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Water Reconciliation Strategy for Richards Bay and Surrounding Towns

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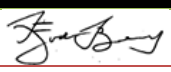
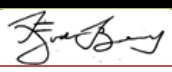
Author signature		Approver signature	
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DEPARTMENT OF WATER AND SANITATION

Directorate: National Water Resource Planning

Water Reconciliation Strategy for Richards Bay and Surrounding Towns

PRELIMINARY STRATEGY

Final: October 2015

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WATER RECONCILIATION STRATEGY FOR RICHARDS BAY AND SURROUNDING TOWNS

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Executive summary

Preliminary Strategy

E1 Introduction

The Study to compile the *Water Reconciliation Strategy for Richards Bay and Surrounding Towns* was undertaken by the Department of Water and Sanitation (DWS), in cooperation with uMhlathuze Water, the uMhlathuze Local Municipality (also called the City of uMhlathuze) and other key stakeholders.

Richards Bay is the economic centre of the uMhlathuze Local Municipality and is one of the strategic economic hubs of the country. Richards Bay, with an estimated current population of 350 000, is an established city with well-developed and significant industries, commercial areas and business centres.

The Richards Bay Water Supply System is shown in Figure E2 on the following page. In the strategy area, water is currently sourced from the Goedertrouw Dam, the Mhlatuze River and from various natural lakes in the catchment, and is augmented by transfers from the Thukela River and the Mfolozi River. Water is released from the Goedertrouw Dam, from where it flows to the Mhlatuze Weir, where it is abstracted.

E2 Water Use

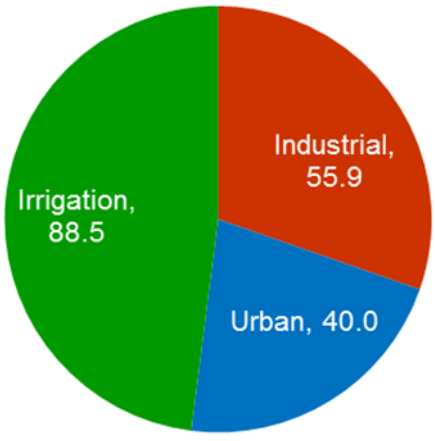

Figure E1 | 2013 Sector Water Usage (million m^3/a)

The water supply sectors in the study area consist mainly of bulk industrial, urban, irrigated agriculture as well as some indirect water uses. Bulk industrial water use is the most significant use in this strategy area, mainly Mondi and RBM with Tronox and Foskor also being large water users. The main urban centres in the study area are Richards Bay and Empangeni. The remaining potable water supply is distributed to the smaller towns and rural areas. The total water allocation is 253 million m^3/a and the best-estimate water use is 184 million m^3/a.

Figure E1 illustrates the breakdown of water use.

