.407	35.065	7.476	18.902	0.85	25.170	0.092	0.00
W12B	33.996	42.413	10.836	18.798	0.86	33.160	0.040	0.00
W12C	43.928	32.699	5.939	17.818	0.94	23.233	0.011	0.00
W12D	13.373	29.364	8.005	13.322	0.77	24.833	0.172	0.01
W12E	6.785	21.411	6.461	6.717	0.43	18.485	0.000	0.00
W12F	81.290	84.512	18.684	46.752	0.64	52.001	0.348	0.01
W12G	4.331	18.967	4.705	9.999	0.49	13.774	0.004	0.00
W12H	26.510	41.556	14.980	13.036	0.90	35.852	0.293	0.02
W12J	123.853	70.890	22.701	42.464	1.00	40.200	0.000	0.00
W13A	12.240	30.793	9.756	6.478	0.82	28.239	0.168	0.03
W13B	10.416	32.147	10.260	4.734	0.93	30.364	0.007	0.00
	426.761	536.149	153.776	226.200		412.706	1.486	0.01

It is evident that much of the recharge drives baseflow. Aquifer recharge is a measure of recharge to the regional aquifer after losses for interflow from high lying springs. In mountainous terrain it is a more realistic measure of groundwater resources. The authorised water use from WARMs represents 1% of aquifer recharge, as measured by the stress index. This suggests that groundwater resources are underutilised in the study area.

Borehole yield

Borehole yield is the volume of water that can be abstracted from a borehole. Although aquifer yield may be large, it may not be possible to abstract the groundwater in economically viable volumes for bulk water supply. Borehole yield was assessed by lithology type (**Table 4-10**).

Many of the boreholes in the Quaternary deposits are shallow boreholes and do not penetrate to the more permeable Tertiary deposits, which may skew the results for boreholes drilled into the Port Durnford Formation. The boreholes with high yields in this Formation are likely drilled where a thick sequence of the Uloa Formation exists. These channels are the main source of groundwater inflow into the coastal lakes. One such channel coincides with the Mhlathuze river and estuary and another runs through the middle of Lake Mzingazi and has a large impact on the lake hydraulics (Kelbe and Germishuyse, 1999). These would be the most likely positions for high yielding boreholes but would have an impact on the lake.

Table 4-10: Yields by geological formation

Geology	N	Median (l/s)	% ≥ 2 l/s	% ≥ 5 l/s
Empangeni and Pre Pongola intrusives	71	0.68	11.3	4.2
Natal Metamorphic Province	52	0.5	15.4	0
Natal Group	120	1.1	29.1	5.8
Dwyka Group	67	0.8	23.9	6
Pietermaritzburg Formation	67	1.07	28.36	0
Vryheid Formation	76	1.29	38.15	2.6
Volksrust Formation	16	1.27	25	0
Karoo Argillaceous rocks	64	0.4	10.9	1.6
Karoo Arenaceous rocks	18	0.3	0	0
Letaba Formation	47	0.5	2.12	2.12
Berea red sands	27	0.6	22.2	0
Port Durnford and underlying Formations	87	1.0	24.1	3.4

The distribution of the percent of boreholes with a blow yield greater than 5 l/s, which is considered viable for bulk supply is shown in **Figure 4-6**.

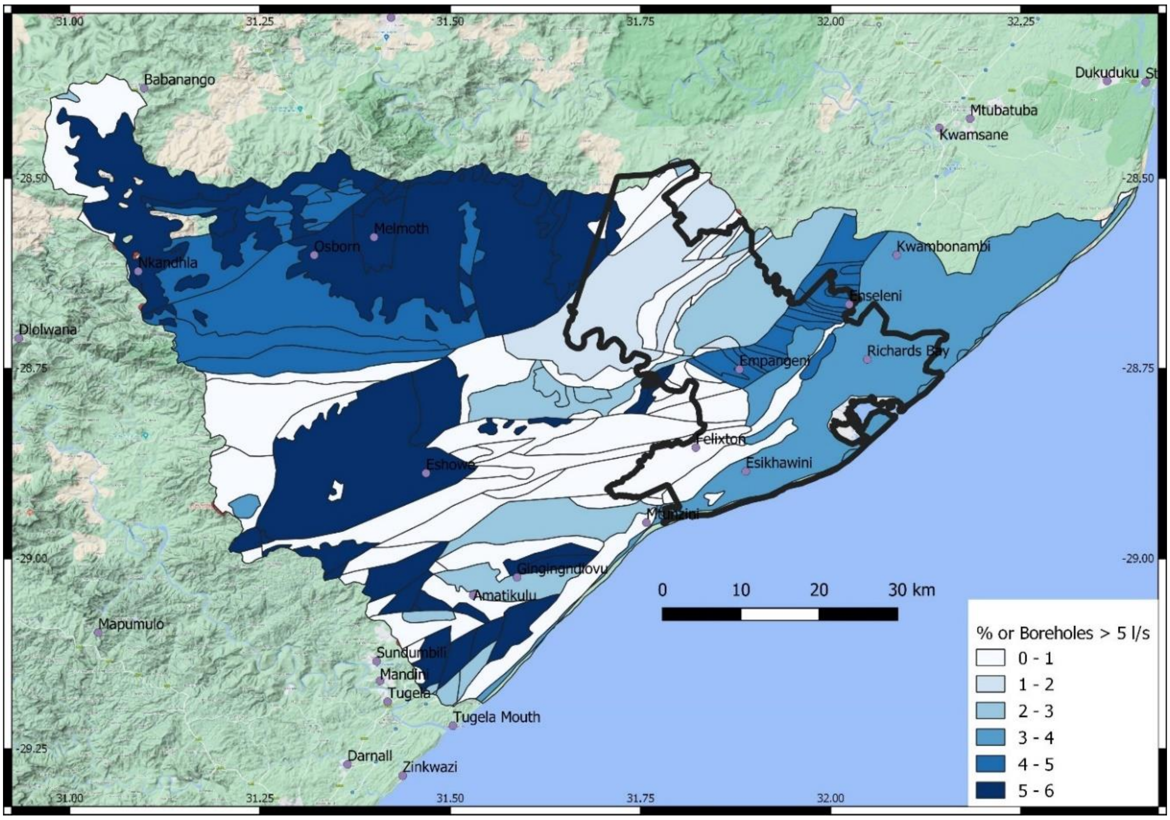


Figure 4-6: Percent of boreholes with median yield > 5l/s

5 CURRENT WATER BALANCE STATUS

The Study area covers the Mhlathuze system, focusing on the Richards Bay Water Supply Scheme. Furthermore, four surrounding towns have been assessed, namely Gingindlovu, Melmoth, Eshowe and Mtunzini. There are therefore five separate water balances considered in this Section. The differentiation considers users that share a common water resource, locality of the storage structures as well as abstraction points. The system is assessed in an integrated manner, and upstream users' water balances are considered when preparing downstream water balances on which they have an impact.

The water balances take into account the assurance of supply as required by different water use sectors. Water supply to urban/industrial and rural domestic users is always provided at a higher assurance than water supply to irrigation. For the purpose of the water balances, a 98% assurance was assumed to be applicable to the urban/Industrial and rural domestic sector and a 75% assurance to the irrigation sector. The 98% assurance relates to shortages in supply that will on average be experienced once in 50 years (1 in 50 year) and the 75% assurance for irrigation, to shortages experienced on average once in 4 years (1 in 4 year).

The raw data used to create the water balances are presented in **Appendix B**.

5.1 Mhlathuze System

The Mhlathuze system water balance (**Figure 5-1**) is produced for users along the Mhlathuze River that have access to releases from Goedertrouw Dam and abstractions from the Mhlathuze weir. In addition, the additional resources of Lakes Nsezi, Mzingazi and Cubhu as well as the existing transfer from the Umfolozi are also included in the water balance representing the Mhlathuze System. These users also make use of river runoff entering the Mhlathuze River from tributaries. It is assumed that the Thukela transfer from Middeldrift (Phase 1) is operational at its maximum installed capacity of 1.2 m^3/s.

The balance using the current resources presents the four water requirement scenario projections as described in **Section 2.8**. The current resources are shown separately as the available system yield as well as additional yield that can be obtained if the system is operated efficiently, and the full benefit of runoff from tributaries is abstracted at the Mhlathuze weir. This efficient operation is reliant on real time monitoring and controlled releases from Goedertrouw Dam.

The current water balance plot shows that the existing system yield is insufficient to supply the growth in requirements from 2021 at a satisfactory assurance of supply level for all of the water requirement projection scenarios.

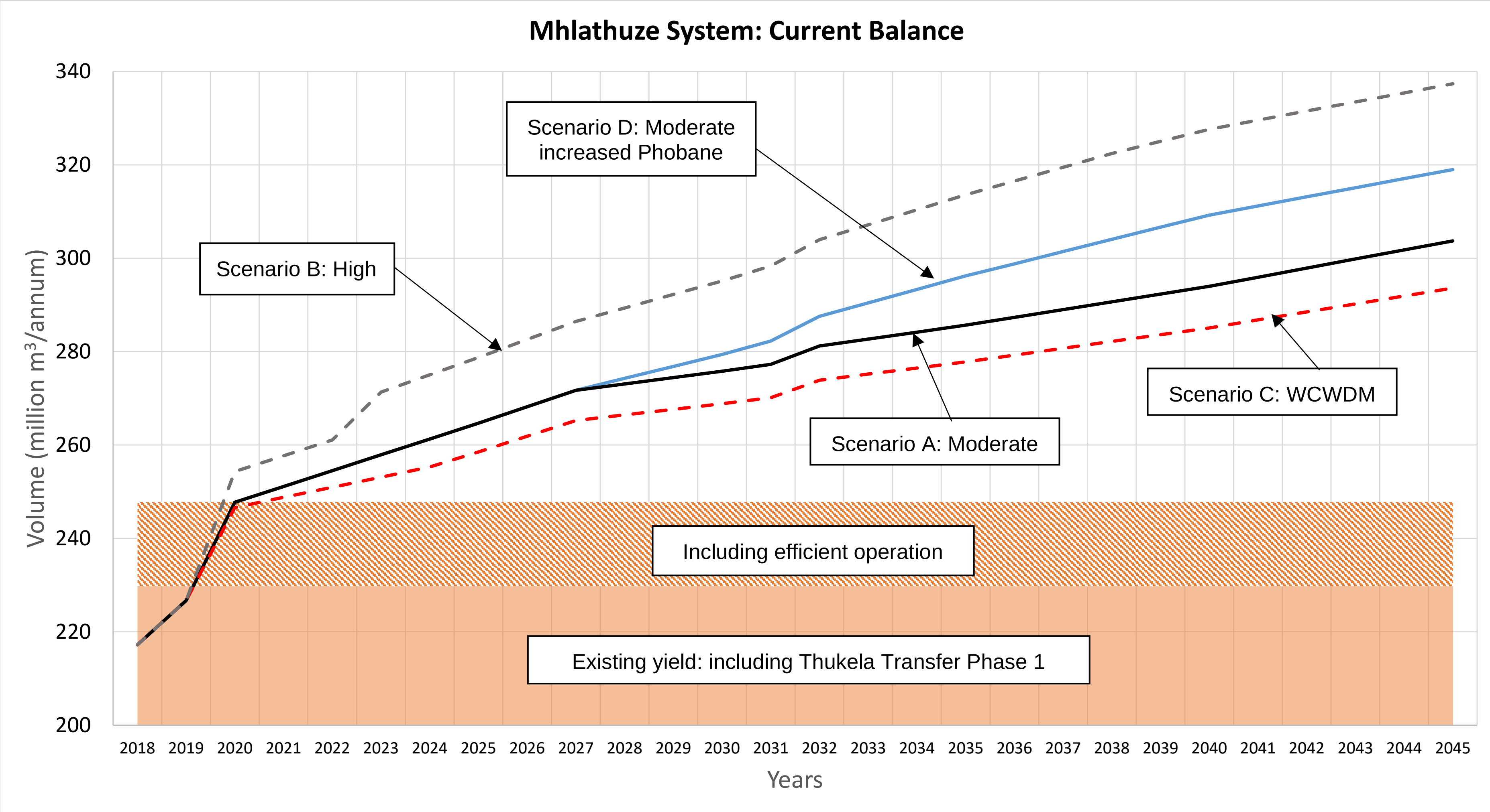


Figure 5-1: Current Water Balance, Mhlathuze System

5.2 Surrounding Towns

5.2.1 Gingindlovu/Amatikuku

The water balance plot for the existing resource supplying the Gingindlovu/Amatikulu urban area highlights a major existing deficit which increases into the future as the requirements grow. The existing run-of-river yield is approximately 0.13 million m^3/annum at a 98% assurance of supply.