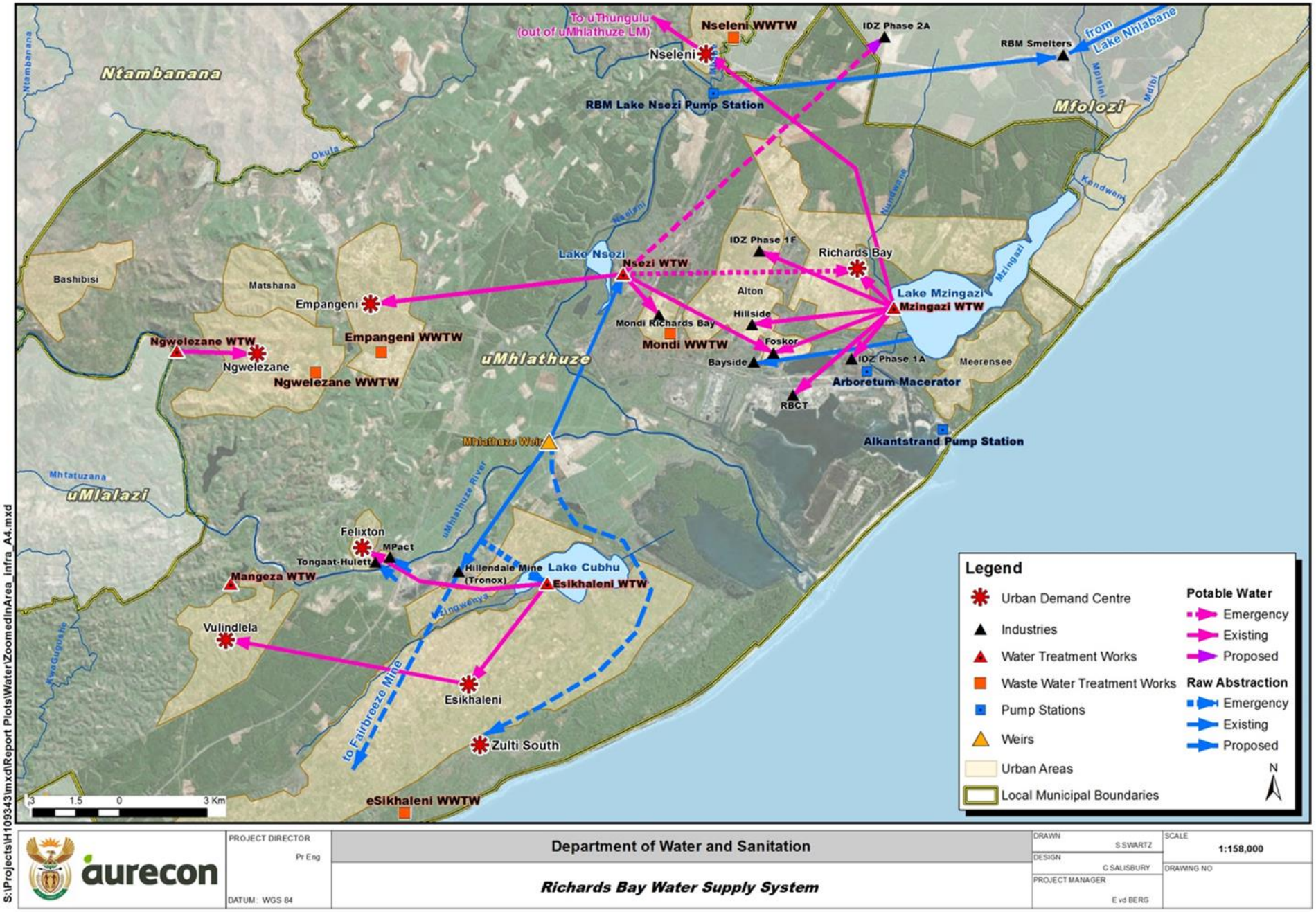

Figure E2 | **Richards Bay Water Supply System**

E3 Future Water Requirements

It is expected that future industrial growth will, over the medium term, mainly be driven by further development of large export-orientated industrial developments, with population growth being moderate. Several future water requirements scenarios were developed, for Low Growth (L), Low to Medium Growth (L-M), Medium Growth (M) and High Growth (H) respectively, as shown in Figure E3.

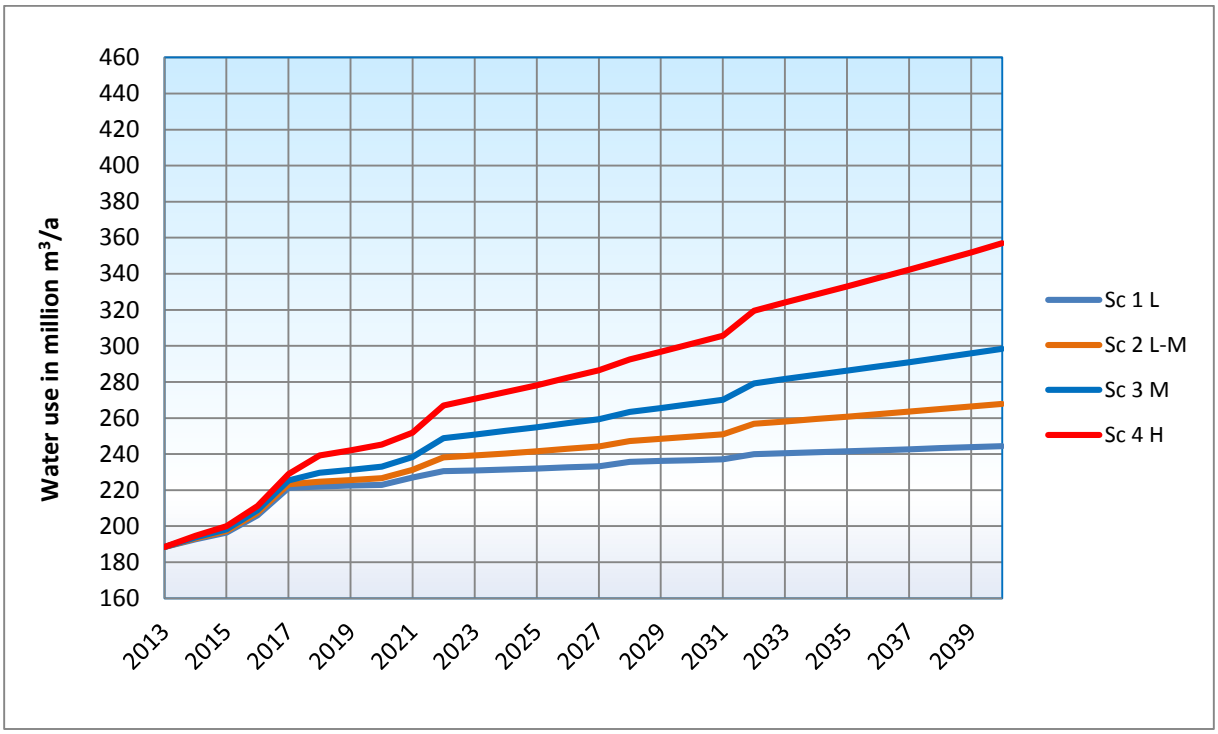

Figure E3 | 'Best-Estimate' future water requirements scenarios

E4 Water Balance

The reliable yield of the current water supply system was determined as 247 million m³/a. There is a small current surplus of water in the system.

It was estimated that the next augmentation scheme is required by:

- 2020 for the high-growth water requirements.
- 2022 for the medium-growth water requirements.

E5 Interventions

An **intervention** can be any measure that could potentially make additional water available. About 45 potential interventions were identified and some new potential interventions were formulated. Following initial technical evaluation and review by key stakeholders, agreement was reached on which interventions to evaluate further in greater depth. The salient features and preliminary implementation programmes of the evaluated schemes are shown in Table E1.

Table E1 | Summary Interventions Table

Intervention	Incremental Yield (million m^3/a)	Comparative cost (URV) in R/m^3	Environmental and socio-economic impacts	Implementation programme (years)*
Bulk industrial WC/WDM	2.8	*Range*	Minimal	5
Urban WC/WDM	4.0	*Range*	Minimal	10
Rainwater harvesting	*200kl/a per household*	*Minimum of R11.04/kl*	Limited	1
Sustainable supply from coastal lakes	-9.9	0	Positive, with negative impacts of replacing lost yield	4.5
Increased capacity of Thukela-Mhlatuze (Middledrift) Transfer Scheme	47.3	7.07	Moderate	8.75
	94.6	4.76	Moderate	8.75
	94.6	3.92	Moderate	7.75
Coastal pipeline from lower Thukela River (treated water option)	15.0	4.96	Limited to moderate	8
	35.0	5.23	Limited to moderate	9
Kwesibomvu Dam on Mfolozi River	66.6	4.21	Significant	10.25
Mfolozi River Off-channel Dam	56.9	5.87	Moderate to significant	9.5
Raising Goedertrouw Dam	3.9	1.61	Minimal	4.5
Dam on Nseleni River (1 MAR)	7.0	1.96	Significant, but mitigatable	8.5
Groundwater schemes	1.55	4.93 to 10.69	Moderate	8.5
Arboretum Effluent Reuse Scheme	10.95	6.97	Moderate	6.5
Seawater desalination (harbour intake)	21.9	7.82	Limited to moderate	7.75

* *Conventional implementation programme times are shown*

The schemes that can *significantly increase the yield of the WSS* are:

a) Increased capacity of the Thukela-Mhlathuze Transfer Scheme,

b) Kwesibomvu Dam on the Mfolozi River. Due to the very high ecological impacts that this scheme would have, it was regarded as preferable to consider an off-channel dam instead,

c) Off-channel transfer scheme from the Mfolozi River,

d) Coastal pipeline from the lower Thukela River,

e) Desalination of seawater.

Medium-sized schemes to be considered, are:

a) Arboretum Effluent Reuse Scheme, and

b) Dam on the Nseleni River.

Feasible interventions that will provide *limited additional yield* include **Urban and Bulk Industrial water efficiency,** and the **raising of Goedertrouw Dam**.

The locations of the schemes are shown in Figure E4.

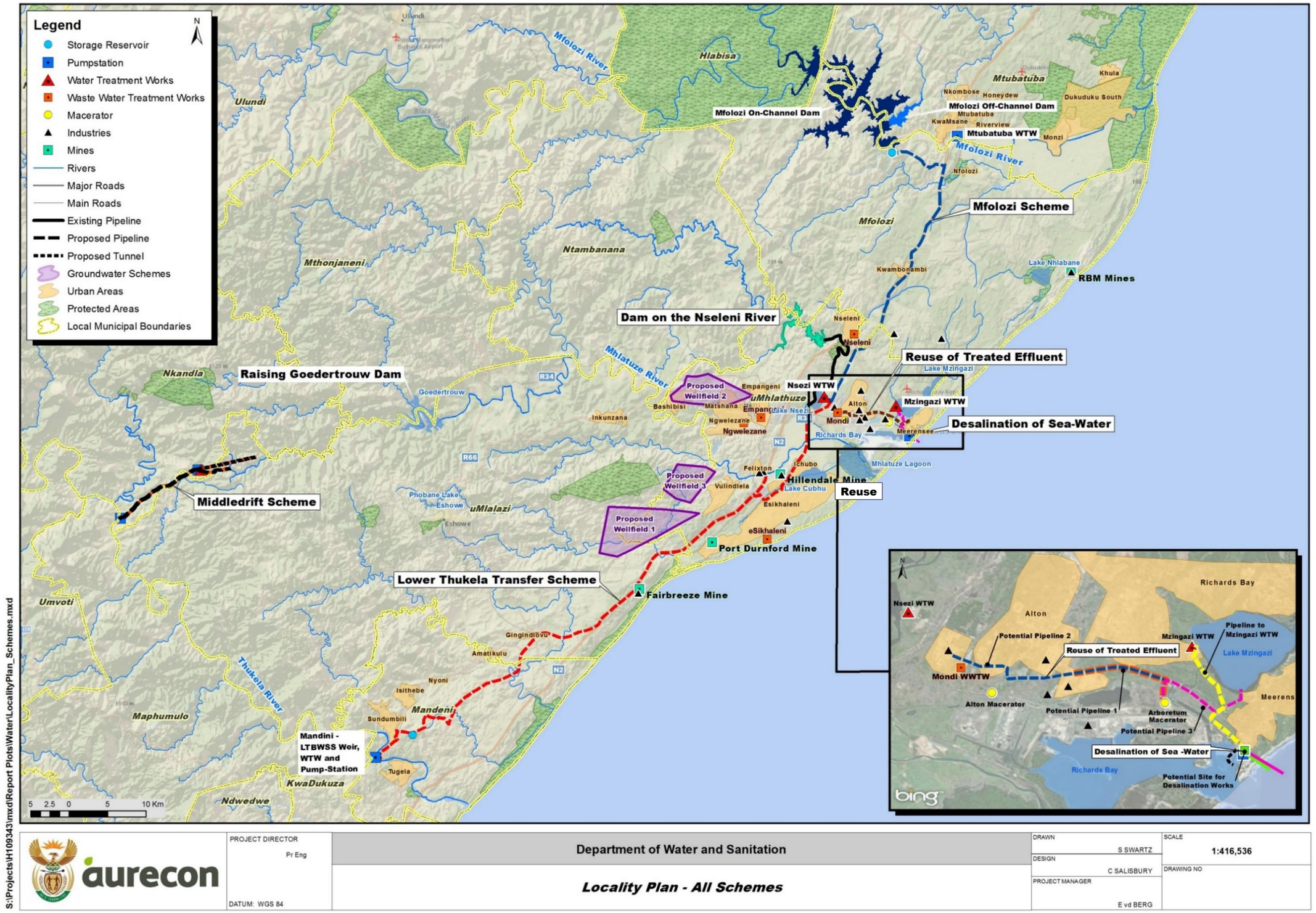

Figure E4 | Locality Plan of all schemes

E6 Water Balance Scenario Planning

Water balance scenario planning was done to determine the potential implementation dates of interventions for selected water balance scenarios from now up to 2040, to avert any shortfalls in supply. This involves a comparison of potential future water requirements with potential interventions.