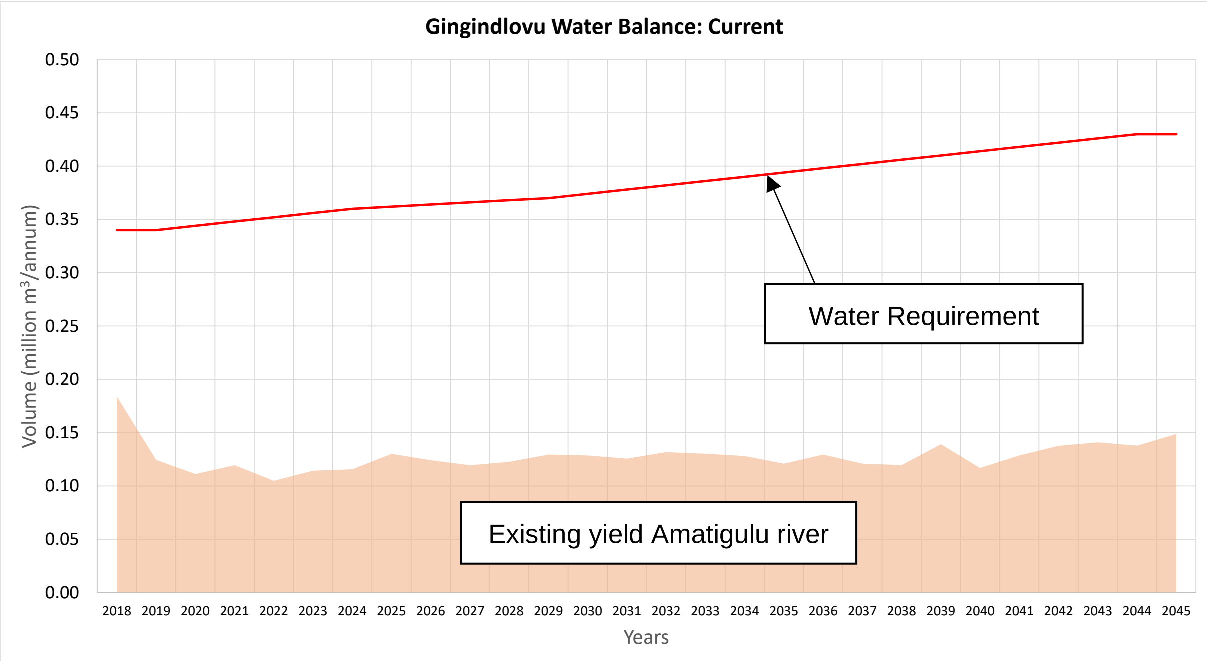


Figure 5-2: Current Water Balance, Gingindlovu/Amatikilu WSS

5.2.2 Eshowe

The water balance plot for the existing resources supplying the Eshowe urban area (**Figure 5-3**) shows that these resources are sufficient to supply the future water requirement projection.

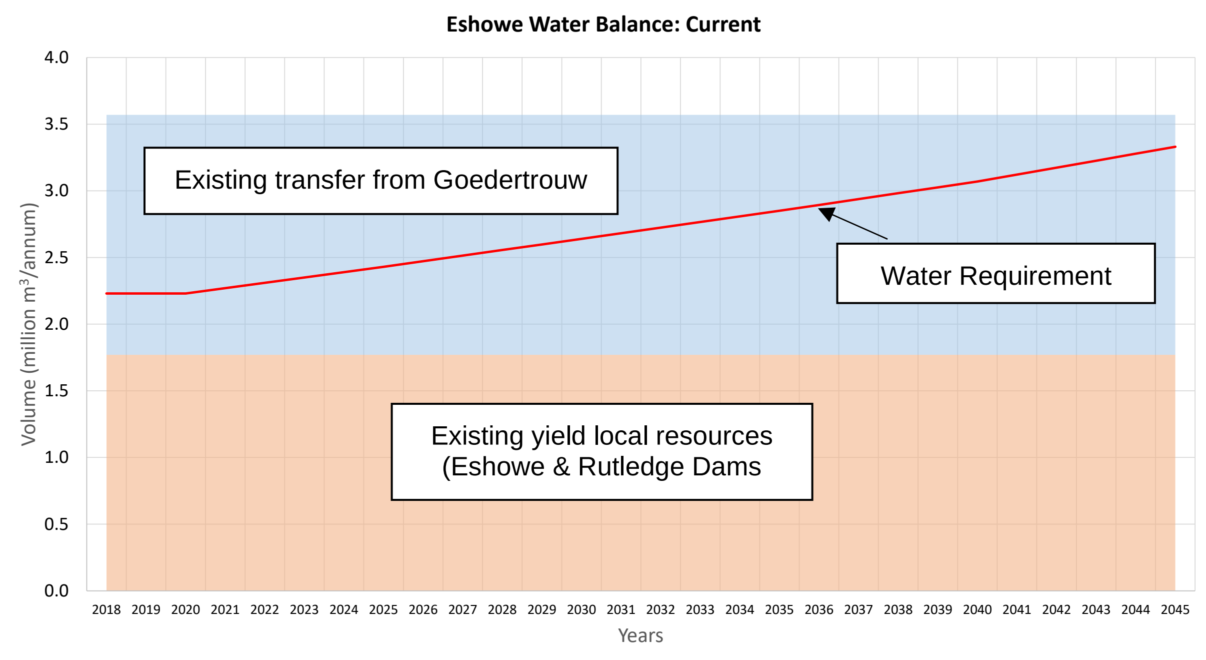


Figure 5-3: Current Water Balance, Eshowe WSS

5.2.3 Melmoth

The water balance plot for the existing resources supplying the Melmoth urban area highlights a shortfall in availability from the combination of boreholes and the Mfulazana River abstraction.

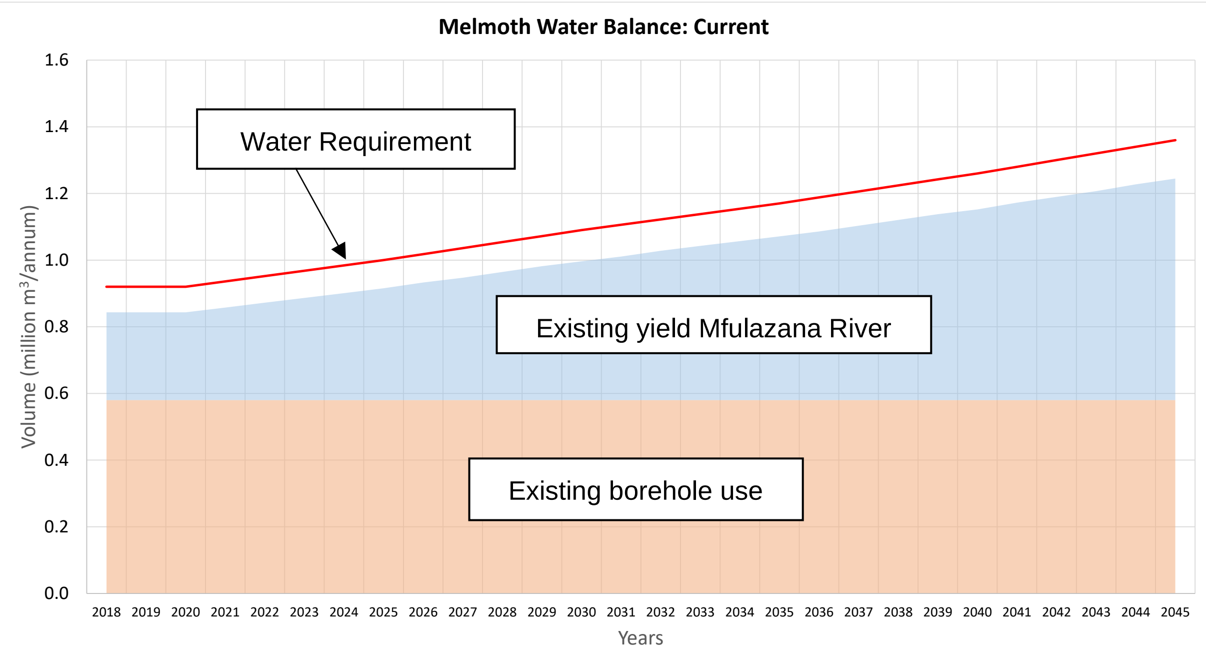


Figure 5-4: Current Water Balance, Melmoth WSS

5.2.4 Mtunzini

The water balance plot for the existing resources supplying the Mtunzini urban area (**Figure 5-5**) shows that these resources are sufficient to supply the future water requirement projection.

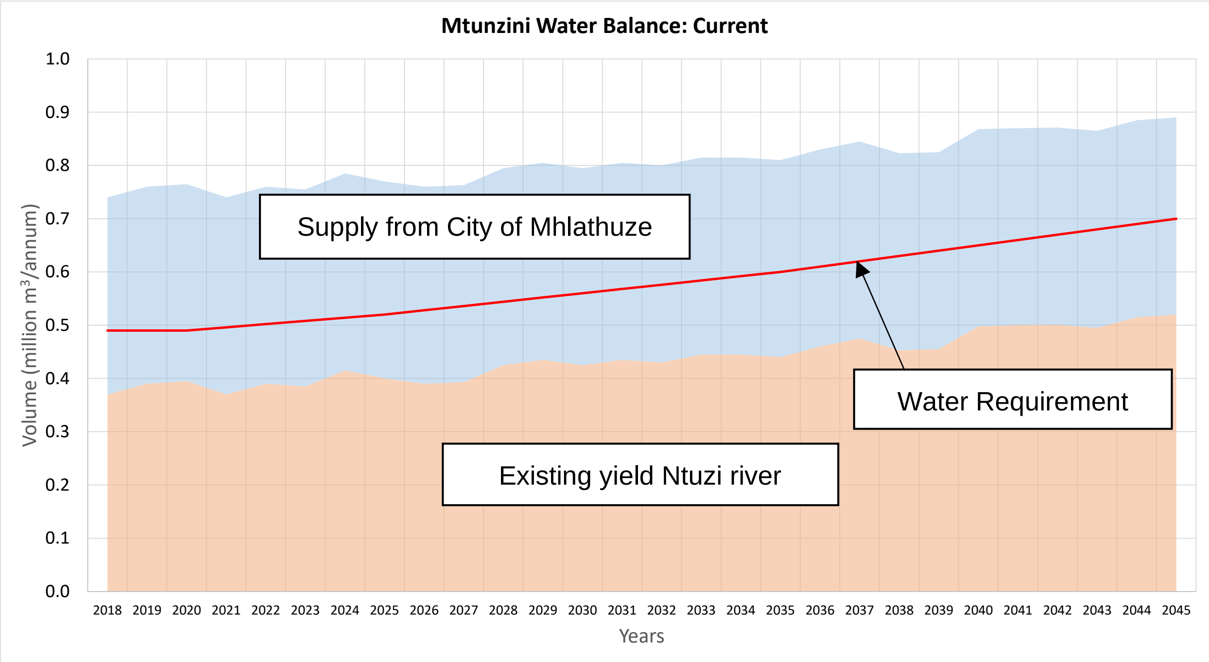


Figure 5-5: Current Water Balance, Mtunzini WSS

6 POSSIBLE INTERVENTION OPTIONS

Intervention options comprise the implementation of various combinations of reconciliation options over time and can be divided into two main categories, namely:

- Reconciliation options used to reduce the water requirements; and
- Reconciliation options that will increase the yield available from the existing water resources.

This section summarises the possible intervention options that exist for the study area. Options as defined in the Reconciliation Strategy (DWS, 2015a) have been included, and the level of their ongoing validity for this Strategy update have been discussed.

6.1 Reconciliation Options that will reduce Water Use

6.1.1 WCWDM

Reducing water demand by introducing WCWDM measures is a necessary intervention for all water reconciliations. The previous Richards Bay Reconciliation Strategy (DWS, 2015a), predicted a total reduction of 6.8 million m^3/annum could be made to the growing demand between the years 2014 to 2024. This was an estimated 2.8 million m^3/annum in the bulk industrial sector over 5 years and 4 million m^3/annum in the domestic sector over 10 years.

On the surface, it appears that WCWDM implementation did not progress at the projected rate over the recent years. Some success cases, for example Tronox, have been reported, however, feedback during Stakeholder engagement meetings has suggested limited progress in the domestic sector.

Notwithstanding the slow progress of WCWDM initiatives since the development of the strategy in 2015, this intervention option should still form part of the updated intervention options. As discussed in **Section 3**, a detailed WCWDM assessment was undertaken for the Study area resulting in realistic and optimistic targets for reducing water wastage. The outcome of the assessment is that the CoMLM could potentially save between 5% and 15% (10 million m^3) of the requirements by implementing WCWDM over the long term.

KCDM have recently (May 2020) started a WCWDM project aiming to reduce water losses in their water supply schemes.

6.1.2 Remove alien vegetation

As with WCWDM, removing alien vegetation is a standard intervention measure for saving water in all Reconciliation Strategies, and is very important in severely water stressed catchments.

The Richards Bay Reconciliation Strategy (DWS, 2015a) did not quantify the additional yield that could be obtained from the removal of alien vegetation. However, the following was stated regarding the intervention "Actively support clearing programmes for invasive alien plants, especially in the catchments above existing and potential future dams (currently only Goedertrouw Dam) that supply the RBWSS, because:

a. If alien vegetation is not removed the impact on water availability increases with time.

b. It is much more costly to remove mature trees so it is important to contain alien vegetation and not allow it to spread further.

This intervention implementation is currently being addressed as part of the Catchment Management Forum initiatives, with a Strategy for removal of plants having been developed.

6.1.3 Water Reuse

The Reconciliation Strategy (DWS, 2015a) recommended the following relating to the water reuse intervention and allocated the responsibility to the City of Mhlathuze LM.

"Initiate a feasibility study to evaluate aspects that have not previously been addressed. Consider:

- Indirect effluent reuse, whereby treated effluent could be discharged to Lake Mzingazi for indirect potable and industrial reuse. For this sub-option, evaluate the potential impact of discharging treated wastewater effluent into the lake on nutrient enrichment of the lake. Carefully consider the location of the discharge point relative to the Mzingazi WTW intake works. Also consider the blending of treated effluent at the Mzingazi WTW or artificial recharge to create a barrier to prevent sea water intrusion.
- Potential uptake of treated effluent by bulk industrial water users close to the Arboretum macerator. Potential users would need to be identified.
- Consider concerns regarding to the remaining presence of endocrine disrupting chemicals (EDCs) and partially metabolised pharmaceuticals, as these compounds are generally not removed during the wastewater treatment process.

- Take into consideration the potential synergy with a seawater desalination plant, especially for brine disposal.
- Consider the institutional requirements and implications regarding the operation and maintenance of specialist WWTW / reclamation plant equipment.
- Undertake an EIA should the decision be taken for the scheme to proceed.

The CoU have obtained funds for a Reuse feasibility study from National Treasury, and have approached some industries in Richards Bay for using and co-funding the scheme."

The implementation of this intervention has started since the completion of the Strategy (DWS, 2015a). The status as at June 2020 was that the CoMLM have initiated a project that entails 75Ml/d (27 million m^3/annum) of treated effluent as well as a 48 km bulk pipeline. The CoMLM have letters of intent from some potential users. The project is a Public-Private Partnership which is divided broadly into two phases. The Feasibility phase is complete and the second phase is underway. The Municipality had revised its bylaws to indicate that the reuse of treated effluent is the preferred source for further industrial water use.

6.2 Reconciliation Options that will increase Water Supply

6.2.1 Efficient system operation

As a result of the location of some of the major abstractions from the system (the Mhlathuze weir) relative to the location of the main resource (the Goedertrouw Dam), the Mhlathuze system is able to benefit from additional yield resulting in something referred to as the leverage effect. The leverage effect occurs because the system is able to leverage more yield as a result of maximising the tributary flow contribution from catchments located between the Goedertrouw Dam and the Mhlathuze weir abstraction point.

It should be noted, however, that this benefit is only avaiable if the system is operated efficiently. Real time flows at varous points in the system should be monitored and operating rules triggered depending on these flows. In this way, water can be held back in Goedertrouw Dam until such time that it is required due to catchment climatic characteristics. This efficient operation is undertaken by the DWS Regional Office.

6.2.2 Implement Operating Rules

A way to manage shortfalls in water availability over the short term, is to implement adaptive restriction rules using variable short-term availability based on water in storage and catchment state. This can be done as an interim measure during the time period before a major intervention becomes operational to augment the deficit.

The approach is to apply a strict restriction rule to the lower priority users, in this case the irrigators. The rule would need to be revisited each year as the growth in primary use occurs in order to allow for the required assurance of supply to the primary users. In this way, the rule is dynamic. Low priority users will receive their full allocations only in the time when the system has sufficient resources to supply all users.

The DWS: WRPS Directorate recently (November 2020) initiated an operating rules study which will undertake annual operating rule analyses over the next three years. The results of study will assist with managing the system's water resources until the next intervention measure is implemented.

6.2.3 Transfers from Neighboring Catchments

The Reconciliation Strategy (DWS, 2015a) suggested that an increase in the Thukela transfer from Middeldrift be compared with other transfer options (Lower Thukela Coastal pipeline and Umfolozi off channel storage Dam) at a prefeasibility level, afterwhich a decision can be made as to the preferred option. However, drought hit the catchment shortly after the completion of the Strategy (2015), and the upgraded Thukela transfer was then selected as an emergency scheme. Construction of the upgrade began, which would increase the size of the existing transfer of 1.2 m^3/s to 2.4 m^3/s. However, the project has been impacted by delays and the latest available information (March 2021) has indicated the earliest expected completion date would be December 2023. While the original urgency as a result of the drought has subsided due to recent rains in the catchment, it is important to continue the momentum and complete the project in order to augment the existing water resources.

6.2.4 New Dam Construction

The preferred potential new infrastructure resource based on options that have been evaluated in previous assignments (DWS, 2015a), is a new dam on the Nseleni River. The proposed dam will be located on the Nseleni River a tributary of the Mhlathuze River just upstream of the Bhejane township, from where water can be released downstream to Lake Nsezi for abstraction. The location of the proposed dam is shown in **Figure 6-1.**

The Nseleni Dam is located upstream of the Nsezi Water Treatment Works (WTW). Water released from the dam can either be released directly into the Nseleni River and then abstracted from Lake Nsezi at the Nsezi WTW, or can be transported by a gravity pipeline to the Nsezi WTW.

The following two options for infrastructure downstream of the Nseleni Dam were identified:

- Option 1:
    - A new abstraction works at the Nsezi WTW;
    - Augmentation of the Nsezi WTW with an additional 49.3 Mℓ/day.

- Option 2:
    - A new DN 1000 gravity pipeline to the Nsezi WTW.
    - A new abstraction works at the Nsezi WTW;
    - Augmentation of the Nsezi WTW with an additional 49.3 Mℓ/day.

An advantage of the location of this dam is that there is only a short distance (approximately 13.6 km) between the release point and the abstraction point at Lake Nsezi. This means that there would be relatively low river losses due to infiltration and evaporation along the route, as well as limited opportunity for contamination of the water downstream of the dam.

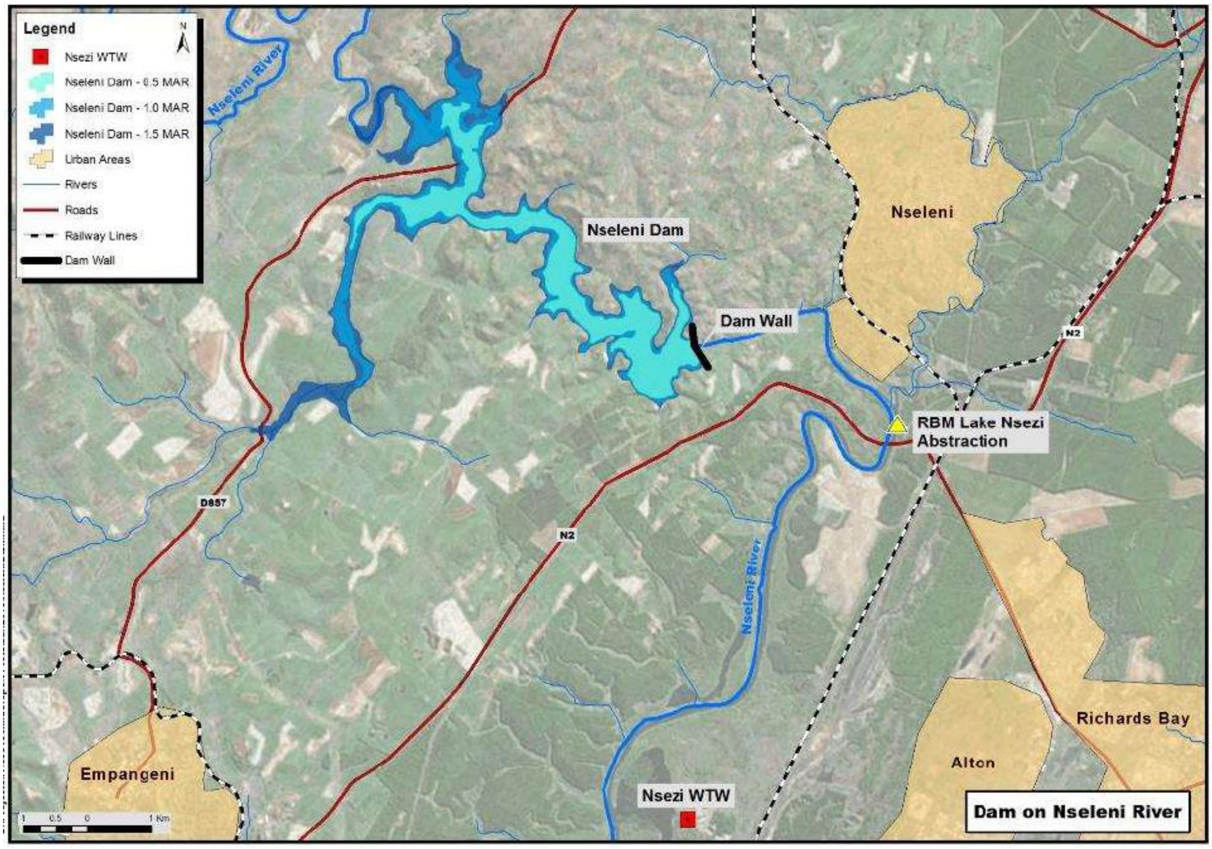


Figure 6-1: Location of proposed Nseleni Dam (improve quality)

The yield assessment carried out as part of this study indicated that an additional 12 million m^3/annum could be obtained from a dam on the Nseleni of 55 million m^3 capacity, which is a 1 MAR size dam.

The updated URVs at a discount rate of 8% are indicated in **Table 6-1** for three options.