The Excel-based *Reconciliation Planning Support Tool* was customised for the Richards Bay system, to undertake scenario planning and to determine the implementation dates of interventions.

Important further influences on the future water balance that were considered are:

- Climate change, of which there is still significant uncertainty,
- Reducing storage capacity of Goedertrouw Dam,
- National perspective on the future allocation of Thukela River water,
- Future availability and cost of Thukela River water, and
- Fast tracking of intervention implementation programmes.

Four small, attractive interventions have been identified that are referred to as the 'baseline' interventions, which were included in (almost) all the scenarios postulated. These are:

a) Bulk industrial WC/WDM,
b) Urban WC/WDM,
c) Raising Goedertrouw Dam,
d) Dam on the Nseleni River.

The baseline interventions (Figure E5), shown in comparison to the low-growth, medium-growth and high-growth water requirements and the existing system yield, can provide a combined yield of 17.7 million m^3/a, depending on the success achieved with water efficiency measures.

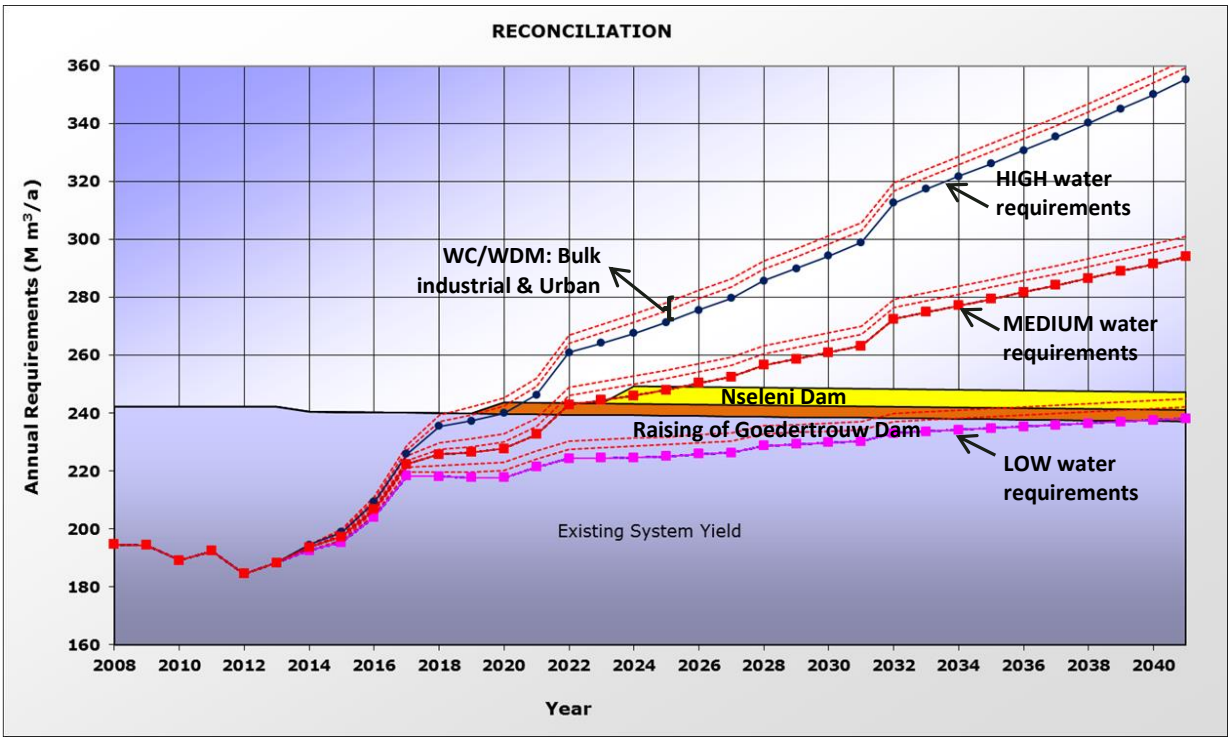

Figure E5 | Baseline interventions showing Water Use Scenarios

The future shortfall for the **Low-growth Water Requirements scenario** can be met by effective industrial and urban water efficiency measures.

It is quite difficult to identify a scenario that represents the most likely scenario at this point in time, given the uncertainty regarding what future water requirements will actually be. The closest is likely this **Medium-growth Water Requirements scenario** (Figure E6) that illustrates the implementation of a fast-tracked Mfolozi River off-channel transfer scheme, in addition to the four baseline interventions. Alternatively a fast-tracked Thukela Middledrift transfer scheme could be considered, or a fast-tracked desalination scheme.

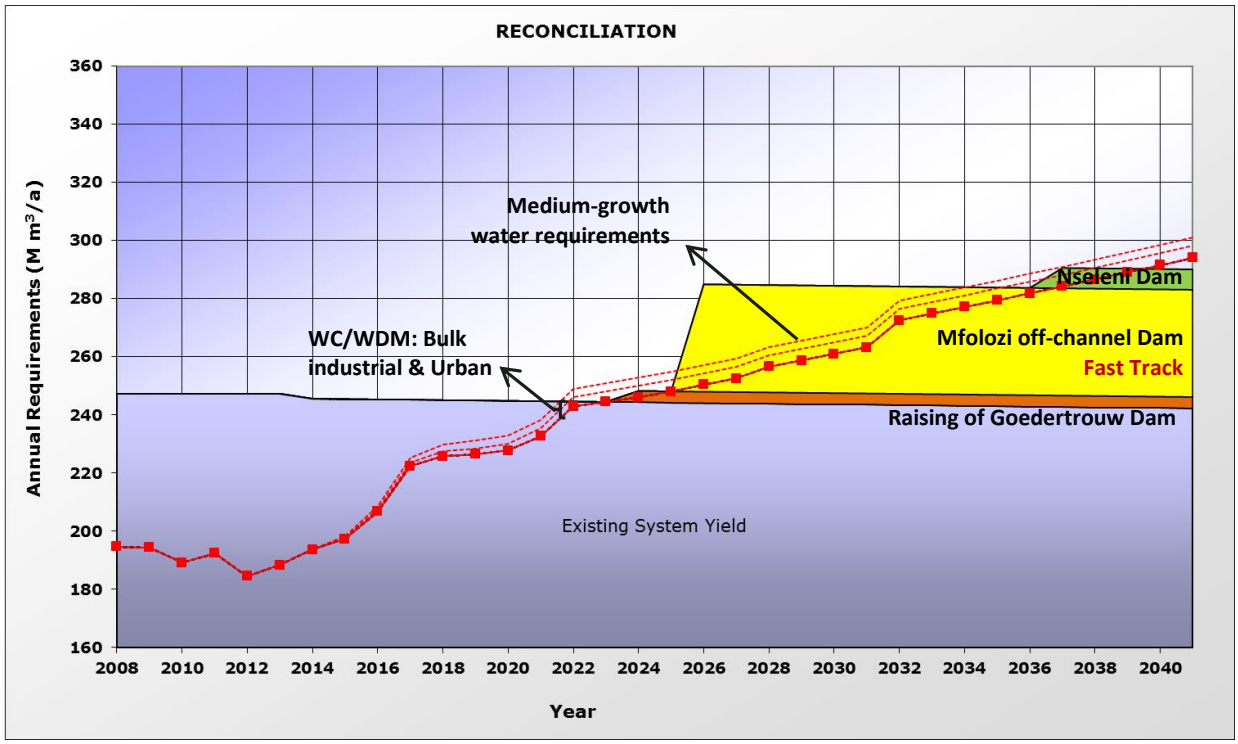

Figure E6 | Medium-growth Water Requirements Scenario

This selected **High-growth Water Requirements scenario** (Figure E7) demonstrates that several schemes are needed to meet the high-growth water requirements. Many variations of especially the High-growth Water Requirements scenarios were evaluated.