Table 6-1: URVs for Nseleni Dam options

Item		1 MAR Dam on the Nseleni River	1 MAR Dam on the Nseleni River and New WTW at Lake Nsezi	1 MAR Dam on the Nseleni River, Pipeline and New WTW at Lake Nsezi
Total Capital Cost	(R million)	299.91	699.36	960.42
Annual Operating Cost	(R million/annum)	1.95	13.11	14.29
Dam Yield	(Mm³/a)	12.0	12.0	12.0
NPV Cost	(R million)	283.06	722.95	969.52
NPV Supply of Water	(million m³)	110.38	110.38	110.38
Unit Reference Value	**(R/m³)**	**2.56**	**6.54**	**8.77**

6.2.5 Existing Dam Raising

The raising of Goedertrouw Dam is a possible intervention option. The dam can be raised by 2.8 metres which will result in an increase in storage capacity from the existing volume of 301 million m^3 to 336 million m^3. The corresponding increase in yield to the system would be 5.8 million m^3/annum.

Capital, operational and maintenance costs were updated to a base date of October 2020 for the raising of the dam and ancillary infrastructure. The unit reference values (URV) have been determined for discount rates of 6%, 8% and 10%, and for a 37 analysis year period as presented in **Table 6-2**.

Table 6-2: Unit Reference Values: Raising Goedertrouw Dam

Item		Discount Rate 6%	Discount Rate 8%	Discount Rate 10%
Total Capital Cost	(R million)	127.54	127.54	127.54
Annual Operating Cost	(R million/annum)	0.28	0.28	0.28
Dam Yield	(Mm³/a)	5.8	5.8	5.8
NPV Cost	(R million)	122.16	118.07	115.54
NPV Supply of Water	(million m³)	74.84	57.95	46.23
Unit Reference Value	**(R/m³)**	**1.63**	**2.05**	**2.51**

6.3 Previous Options Considered

6.3.1 Lower Thukela Transfer

As mentioned in **Section 6.2.3**, the Reconciliation Strategy (DWS, 2015a) recommended that a prefeasibility study be initiated to compare the options of taking additional water from the Thukela at either the Middeldrift abstraction point or a new pipeline from the Lower Thukela, known as the Coastal pipeline. As a result of the drought, an emergency scheme was implemented and the option selected was to increase the existing Middeldrift transfer scheme.

It is highly unlikely that of both scheme transfer options would be required for the Richards Bay area when assessing the future growth in requirement scenarios. Furthermore, there is uncertainty regarding the excess availability in the Lower Thukela as a result of outdated hydrology as well as the Classification process currently ongoing in the Thukela catchment. Additional resources from the Thukela are required to supply the growing Gauteng Region, and increasing local demands from the Thukela are also needing to be supplied. All these aspects, including the updating if the hydrology will be assessed in more detail as part of the upcoming East Reconciliation Strategy Study, which has a specific component dedicated to reviewing the Thukela water balance.

A further aspect which requires consideration of the Coastal transfer to the North is the existing lawful allocations (licenses) associated with the Thukela water abstraction. Currently, both Umgeni Water and Mhlathuze Water have licenses to abstract from the Lower Thukela of 40 million m^3/annum and 47.3 million m^3/annum respectively. Umgeni Water has built infrastructure and has taken up part of their allocation. They are currently (2021) looking into the feasibility of making use of their full allocation and to supply the KCDM with water from the Lower Thukela. Mhlathuze Water have never exercised their allocation from the Lower Thukela, and in fact, the allocation is set to be transferred over to the Middeldrift upgrade in which case it will no longer available.

As a result of all of the above, the option of supply the Richards Bay area with water through the Thukela Coastal Pipeline has not been considered as an intervention option in this Strategy update.

6.3.2 Umfolozi Off Channel Storage Dam and Transfer

The Mfolozi transfer scheme was also considered in the Reconciliation Strategy (DWS, 2015a) as an intervention option, and, as with the Lower Coastal pipeline from the Thukela, it was recommended that a comparison Study between it and the Thukela options be undertaken.

The option has decreased in priority as an option for Richards Bay with the implementation of the Middeldrift Transfer upgrade.

There still remains uncertainty regarding the available water resources of the Mfolozi, and this will be addressed when the hydrology of the Mfolozi is revisited as part of the East Reconciliation updated scheduled to start in May 2021.

6.3.3 Desalination of Seawater

The desalination of seawater was suggested as an intervention in the Strategy (DWS, 2015a) that required further investigation.

The identification of available and appropriate land is essential to the planning of a desalination plant. The size of the site depends on the capacity of the desalination plant and the method of desalination to be implemented. For the purpose of the study an approximate area of 2.5 ha was considered for the plant footprint.

The initial identification and screening of potential locations for the proposed desalination plant should be based primarily on the exclusion of sensitive areas and identified existing and planned built up land use areas. Opportunities to utilize existing brown fields sites situated within the existing or planned development areas should however also be considered.

The location and layout of the scheme is shown in **Figure 6-2**.

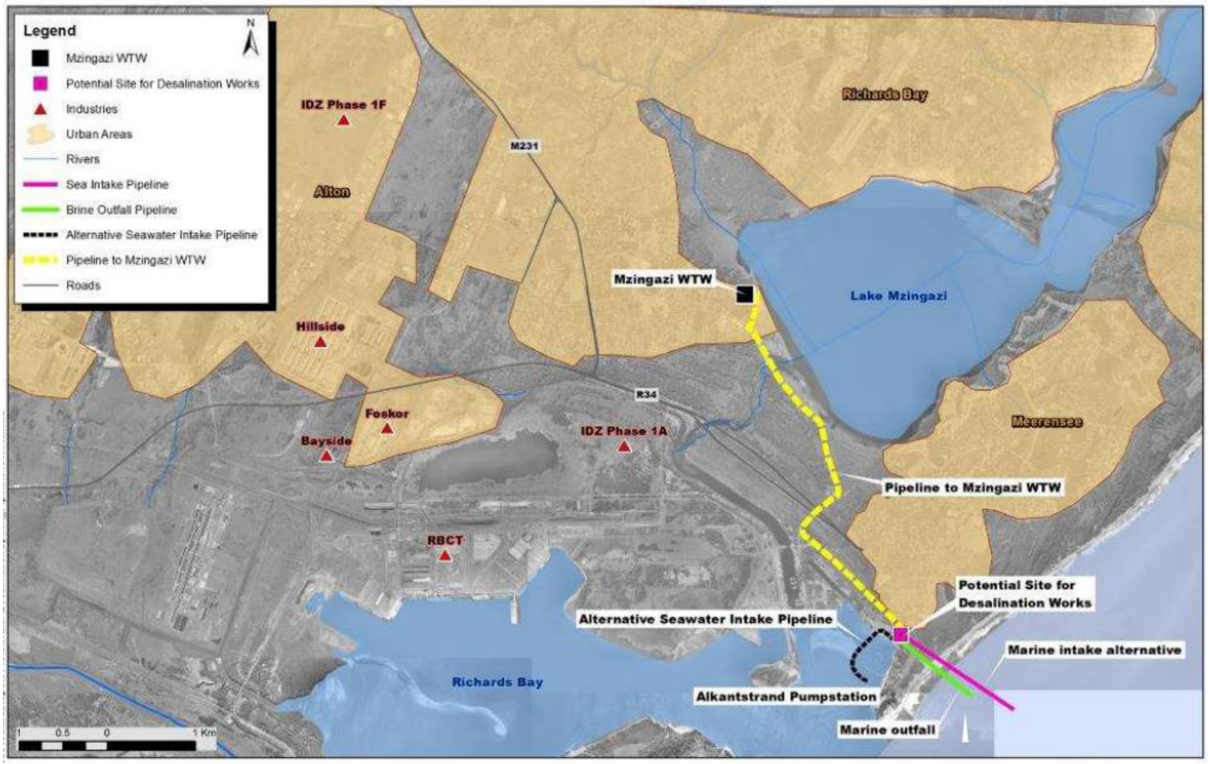


Figure 6-2: Layout of desalination infrastructure(improve quality)

Reverse Osmosis (RO) is currently the most widely implemented desalination process globally. RO technology has been applied in over 90% of the municipal desalination plants built over the past two decades (Voutchkov) and RO is the recommended desalination process.

The costs of operating RO plants have been lowered by two significant developments over the past decade: (1) the development of membranes that can operate under lower pressures, and (2) the incorporation of an energy recovery device in the brine stream leaving the pressure vessel.

Membrane desalination is based on the ability of semi-permeable membranes to separate mineral salts and water by allowing the selective migration of water (but almost no salts) from one side of the membrane to the other side.

The preferred technologies and final process configurations chosen for the plant components are informed by the preferred site location.

Seawater could yield a limitless volume. The water demand versus available sources at the time of implementation will determine the yield of the scheme to be developed. For the purposes of this assessment, a treated water output of 60 Mℓ/d (21.9 million m^3/a) was considered to be comparable with some of the other potential interventions. Phased development would be considered.

Economics of scale dictates that the larger the plant the lower the unit cost of the water produced. It is estimated that the overall cost of water production through desalination will reduce further in the future.

Comparative cost estimates for the different options were developed based on the conceptual design considerations (marine intake compared to harbour intake). Capital and operational and maintenance costs were obtained from a local RSA engineering firm that designs and installs desalination plants. The costs were compared with the escalated costs (costs were updated to a base date of October 2020) from the previous reconciliation strategy (2015). The costs summarized in in Table 6-3 and Table 6-4 for the two options (marine intake and harbour intake) were based on the escalated costs from the previous reconciliation strategy (2015) and recent 2020 costs obtained from the local RSA engineering firm.

It was assumed that the plant would be constructed in two 30 Mℓ/d phases. These are shown in Table 6-3 and Table 6-4 along with the URVs.

Table 6-3: Unit Reference Values: Desalination Option: Marine Intake

Item		Discount Rate 6%	Discount Rate 8%	Discount Rate 10%
Total Capital Cost	(R million)	2747.09	2747.09	2747.09
Annual Operating Cost	(R million/annum)	287.57	287.57	287.57
NPV Cost	(R million)	6336.44	5408.76	4747.62
NPV of Water Supply	(million m³)	285.15	221.29	176.93
Unit Reference Value	**(R/m³)**	**22.22**	**24.44**	**26.83**
(no adjustment for treatment saving)				
Unit Reference Value	**(R/m³)**	**15.56**	**17.78**	**20.17**
(adjusted for treatment saving)				

Table 6-4: Unit Reference Values: Desalination Option: Harbour Intake

Item		Discount Rate 6%	Discount Rate 8%	Discount Rate 10%
Total Capital Cost	(R million)	2526.87	2526.87	2526.87
Annual Operating Cost	(R million/annum)	285.32	285.32	285.32
NPV Cost	(R million)	6090.72	5178.37	4529.26
NPV of Water Supply	(million m³)	285.15	221.29	176.93
Unit Reference Value	**(R/m³)**	**21.36**	**23.40**	**25.60**
(no adjustment for treatment saving)				
Unit Reference Value	**(R/m³)**	**14.70**	**16.74**	**18.94**
(adjusted for treatment saving)				

The costs indicate that the treated-water options are more expensive than the raw-water

Possible positive impacts of this system include:

- Utilisation of a potential previously unused water source;
- It provides a 100% reliable source of water that is not subject to climate variability or changes in allocation policies as with other surface water sources.
- It is not subject to the impacts of droughts or restrictions.
- It is not subject to water quality concerns particular from emerging contaminants or social concerns with the use of treated effluent.
- The operator will have complete control of the supply from the desalination plant.
- Reduced demand on natural resources.

Possible negative impacts include:

- Very high energy requirements.
- High capital and operating costs.
- High concentrations of reject water/brine disposal into the sea.
- Impacts related to the construction of the scheme.
- Specialist skills required to operate the desalination plant.
- Institutional implications regarding the operation and maintenance of the desalination plant.

A large component of the project requires the importation of specialist equipment. The cost of equipment is thus dependent on the Rand exchange rate.

Due to the lower URVs for other intervention options that maintain the water balance for the planning horizon period, desalination of seawater has not been considered as an option in this Strategy update.