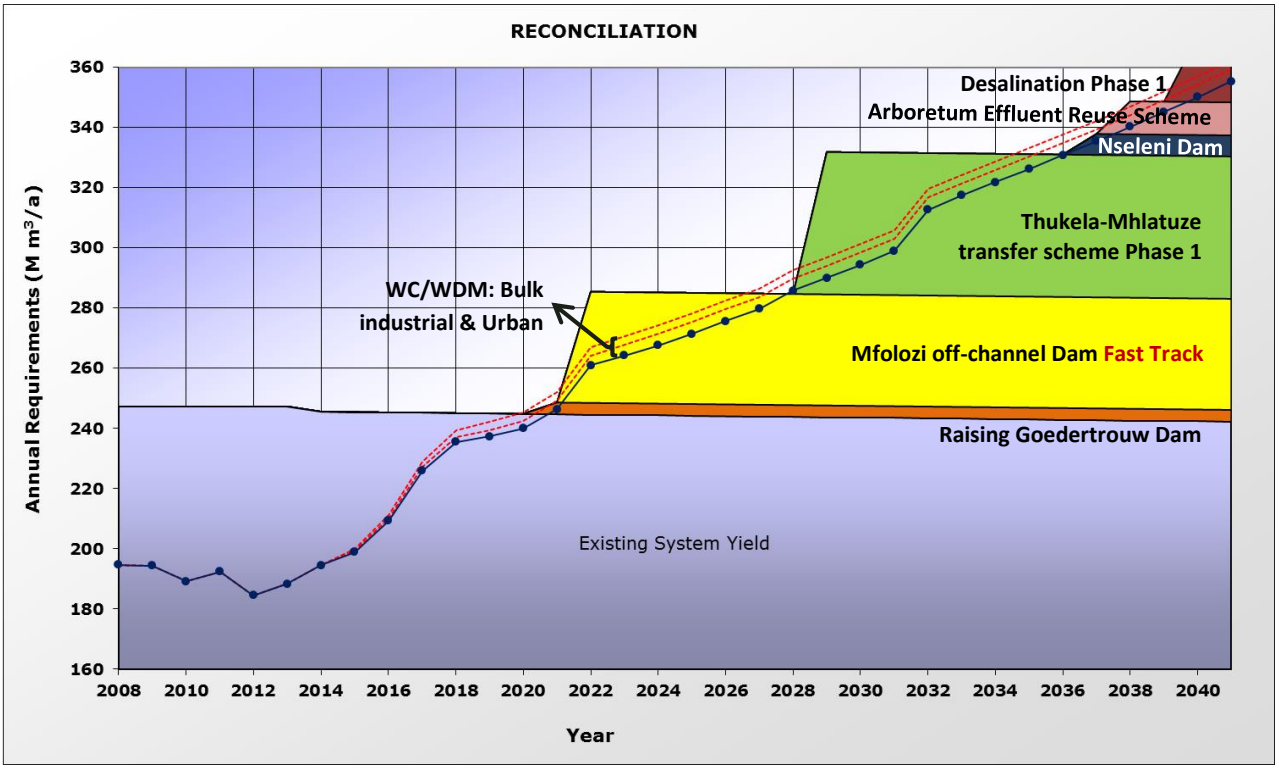

Figure E7 | High-growth Water Requirements Scenario – theme Mfolozi fast-track

Apart from the four recommended baseline interventions, scenario assessment demonstrated that three significant schemes (that would make large quantities of water available) have been identified to meet the future water requirements of the Richards Bay WSS. It is not yet clear which of these three schemes are preferable. These are:

- Mfolozi River off-channel dam transfer scheme,
- Increased transfers from the Thukela River, or
- Seawater desalination.

The Arboretum Effluent Reuse Scheme is a medium-sized scheme that seems promising.

A national perspective on the likely future allocation of water from the Thukela River needs clarification, including the future availability and cost of Thukela River water for transfer to the Mhlatuze River.

E7 Stakeholder Engagement

A stakeholder engagement process was followed for the development of the Reconciliation Strategy, to create awareness of the project at a broad-based level throughout the system supply area and for potentially affected areas. The stakeholder process continued throughout the study, although stakeholder interaction was mainly concentrated around:

- Targeted meetings with staff from water management institutions and significant water users,
- Stakeholder meetings and strategy deliverable workshops held in Richards Bay with key stakeholder representatives,
- Providing contributions to selected Mhlathuze Catchment Management Forum meetings, and
- Distribution of draft and final reports by email, inviting comment and contributions.

E8 Implementation Arrangements

It is recommended that a Richards Bay **Strategy Steering Committee** be established, to:

a. ensure that the strategy remains relevant and is regularly updated,
b. monitor and co-ordinate the implementation of the relevant actions identified in the strategy,
c. make recommendations on long-term planning activities required to ensure reconciliation of requirements and supply.

It is further recommended that an **Administrative and Technical Support Group** be constituted, to provide administrative and technical support to the SSC.

A Strategy **Implementation Plan** was developed in close interaction with key stakeholders. The Plan identifies the actions to be taken, the responsible authorities and the timing of actions, in support of the implementation of the reconciliation strategy.

E9 Recommendations

A **Strategy Steering Committee**, supported by an **Administrative and Technical Support Group**, should be formed as soon as possible.

Evaluation of a suite of interventions is recommended to ensure that the growing water requirements of the system can be met in the long term. The **implementation** of the following interventions is recommended:

- **Urban WC/WDM,** comprising a range of measures and the continuation of existing initiatives,
- **Bulk industrial WC/WDM**, comprising the continuation of existing initiatives essentially aimed at the significant industrial water users, but also at other industrial water users,
- **Raising of Goedertrouw Dam** by 2.8m.

The following studies should be undertaken **as a priority**:

- A catchment and development **Mfolozi River study**, that should include a pre-feasibility level evaluation for the inter-basin transfer scheme options to the Mhlatuze WSS, before proceeding to feasibility level evaluation.
- A **Comparison Pre-feasibility Study**, to *inter-alia* compare the following development options, and to select one or more augmentation schemes to evaluate further at feasibility level:
    a) Increased capacity of the Thukela-Mhlathuze Transfer Scheme at Middledrift and potential phasing thereof,
    b) Coastal transfer pipeline from the lower Thukela River at Mandini,
    c) The preferred Mfolozi River transfer scheme,
    d) A dam on the Nseleni River,
    e) Use of treated effluent from the Arboretum macerator site,
    f) Seawater desalination.

  Under the Pre-feasibility Study, also consider the current ***availability of Thukela River water*** and the water available for later transfer phases, considering existing and planned developments for transfer to the Vaal River System, the frequency of Thukela water being transferred to the Vaal System, as well as other water requirements from the Thukela River.
- **Feasibility Study (or studies) of selected option/s**. This could potentially be investigated by different organisations.

Acknowledgements

The suite of supporting reports produced during the formulation of the strategy culminated in this strategy report. The assistance, guidance and inputs from the various Aurecon project team members and the Geomeasure Group are recognised.

The study team would further like to specifically acknowledge the valuable contributions made by the staff of the following client and stakeholder organisations, who provided essential support and information for the study:

- Various Directorates of the DWS national office,
- DWS KwaZulu-Natal Regional Office,
- City of uMhlathuze Local Municipality, and
- Mhlathuze Water.

In addition, we would like to acknowledge the contributions made by a wide variety of stakeholders who attended meetings and workshops and who provided valuable written and verbal feedback on aspects of the strategy study. Key water users who made an effort to provide information in support of the strategy and guided the project team and client are specifically thanked. The general positive attitude encountered has significantly contributed to the compilation of the strategy.

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Acronyms

ASAP	As soon as possible
ATSG	Administrative and Technical Support Group
CORDEX	Co-ordinated Regional Climate Downscaling Experiment
CoU	City of uMhlathuze, also called the uMhlathuze Local Municipality
CMA	Catchment Management Agency
DARD	KwaZulu-Natal Provincial Department of Agriculture and Rural Development
DWA	(Previous) Department of Water Affairs
DWS	Department of Water and Sanitation
EDTEA	KwaZulu-Natal Provincial Department of Economic Development, Tourism and Environmental Affairs
EFR	Estuarine flow requirement
EIA	Environmental impact assessment
EWR	Ecological water requirement
GDP	Gross domestic product
HFY	Historic firm yield
IDZ	Industrial development zone
IFR	Instream flow requirements
kℓ	Kiloliter
kℓ/a	Kiloliter per year
KZN	KwaZulu-Natal
KZNRO	KwaZulu-Natal Regional Office of DWS
LM	Local municipality
MAP	Mean annual precipitation
MAR	Mean annual runoff
MCMF	Mhlathuze Catchment Management Forum
Mℓ/d	Megaliter per day
MORFP	Mhlathuze Operating Rules and Future Phasing
MW	uMhlathuze Water
MWAAS	Mhlathuze Water Availability Assessment Study
m^3/a	Cubic meter per year
m^3/s	Cubic meter per second
Mm^3/a	Million cubic meters per year
NWRI	National Water Research Institute
D: NWRP	Directorate National Water Resource Planning of the DWS
NGO	Non-government organisation
NPV	Net present value
NRW	Non-revenue water

D: OA	Directorate Options Analysis of the DWS
RPST	Reconciliation Planning Support Tool
RBCT	Richards Bay Coal Terminal
RBM	Richards Bay Minerals
RBWSS	Richards Bay Water Supply System
SANBI	South African National Biodiversity Institute
SALGA	South African Local Government Organisation
SFRA	Streamflow reduction activities
SSC	Strategy Steering Committee
URV	Unit reference value
WAAS	Water availability assessment study
WUA	Water user association
WC/WDM	Water conservation and water demand management
WfW	Working for Water
WRYM	Water Resources Yield Model
WRPM	Water Resources Planning Model
WSA	Water service authority
WSP	Water service provider
WSS	Water supply system
WTW	Water treatment works
WWTW	Wastewater treatment works

Glossary of Terms

Allocation:	An authority to take water from a water source.
Assured yield:	Also called historic firm yield, it is a conservative yield value, indicating an assured volume of water that can be provided each year from a water supply system, without any shortages in supply being experienced.
Catchment:	The land area drained by a river and its tributaries.
Climate change:	Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.
Demand or requirement:	A measure of the need for a portion of the supply of water.
Demand reduction:	The result of measures implemented by a water service provider to reduce water demand and to improve water use efficiency; for example stopping leaks.
Drought:	A period of abnormally dry weather long enough to cause a serious hydrological imbalance.
Entitlement:	The general term used to describe a right to use water in terms of any provision of the National Water Act, 1998, or in terms of an instrument issued under the Act. This can be a water allocation, an interim water allocation, an existing lawful water use or a water use licence.
Intervention or option:	A potential future water resource, defined as any location-specific change to water availability, infrastructure or reliable off-take that will (mostly) result in the total available water supply being changed. This can either reduce water demand or increase water availability.
Invasive alien plants:	A plant species introduced outside its natural past or present distribution (i.e., an alien species) that becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity.
Monitoring:	To be aware of and continuously measure and assess the state of a system and any changes which may occur over time.
Non-revenue water:	This is the difference between the volume of water supplied into a system and the billed authorised consumption for the area being supplied.
Reliability of supply:	Also referred to as “assurance of supply”, this is the probability of providing a specified water entitlement under given operating conditions for a specified period of time.
Reliable yield:	Also referred to as “assured yield”, this is the quantity of water that can be abstracted for a given use from a supply source with a specified degree of certainty and predictability, which is determined through analysis.

Reserve:	The Reserve consists of an ecological component and a basic human needs component, both expressed as a percentage of the natural mean annual runoff that has to remain in the water bodies. It is a legal requirement that has to be complied with in the operation of a water supply system.
Supply:	The quantity of water available for meeting a water demand.
Reconciliation:	Reconciliation is the process of long-term bulk water planning and implementation to ensure that there is no shortfall in water supply within a water supply system within a planning period.
Scenarios:	Scenarios are combinations of selected interventions.
Scenario planning:	A process of evaluating different approaches that can be followed to maintain a long-term water balance within a water supply system.
Sustainable development:	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Sustainable yield:	This indicates a situation where the water that is supplied by a water source in the long term is regularly replenished, so that the demand does not exceed the supply.
Unit reference value:	This scheme cost parameter is a means of comparing different interventions on an equal base by calculating a cost per cubic meter of water (R/m^3) for each intervention, which provides a comparative indication of the unit cost of unpurified water supplied from a scheme during the lifetime of the scheme.
Water balance:	The difference between water demand and water supply at a given time.
Water supply system:	This can be a single source such as a river or dam with associated pump and bulk conveyance infrastructure or an integrated system of several water sources, pump stations and integrated bulk conveyance infrastructure.
Yield:	The average annual volume that can be drawn from a water supply source or from a supply option to meet a specified demand at a specified service level. Yield is always associated with some measure of probability of occurrence, whether that is reliability (see 'reliable yield' and 'historic firm yield') or probability of achieving a level of service.