6.4 Environmental Considerations

A desktop environmental assessment update was undertaken to screen environmental sensitives associated with each intervention. Holistically, the following observations can be made:

- Protected Areas: Apart from the two linear schemes (Mfolozi and Lower Thukela) which pass the Lake Eteza, Umalazi and Amatikuklu Nature Reserves, no other intervention options occur in close proximity to the formally protected areas. The desalination project falls outside of the uTukela Marine Protected Area.
- River PES: Most rivers in the study area are of either A, AB, or B classification, i.e., unmodified, or approximate natural conditions, or largely natural with few modifications. These include the Mhlathuze River upstream of the Goedertrouw Dam (Class B); Nseleni River (Class A), the Thukela River (Class AB); and the Mfolozi River (Class A). Downstream of the Goedertrouw Dam, the Mhlathuze River is classed as C (moderately modified) above the dam and C below the dam. The condition of the Nkatha River (on which Mfolozi off-channel dam is proposed) is categorised as Class Z (unknown).
- Biodiversity: For the most part, intervention strategies will build on existing infrastructure and servitudes, and only expand on these areas. However, certain interventions are proposed which will impact on Critical Biodiversity Areas (CBA)-Optimal and CBA-Irreplaceable areas. In particular, the Thukela-

Mhlathuze Transfer Scheme and coastal pipeline from the lower Thukela River will impact sensitive areas. The desalination and effluent re-use interventions are also proposed within the sensitive estuarine wetland. However, much of the proposed infrastructure are on existing footprint areas, owned by the municipality.

Key environmental observations from the evaluated interventions are documented in **Table 6-5**.

Table 6-5: Summary interventions table

Intervention	Environmental Observations
Raising of Goedertrouw Dam	• Marginal impacts as dam already exists • Additional inundation area mostly outside of Ecological Support Areas (ESA), small areas of ESA Optimal • Mhlathuze River classified as B (upstream) and C (downstream)
A new dam on the lower Nseleni River	• Inundation area comprises mostly commercial agricultural land (sugarcane) • CBA Irreplaceable areas closer to dam wall (with associated floodplain wetlands) and at the Nsezi WTW (seep wetlands) • Section of Nseleni River impacted has PES of A and within the Enseleni Nature Reserve. • Considered to be fatally flawed by KZ Wildlife
Bulk Industrial and Urban WCWDM	• Mostly positive environmental impacts • Increased concentration in effluent being discharged to the marine environment
Increased capacity of the Thukela-Mhlathuze Transfer Scheme	• Phase 2 already being constructed • Proposed raising main 1 is located primarily within CBA Irreplaceable areas, while raising mains 2 and 3 are located within CBA Optimal. • Section of Thukela River impacted has PES of A/B • Tunnel generally lower environmental impact than pipeline • Outfall point could cause erosion impacts • Acid Mine Drainage from upstream coal mines
Coastal pipeline from the lower Thukela River	• Pipeline would cross mainly transformed areas, but also short sections of Irreplaceable CBAs • Weir, pumpstation and reservoir located in irreplaceable CBAs • Section of Thukela River impacted has PES of C • Siltation (Thukela River) and erosion (Mhlathuze River)
Mfolozi Off-Channel Storage Dam	• Reduced streamflow downstream of wall • Mfolozi River is classified as having a PES A, off-channel site PES Z. Associated with floodplain and seep wetland types. • Minimal impact on water quality • Minimal ecological impact of inundation area • Raising main to the storage reservoir traverses some CBA Optimal areas
Re-use of Treated Effluent	• Site owned by municipality and pipeline will be routed adjacent to existing reserves

	• Located in an estuary wetland, a CBA irreplicable • Positive ecological impact in that it delays other development • Nutrient enrichment of Lake Mzingasi if indirect reuse • The removal of sludge will impact on landfill areas
Desalination of Seawater	• Site owned by municipality and pipeline will be routed adjacent to existing reserves • Both desalination plant and pipeline are within irreplaceable CBAs • Direct and indirect impacts of high energy consumption • Impacts associated with discharge waste streams

7 RECONCILING WATER REQUIREMENTS WITH IDENTIFIED INTERVENTION OPTIONS

The water balances presented in **Section 5** indicate that the implementation of interventions will be required to ensure sufficient water supply to the year 2045 for most of the water supply systems.

Section 6 describes the potential intervention options that are applicable to the Study Area. The following section presents water balances, including the various scenarios of projected requirements and the potential intervention options applicable to each system, over a time line till 2045.

7.1 Mhlathuze System

The current water balance presented in **Section 5.1** shows the Mhlathuze catchment will enter a deficit from 2021. Figure 7-1 to Figure 7-3 provide the water balances including possible intervention options for reconciling the various requirement scenarios. Options for reconciliation for the Mhlathuze system include the following:

- WCWDM;
- Efficient system operation;
- Restriction rules on lower priority users;
- Implementation of Thukela transfer upgrade;
- Reuse;
- Raising of Goedertrouw Dam, and
- Construction of a Dam in the Nseleni River.

Further to the above, additional options that should remain under consideration at a lower level of priority are the off channel storage dam on the Umfolozi and the desalination of seawater.

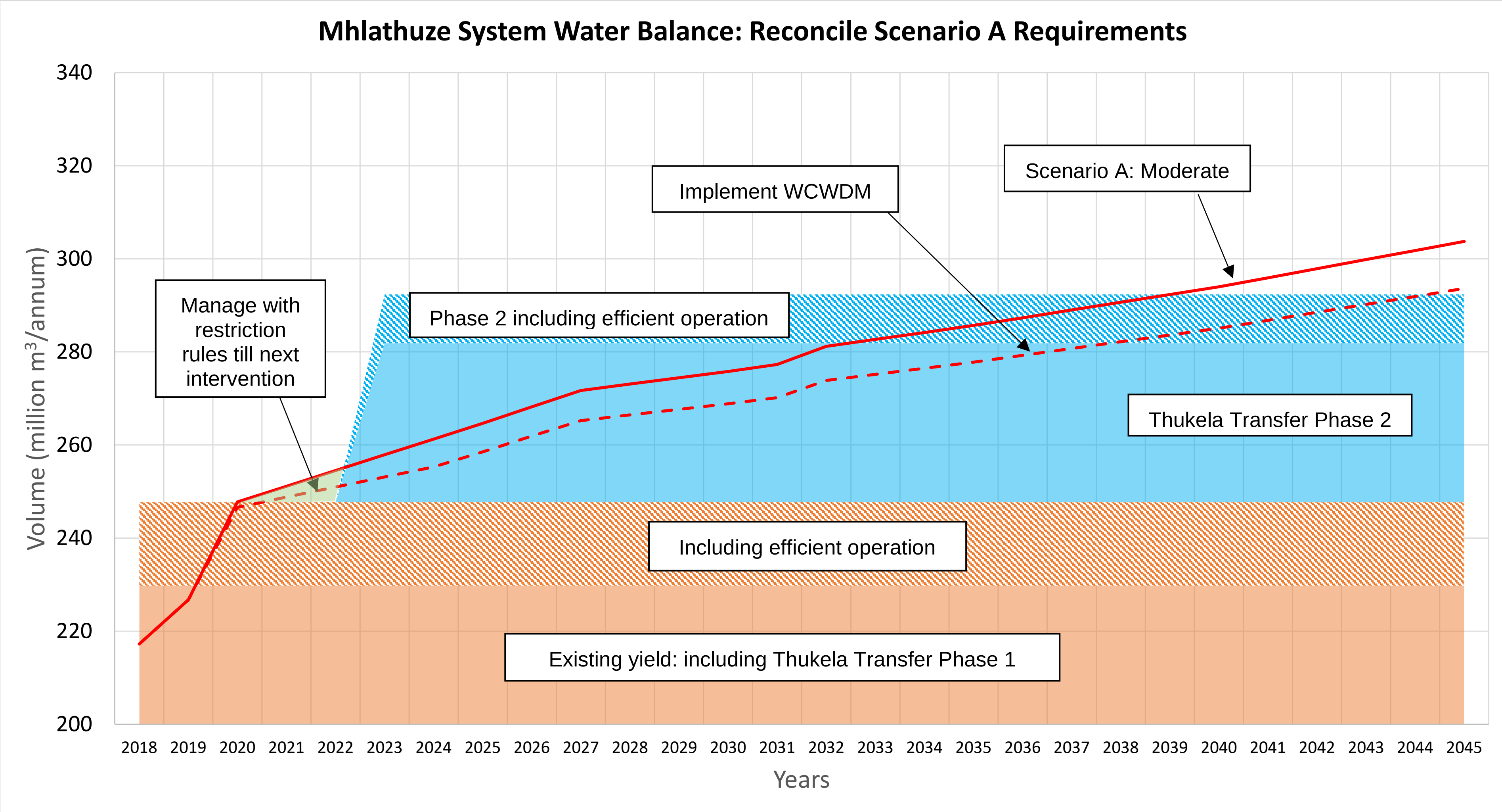


Figure 7-1: Mhlathuze System Water Balance: Reconciliation of Scenario A requirements

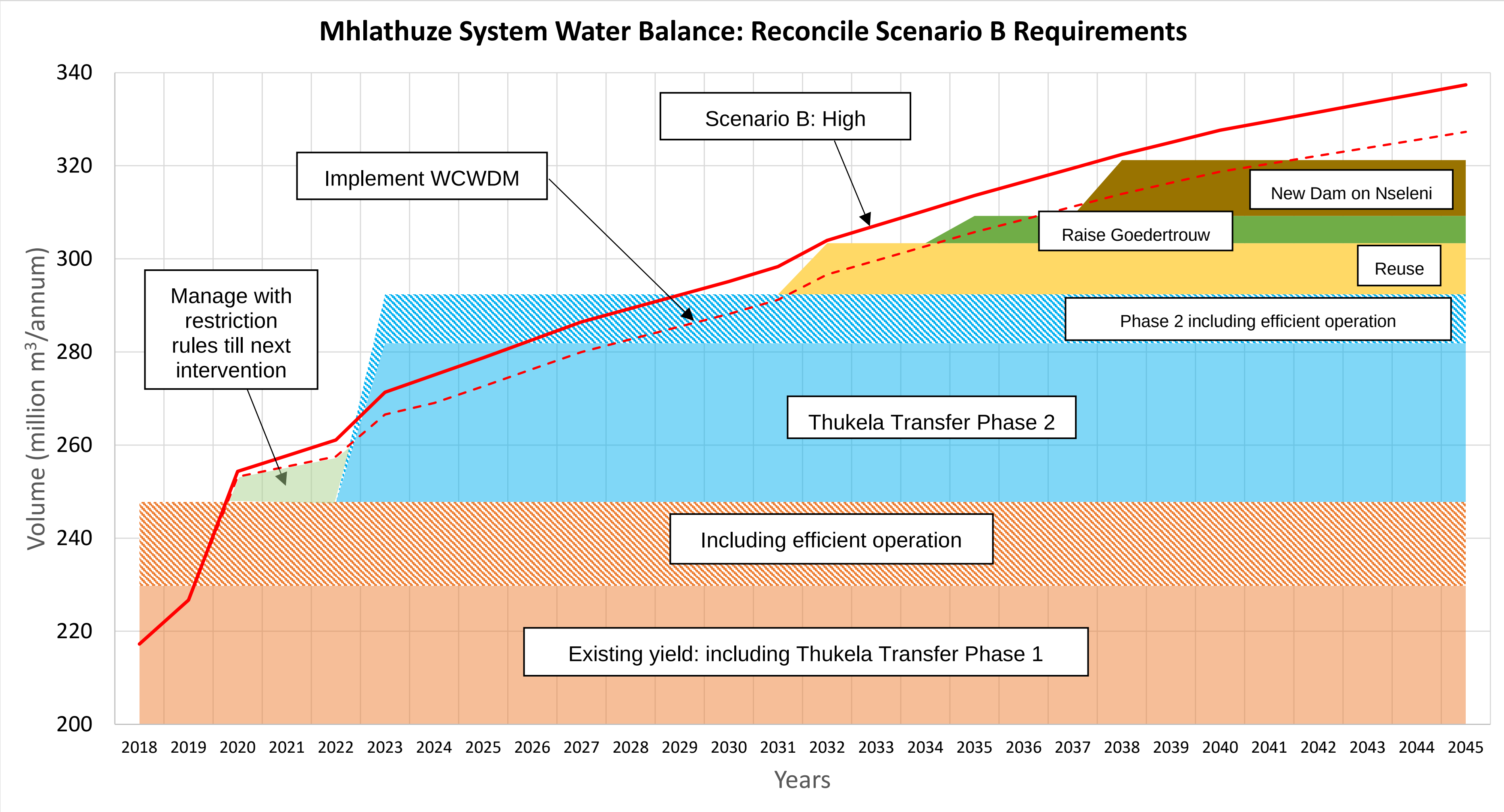


Figure 7-2: Mhlathuze System Water Balance: Reconciliation of Scenario B requirements

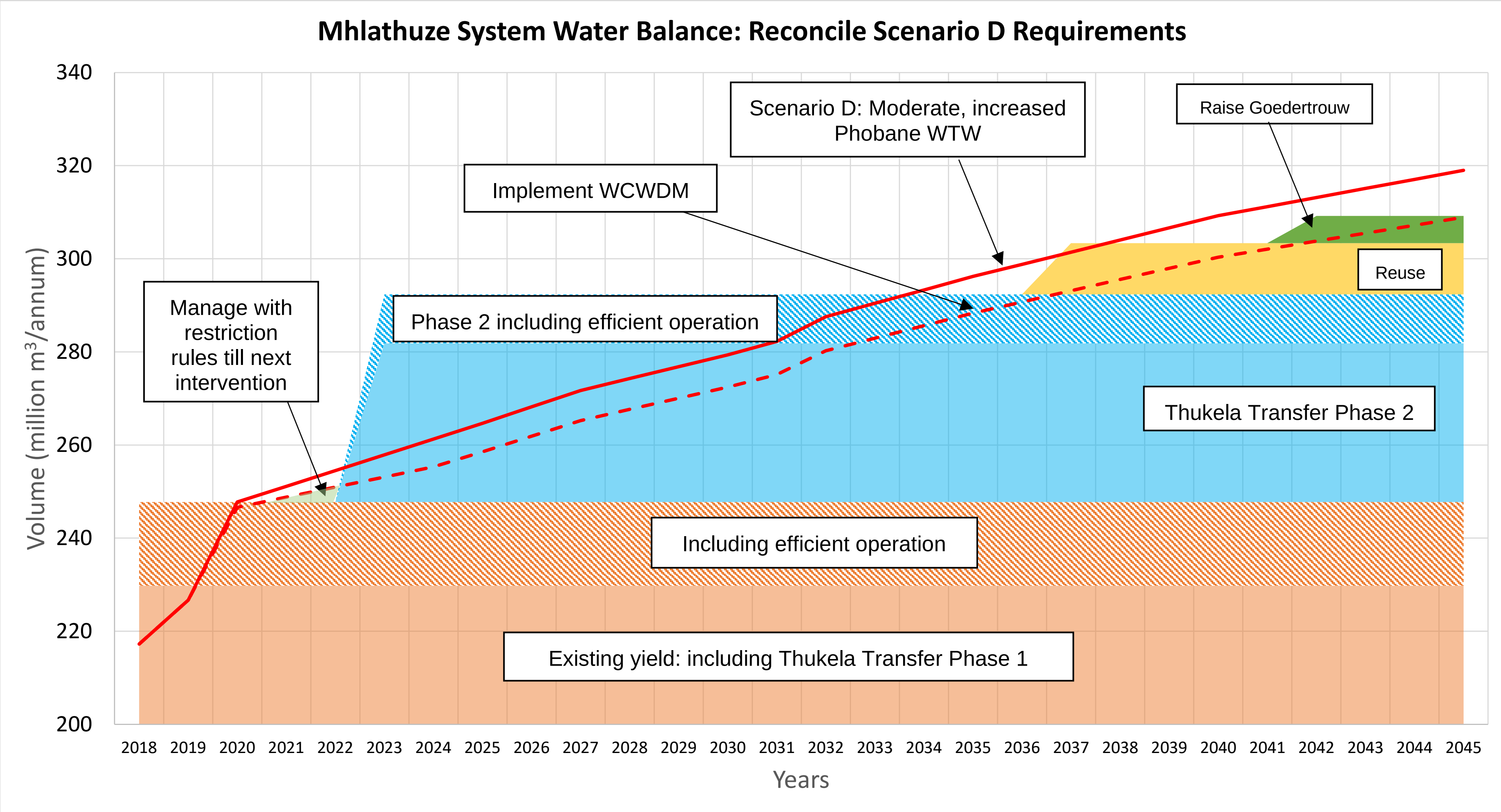


Figure 7-3: Mhlathuze System Water Balance: Reconciliation of Scenario D requirements

From the figures it should be noted that:

- From 2021, the projected requirements start to exceed the long term yield of the available resources;
- The earliest date for the increased transfer from Thukela Middeldrift to be operational is 2023.
- In the short term future, until the time that the upgraded scheme is operational, the system should be managed with restriction rules determined under the operating rules study with the approach to restrict lower priority users and protect higher priority users. It should be noted that the recent rains and current higher dam level should allow for greater short term yield in the upcoming year that could delay the requirement for restrictions.
- Under all scenarios it is important to continue to manage the system efficiently, and to make full use of tributary water at the Mhlathuze weir prior to making releases from Goedertrouw Dam.
- **Figure 7-1** is the reconciled water balance under the Scenario A water requirement projection. The assumption for Scenario A is the normal future growth determined for the users, without any additional transfers to Mtubatuba / Mpukunyoni, or further supply to Eskom, the IDZ or the increased capacity of Phobane WTW. Under the condition of this water requirement projection, only the increased Thukela transfer and the implementation of WCWDM is required in the planning horizon until the year 2045.
- **Figure 7-2** is the reconciled water balance under the Scenario B water requirement projection, which is the highest projection considered. The assumption for Scenario B is the normal future growth determined for the users, as well as additional transfers to Mtubatuba / Mpukunyoni, further supply to Eskom, the IDZ and the increased capacity of Phobane WTW. Under the condition of this water requirement projection, a few further interventions are required as follows:
    - the implementation of WCWDM is required.
    - Reuse of 11 million m^3/annum (30 Ml/d) should start from 2032.
    - Raising of Goedertrouw Dam would be required from 2042.
    - New Dam on the Nseleni would be required from 2038.
    - The above would be sufficient to satisfy requirements up till 2041 afterwhich another intervention would be required. There is sufficient time to determine the next intervention and it is important to carefully

monitor the actual growth projection in order to determine if the high anticipated growth relating to the high projection scenario occurs.

- **Figure 7-3** is the reconciled water balance under the Scenario D water requirement projection, which is an alternative projection considered. The assumption for Scenario D is the normal future growth determined for the users, and the increased capacity of Phobane WTW. The additional transfers to Mtubatuba / Mpukunyoni, further supply to Eskom and the IDZ are not included in this scenario. Under the condition of this water requirement projection, a few further interventions are required as follows:
    - the implementation of WCWDM is required.
    - Reuse of 11 million m^3/annum (30 Ml/d) should start from 2037.
    - Raising of Goedertrouw Dam would be required from 2042.

7.2 Surrounding Towns

The water balances including current resources for Mtunzini and Eshowe (**Figure 7-4** and **Figure 7-5**) indicate sufficient resources to supply these areas in the planning horizon. No future augmentation is therefore required, however WCWDM should be implemented.

7.2.1 Gingindlovu/Amatikulu

The reconciled water balance for the Gingindlovu/Amatikulu supply area is presented in **Figure 7-4**. The implementation of WCWDM in the town is required. The option to further balance the shortfall should be to augment supply from the Coastal pipeline from the lower Thukela. Umgeni Water has initiated a feasibility study in this regard and this should be included into that study.

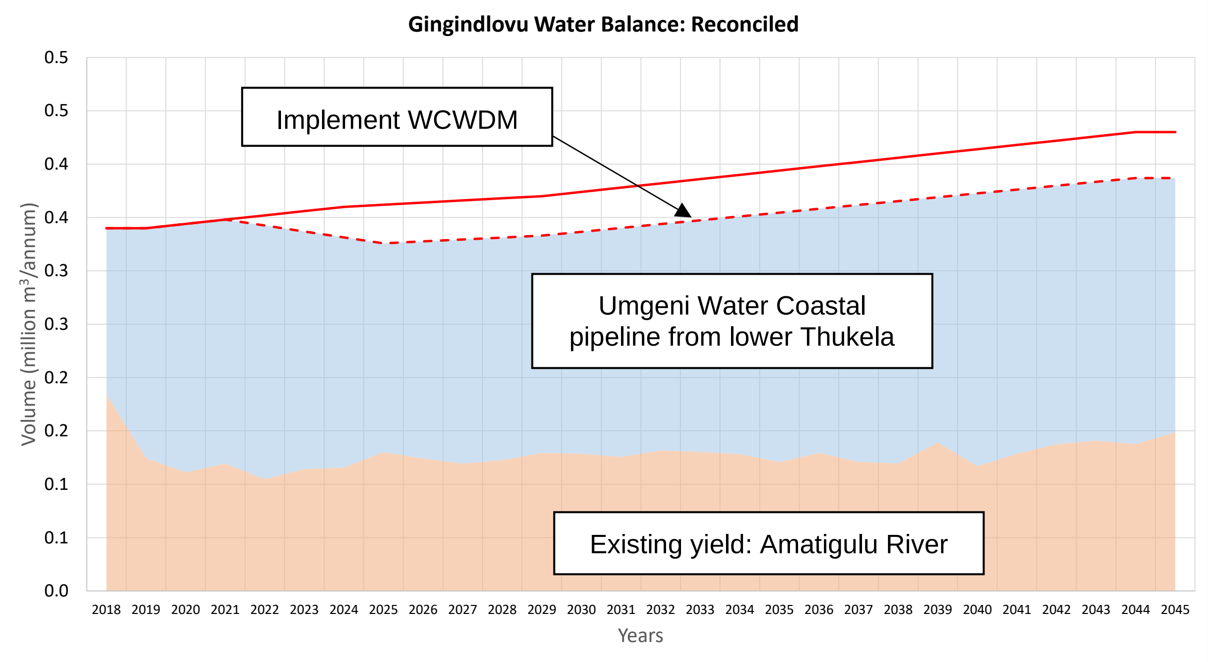


Figure 7-4: Gingindlovu Water Balance

7.2.2 Melmoth

The reconciled water balance for the Gingindlovu/Amatikulu supply area is presented in **Figure 7-5**. The water balance shows that the implementation of WCWDM is a sufficient measure to obtain a balance over the planning horizon period.

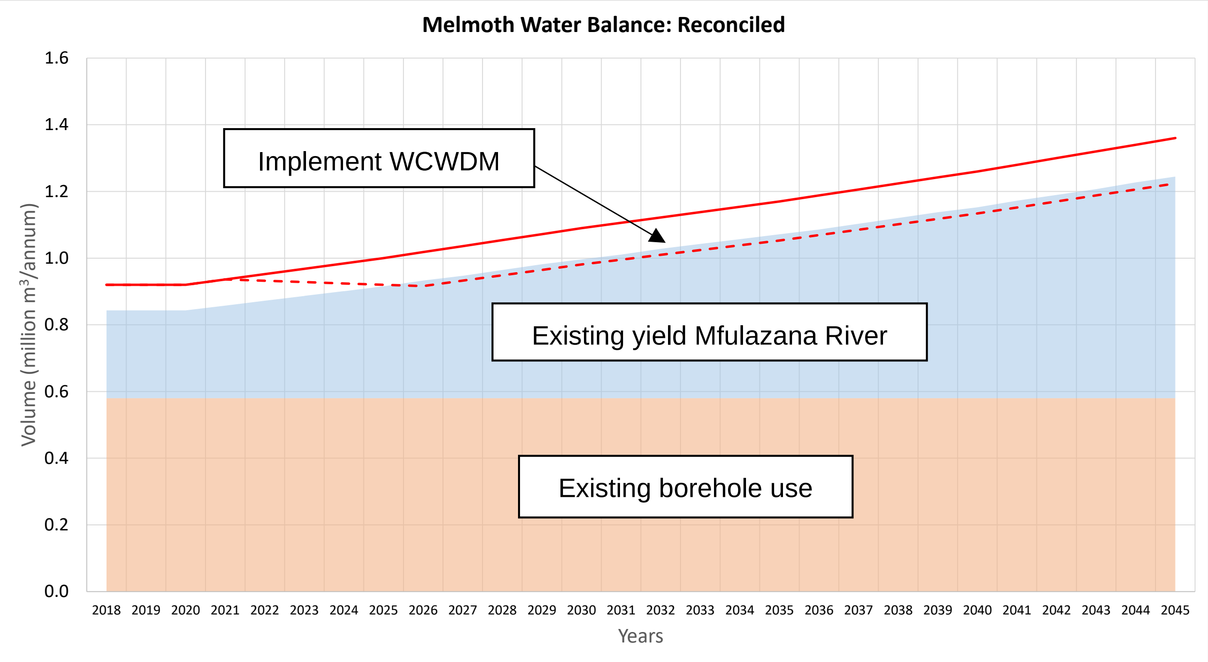


Figure 7-5: Melmoth Water Balance

8 IMPLEMENTATION ARRANGEMENTS AND ACTION PLAN

It important to note that DWS, as custodian of the country's water resources, is only facilitating the process of water reconciliation *planning*, and that *implementation* is the responsibility of several other institutions. This Section provides an overview of the various intervention options, their required timing as well as the organization deemed responsible for the implementation of the option. This action plan can be used as a basis for the Strategy Steering Committee (StraSC) to track and monitor future progress of implementation, by obtaining feedback from the various institutions and organisations on the status of implementation at future StraSC meetings.

Typically, implementation of options is carried out by three main organisations within a catchment as follows:

- The DWS National Office is responsible for implementation of options that will benefit the water balance from a Regional perspective. This would include most large scale infrastructure options.
- The DWS Regional Office and/or a Catchment Management Agency are typically responsible for addressing options that relate to a localised perspective and will still benefit multiple user sectors.
- Municipalities and Water Boards are responsible for implementation options that fall within their local boundaries for the benefit of either increasing their supply (smaller infrastructure schemes) or reducing their requirements.

Table 14.1 outlines the different interventions that have been considered for achieving a water balance, the required actions, and the institutional responsibility for those actions. It should be noted that allocations of responsibility and target dates are indicative.

Table 8-1: Institutional responsibilities and target dates

Intervention	Description of Actions	Primary Responsibility	Comments	Target Date (priority)
WCWDM	Implementation of proposed WCWDM plan: **Institutional**: Improved political backing, capacity building **Financial**: Enhance revenue collection, improved tariff structure **Social**: Raise public awareness **Technical**: reduce water wastage, pressure management, bulk metering	Local Municipalities: City of Mhlathuze LM, KCDM,	CoMLM & KCDM to continue with existing WCWDM programmes	High priority, implementation to continue/start immediately CoM: 10% savings, reduction in growth by 2025 (6.3 million m^3) KCDM: 15% savings, reduction in growth by 2025 (0.6 million m^3)
Maintain existing Thukela Transfer scheme	Ongoing maintenance of existing transfer scheme to ensure transfer can take place as and when required	MW DWS: RO: NWRI		Immediate and ongoing (34 million m^3/annum)
Complete Thukela Transfer upgrade from Middeldrift	Minister to sign directive for Mhlathuze Water to complete the work MW to finalise the construction and implement the scheme	DWS: RO MW	The scheme was originally initiated as an emergency scheme. The initial urgency to implement should be maintained	High priority (December 2023) (34 million m^3/annum)
Water Reuse	Continue with existing PPP efforts to implement intervention, including establishing takers	CoM LM	This intervention has been started.	Medium priority level (2032) 11 million m^3/annum (30 Ml/d)

Intervention	Description of Actions	Primary Responsibility	Comments	Target Date (priority)
Interim Restriction Rule to Benefit Priority (Primary) Users	Carry out annual operating analyses to determine level of restrictions to be imposed on users on an annual basis, water requirement dependent Implement restrictions on lower priority users according to priority classification table Continuously monitor water use of large users to confirm actual growth is in line with projections	DWS: Directorate Water Resources Planning Systems	This study is underway	Immediate and ongoing
Efficient system operation	Continuous maintenance of real time flow monitoring system, both data capture (measurement) and data sharing (cloud based) Enhancement of real time system based on pre-determined strategic monitoring points	DWS RO	The existing system should not be allowed to fail, and should be expanded to additional key flow monitoring points throughout the catchments. It is specifically important to improve the flow monitoring in the tributary catchments upstream of the Mhlathuze weir in order to forewarn of water coming	Immediate and ongoing (28 million m^3/annum)
Existing Dam Raising	Feasibility Study and detailed design of raising Goedertrouw Dam	DWS: OA		Low priority (2035) (6 million m^3/annum)
New Dam Construction	Feasibility Study on new dam on the Nseleni River	MW	Tendering to be undertaken by implementing agent, Construction to be outsourced.	Low priority (dam construction) (2038)

Intervention	Description of Actions	Primary Responsibility	Comments	Target Date (priority)
				Medium priority (feasibility study) (12 million m^3/annum)
Lower Thukela Transfer to KCDM	Feasibility study into utilizing Umgeni Water's lower Thukela allocation for supply to KCDM	Umgeni Water	This study has been initiated and communication with the study team should be ongoing	High priority
Remove alien vegetation	Implement programme to systematically clear alien vegetation and continuously maintain cleared areas Rehabilitate land and re-establish indigenous vegetation	Department of Environmental Affairs, Mhlathuze CMF	Focus on areas upstream of Dams and Lakes	Immediate and ongoing
Groundwater use	Promote development of Groundwater resources on a local level	Municipalities	Determine groundwater resources for local water supply of small water supply schemes. Consider impacts of abstractions on existing Lakes.	As and when required

9 RECOMMENDATIONS FOR FURTHER WORK

Over and above the implementation actions assigned to various Institutions presented in **Table 8-1**, additional activities can be undertaken as part of a future Reconciliation Strategy update in order to enhance the Strategy and provide the water balance results with improved accuracy. A continuation of the implementation of the Richards Bay Reconciliation Strategy has been initiated and will begin from May 2021. The following is recommended for further work in a Strategy continuation:

- Accurate water use and water requirement projections are an important input to the water balances, specifically relating to the timing of required intervention activities. Implementation of the Strategy should include a water requirement assessment and update given that this Strategy obtained actual use data till 2017. Extending the actual use and comparing it with the projected requirements will assist in establishing the accuracy of the water requirement projections.
- Further Strategy updates should include the ongoing monitoring of intervention implementation and coordination in terms of facilitation of Strategy Steering Committee meetings. These meetings should be convened twice each year at which institutions responsible for the various interventions can provide feedback of progress.
- Incorporation of additional information relating to either water resources or water requirements as and when it becomes available is required in order to keep the Strategy updated and relevant. Keeping up to date with the latest information will be required in the following phase of the implementation study.

10 REFERENCES

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

DWA (2011a) Uthungulu District Municipality: Reconciliation Strategy for the Mtunzini Water Supply Scheme Area - UMlalazi Local Municipality: conducted by Water for Africa (Pty) Ltd in association with Aurecon (Pty) Ltd, Water and Geoscience, and Charles Sellick and Associates in 2011, for the Department of Water Affairs Directorate: Water Resource Planning Systems, Pretoria, South Africa.

DWA (2011b) Uthungulu District Municipality: First Stage Reconciliation Strategy for the Gingindlovu Water Supply Scheme Area - Umlalazi Local Municipality. Prepared by Water for Africa (Pty) Ltd in association with Aurecon (Pty) Ltd, Water and Geoscience, and Charles Sellick and Associates for 2011, for the Department of Water Affairs Directorate: Water Resource Planning Systems, Pretoria, South Africa.

DWA (2011c) Uthungulu District Municipality: First Stage Reconciliation Strategy for the Eshowe Water Supply Scheme Area - Umlalazi Local Municipality. Prepared by Water for Africa (Pty) Ltd in association with Aurecon (Pty) Ltd, Water and Geoscience, and Charles Sellick and Associates in 2011, for the Department of Water Affairs Directorate: Water Resource Planning Systems, Pretoria, South Africa.

DWA (2011d) Uthungulu District Municipality: First Stage Reconciliation Strategy for the Melmoth Water Supply Scheme Area – Mthonjaneni Local Municipality. Prepared by Water for Africa (Pty) Ltd in association with Aurecon (Pty) Ltd, Water and Geoscience, and Charles Sellick and Associates in 2011, for the Department of Water Affairs Directorate: Water Resource Planning Systems, Pretoria, South Africa.

DWS (2015a) Reconciliation Strategy for Richards Bay and Surrounding Towns. Prepared by Aurecon South Africa (Pty) Ltd for the Department of Water and Sanitation, South Africa.

DWS (2015b) IRRIGATION - Final Schedule. Located at:

http://www.dwa.gov.za/WAR/documents/Final/MCL_IRRIG_ELU_FINAL.pdf

DWS (2015c) Government Gazette no 38599. Volume 597, 25 March 2015

DWS (2015d) Reconciliation Strategy for Richards Bay and Surrounding Towns. Yield Analyses Report, Prepared by Aurecon South Africa (Pty) Ltd for the Department of Water and Sanitation, South Africa.

DWS (2016) Water Supply and Drought Operating Rules for Stand-Alone Dams and Schemes Typical of Rural/Small Municipal Water Supply Schemes: Eastern Cluster. P RSA 000/00/14711/ - The Eshowe Water Supply Scheme: Rutledge and Eshlazi Dams. Report Prepared by AECOM

DWS (2018a) Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns: Demographics Report. Prepared by BJ/iX/WRP Joint Venture for the Department of Water and Sanitation, South Africa

DWS (2018b) Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns: Water Requirements and Return Flows Report. Prepared by BJ/iX/WRP Joint Venture for the Department of Water and Sanitation, South Africa

DWS (2019) Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns: Water Conservation and Water Demand Management Report. Prepared by BJ/iX/WRP Joint Venture for the Department of Water and Sanitation, South Africa

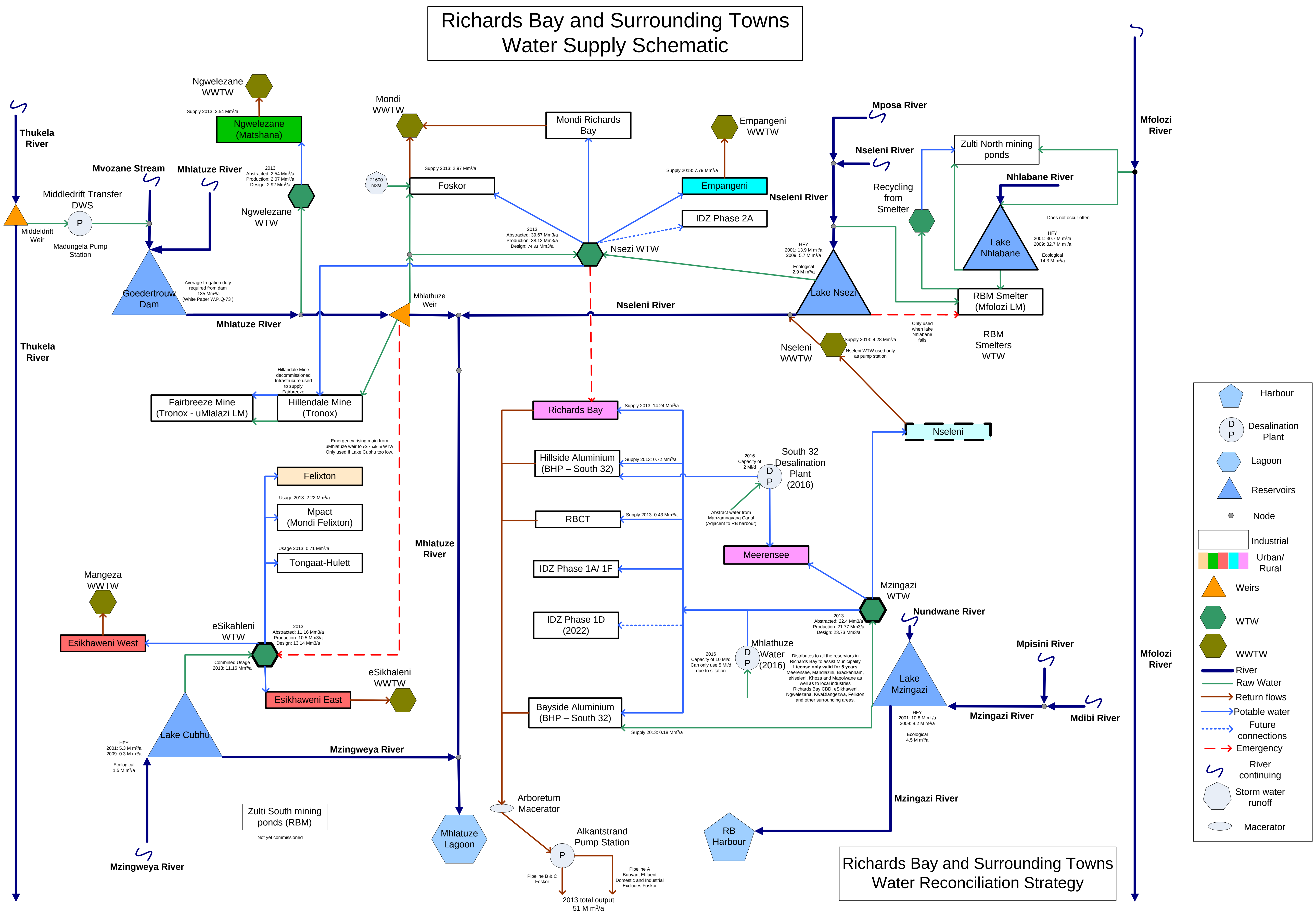
DWS (2020a) Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns: Water Resources Report. Prepared by BJ/iX/WRP Joint Venture for the Department of Water and Sanitation, South Africa

DWS (2020b) Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns: Infrastructure and Cost Assessment Report. Prepared by BJ/iX/WRP Joint Venture for the Department of Water and Sanitation, South Africa

Kelbe, B.E., and Germishuyse, T. (1999) Geohydrological Studies of the Primary Coastal Aquifer in Zuluand. Report to the Water Research Commission (K5/720)

Kelbe, B.E., and Germishuyse, T. (2001) Geohydrological Studies of the Primary Coastal Aquifer in Zululand. Report to the Water Research Commission (720/1/01)

APPENDIX A


Richards Bay and Surrounding Towns
Water Supply Schematic
Thukela River
Middledrift Transfer DWS
Middeldrift Weir
Madungela Pump Station
Mvozane Stream
Mhlatuze River
Goedertrouw Dam
Ngwelezane WWTW
Ngwelezane (Matshana)
Ngwelezane WTW
Mondi WWTW
Mondi Richards Bay
Foskor
Empangeni WWTW
Empangeni
IDZ Phase 2A
Nseleni River
Nsezi WTW
Mposa River
Zulti North mining ponds
Recycling from Smelter
Nhlabane River
Lake Nhlabane
Lake Nsezi
RBM Smelter (Mfolozi LM)
RBM Smelters WTW
Mfolozi River
Mhlathuze Weir
Nseleni WWTW
Fairbreeze Mine (Tronox - uMlalazi LM)
Hillendale Mine (Tronox)
Richards Bay
Hillside Aluminium (BHP – South 32)
South 32 Desalination Plant (2016)
Nseleni
Felixton
Mpact (Mondi Felixton)
Tongaat-Hulett
RBCT
Meerensee
IDZ Phase 1A/ 1F
IDZ Phase 1D (2022)
Mzingazi WTW
Nundwane River
Mhlatuze River
Mangeza WWTW
Esikhaweni West
eSikhaleni WTW
Esikhaweni East
eSikhaleni WWTW
Mhlathuze Water (2016)
Lake Mzingazi
Mpisini River
Mzingazi River
Mdibi River
Bayside Aluminium (BHP – South 32)
Lake Cubhu
Mzingweya River
Zulti South mining ponds (RBM)
Not yet commissioned
Mhlatuze Lagoon
Arboretum Macerator
Alkantstrand Pump Station
2013 total output 51 M m³/a
RB Harbour
Harbour
Desalination Plant
Lagoon
Reservoirs
Node
Industrial
Urban/ Rural
Weirs
WTW
WWTW
River
Raw Water
Return flows
Potable water
Future connections
Emergency
River continuing
Storm water runoff
Macerator
Richards Bay and Surrounding Towns
Water Reconciliation Strategy

APPENDIX B

	chan no	allocation & base	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
RBM smelter	323	8.10	5.60	5.60	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10	8.10
RBM ponds	146	20.70	14.40	14.40	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70	20.70
Foskor pot	641	5.80	4.00	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60	5.60
Rich Bay	167	11.60	10.93	11.20	11.47	11.77	12.07	12.37	12.66	12.96	13.29	13.62	13.96	14.29	14.63	14.99	15.36	15.73	16.09	16.46	16.88	17.30	17.72	18.14	18.55	19.02	19.50	19.98	20.45	20.93
Foskor clarif	638	4.47	3.00	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
Rich Bay	637	6.57	6.19	6.34	6.50	6.66	6.83	7.00	7.17	7.34	7.53	7.72	7.91	8.10	8.28	8.49	8.70	8.91	9.12	9.33	9.56	9.80	10.03	10.27	10.51	10.78	11.05	11.31	11.58	11.85
Nseleni	118	5.00	4.74	4.89	5.04	5.18	5.33	5.48	5.63	5.78	5.93	6.09	6.25	6.40	6.56	6.72	6.88	7.04	7.20	7.37	7.53	7.70	7.87	8.03	8.20	8.42	8.64	8.86	9.08	9.30
Ngwelezane	89	2.80	2.47	2.54	2.61	2.67	2.74	2.81	2.88	2.95	3.03	3.10	3.18	3.25	3.32	3.41	3.49	3.57	3.65	3.74	3.83	3.92	4.01	4.10	4.18	4.29	4.40	4.51	4.61	4.72
Esikhaweni	636	12.49	10.86	11.08	11.31	11.55	11.79	12.03	12.27	12.51	12.78	13.04	13.31	13.58	13.84	14.13	14.42	14.71	15.00	15.29	15.60	15.92	16.24	16.55	16.87	17.23	17.58	17.94	18.29	18.65
Empangeni	127	9.36	8.55	8.82	9.08	9.38	9.68	9.98	10.27	10.57	10.92	11.26	11.60	11.95	12.29	12.67	13.05	13.43	13.81	14.19	14.62	15.06	15.49	15.93	16.36	16.88	17.41	17.93	18.45	18.97
Tronox	635	8.54	5.80	8.92	17.83	17.83	17.83	17.83	17.83	17.83	17.83	17.83	17.83	17.83	17.83	17.83	20.26	20.26	20.26	20.26	20.26	20.26	20.26	20.26	20.26	20.26	20.26	20.26	20.26	20.26
Mondi	644	49.28	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10	20.10
Bayside	640	0.34	0.11	0.16	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Mpact	135	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48
Tongaat	950	2.79	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
Small Industry	642	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Goedertrouw direct	301	13.95	1.39	2.79	4.18	5.58	6.97	8.37	9.76	11.16	12.55	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95	13.95
Lake Nsezi	648	1.60	0.16	0.32	0.48	0.64	0.80	0.96	1.12	1.28	1.44	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
W12A outlet	649	1.16	0.12	0.23	0.35	0.47	0.58	0.70	0.82	0.93	1.05	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
W12B outet	650	0.17	0.02	0.03	0.05	0.07	0.08	0.10	0.12	0.13	0.15	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
W12C outlet	651	3.28	0.33	0.66	0.98	1.31	1.64	1.97	2.30	2.63	2.95	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28
W12E Mhlat River	646	1.44	0.14	0.29	0.43	0.58	0.72	0.86	1.01	1.15	1.30	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
Irrig		113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92	113.92
SCENARIO A		285.88	217.24	226.70	247.76	251.12	254.51	257.90	261.28	264.67	268.20	271.71	273.09	274.45	275.80	277.29	281.21	282.70	284.18	285.69	287.33	289.01	290.67	292.33	293.98	295.93	297.89	299.84	301.77	303.73
Adjustment for Scen D																														
Goedertrouw direct	301	13.95	1.39	2.79	4.18	5.58	6.97	8.37	9.76	11.16	12.55	13.95	15.14	16.34	17.53	18.92	20.31	21.70	23.08	24.47	25.42	26.37	27.32	28.27	29.22	29.22	29.22	29.22	29.22	29.22
SCENARIO D			217.24	226.70	247.76	251.12	254.51	257.90	261.28	264.67	268.20	271.71	274.28	276.84	279.38	282.26	287.56	290.44	293.31	296.21	298.80	301.43	304.04	306.65	309.25	311.20	313.16	315.11	317.04	319.00
Adjustment for Scen B																														
Eskom								1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
IDZ					6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575	6.575
Mtubatuba / Mpukunyoni								5.05	5.38	5.71	6.04	6.37	6.7	7.03	7.36	7.69	8.02	8.35	8.68	9.01	9.34	9.67	10	10	10	10	10	10	10	10
SCENARIO B			217.24	226.70	254.34	257.70	261.09	271.33	275.03	278.75	282.61	286.45	289.36	292.24	295.11	298.32	303.96	307.17	310.36	313.59	316.51	319.47	322.41	325.02	327.62	329.57	331.53	333.48	335.41	337.37
Adjustment for Scen C																														
Rich Bay	167	11.6	10.93	11.2	11.11	11.02	10.94	10.85	10.76	11.02	11.3	11.58	11.87	12.15	12.43	12.74	13.06	13.37	13.68	14	14.35	14.71	15.06	15.42	15.77	16.17	16.58	16.98	17.38	17.79
Rich Bay	637	6.57	6.19	6.342	6.293	6.243	6.194	6.144	6.095	6.239	6.399	6.559	6.722	6.882	7.041	7.217	7.395	7.573	7.748	7.926	8.126	8.329	8.529	8.732	8.932	9.159	9.389	9.617	9.844	10.07
Nseleni	118	5	4.74	4.89	4.925	4.961	4.996	5.032	5.067	5.202	5.337	5.481	5.625	5.76	5.904	6.048	6.192	6.336	6.48	6.633	6.777	6.93	7.083	7.227	7.38	7.578	7.776	7.974	8.172	8.37
Ngwelezane	89	2.8	2.47	2.54	2.55	2.561	2.571	2.582	2.592	2.655	2.727	2.79	2.862	2.925	2.988	3.069	3.141	3.213	3.285	3.366	3.447	3.528	3.609	3.69	3.762	3.861	3.96	4.059	4.149	4.248
Esikhaweni	636	12.49	10.86	11.08	11.2	11.31	11.43	11.54	11.66	11.88	12.14	12.39	12.64	12.9	13.15	13.42	13.7	13.97	14.25	14.53	14.82	15.12	15.43	15.72	16.03	16.37	16.7	17.04	17.38	17.72
Empangeni	127	9.36	8.55	8.82	8.802	8.784	8.766	8.748	8.73	8.985	9.282	9.571	9.86	10.16	10.45	10.77	11.09	11.42	11.74	12.06	12.43	12.8	13.17	13.54	13.91	14.35	14.8	15.24	15.68	16.12
SCENARIO C			217.24	226.70	246.63	248.80	250.96	253.13	255.30	258.54	261.90	265.25	266.46	267.65	268.84	270.15	273.88	275.19	276.49	277.81	279.25	280.72	282.18	283.63	285.08	286.79	288.51	290.22	291.91	293.63

Table B1: Detailed breakdown of individual water users included in water requirement scenarios A,B,C and D