1. Introduction to the Strategy

1.1 Background

As a proactive activity to ensure water availability for continued growth and development in the country the Directorate: National Water Resource Planning of the Department of Water and Sanitation (DWS) embarked on a number of reconciliation strategy studies of large metropolitan areas. This strategy is one of 12 reconciliation strategies compiled to date for large water supply systems (WSSs) and metropolitan areas in South Africa. The principles and approach on which the strategy is based to deal with complex water management issues has become well entrenched and has been very successful in most strategy areas. Reconciliation strategies have also been undertaken for all other towns located outside of the main urban centres.

The Study to compile the *Water Reconciliation Strategy for Richards Bay and Surrounding Towns* was undertaken by DWS, in cooperation with Mhlathuze Water, the uMhlathuze Local Municipality (also termed the City of uMhlathuze (CoU)) and other key stakeholders in order to secure a sustainable future water supply for Richards Bay, Empangeni and the other supply areas currently served by the Richards Bay WSS, as well as potential future supply areas.

Integral to the recommendations presented in this Strategy is an integrated water resource management approach that requires the cooperative contributions of the key role-players and affected parties. Some of the recommendations that are presented in this Strategy are challenging, but they comprise practical and logical next steps to ensure the sustainable and improved future management of the Richards Bay WSS including the study and implementation of schemes to balance future water supply with the requirements of the various water user groups.

New approaches are needed to plan and supply urban and industrial water needs, including altered consumer behaviour and appreciation of the scarcity of water, and the development and funding of more diversified portfolios of previously untapped water sources, ensuring sustainable levels of water abstraction, and new institutional arrangements. Sustained attention, resources and continued hands-on leadership and action will be necessary to ensure that this Strategy is successfully implemented and continually updated. It is critical that plans to reconcile water supply with future requirements are timeously developed and implemented.

1.2 Strategic Considerations

Reconciliation strategy planning can assist in guiding the management of a WSS in a co-ordinated, efficient, cost effective and environmentally sound fashion. Sustainability in water supply and management is a central strategy principle, to ensure a sustained water supply for following generations. Stakeholder engagement and cooperation is another key component of the strategic planning process.

A deep understanding of the WSS and its relevant environments is needed; the human, economic, natural and built environments and the interaction between these. This allows the issues, risks, opportunities, trends and limitations to be considered in the development of possible long-term 'potential futures' and ultimately the development of a 'future direction'. Such a 'future direction' cannot be developed in isolation from the community, the State, municipalities, bulk industries, irrigators and other stakeholder organisations.

In the development of a 'future direction' for the Richards Bay WSS, some 'big picture' questions had to be considered. These include the balance/supply situation of the Mfolozi and Thukela rivers, whilst ensuring that regional or national interests are not harmed.

1.3 Focus of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns

The Reconciliation Strategy aims to meet the potential future water requirements in Richards Bay and surrounding towns up to 2040, and its implementation is supported by an Implementation Plan with recommended actions, responsibilities and timelines for the effective implementation of the Strategy.

This will ensure a continued and adequate water supply up to 2040 and sustainable reconciliation of future water requirements within the uMhlathuze Local Municipality, especially that of Richards Bay / Empangeni, their significant industries, as well as the smaller towns and potential external users that may be supplied with water from the WSS in future.

1.4 Approach and Methodology

1.4.1 Determining the extent of the strategy area

Although the main focus of this strategy is the uMhlathuze Local Municipality WSS, some areas outside of it are relevant as well, such as e.g. Richards Bay Mineral's (RBM's) operations, other existing and planned mines and urban supply to northern and southern towns and villages. Therefore, although the study area is intended to cover the uMhlathuze Local Municipality, it is necessary to consider water requirements from some of the surrounding local and district municipalities as well and their intended use of water resources that will impact on this strategy area.

In addition, the WSS is influenced by activities upstream in the Mhlatuze Catchment. The full catchment of the Mhlatuze River has therefore been taken into account and this includes current uses, potential mining development and increased domestic/rural water supply.

As water is imported from both the Thukela and Mfolozi Rivers into the WSS, significant changes in land uses or other activities in the catchments of these rivers may impact on the water situation in the strategy area. The potential schemes that can augment the supply to the WSS can potentially further influence the extent of the strategy area.

1.4.2 Reconciliation steps

Once the current extent of the strategy area has been established, the approach and methodology that was followed included, but was not limited to, the following:

(i) Close consultation with the client/core stakeholders throughout and with key stakeholders at critical decision points, with stakeholder review of, and input to, reports.

(ii) Identifying the existing water allocations, water uses and current operating practices.

(iii) Determining the current and potential future water requirements for various scenarios based on historical use, identifiable short to medium-term significant developments and various growth rates.

(iv) Determining the water availability from the WSS under certain operating conditions.

(v) Performing a water supply/requirement balance assessment to identify shortfalls in existing water supplies to meet current and future water requirements.

(vi) Identifying the potential for making better use of existing supplies, for example, improved water conservation and water demand management (WC/WDM) measures.

(vii) Evaluation of water reconciliation options that would address future water supply deficits.

(viii) Prioritising the range of potential interventions based on a list of criteria.

(ix) Making recommendations on the development and implementation of interventions.

(x) Combining measures identified in the steps above to propose a water reconciliation strategy for the strategy area on the basis of economic, social and environmental criteria.

(xi) Identifying the actions and the institutional arrangements required to implement the water reconciliation strategy on the basis of a responsibility matrix.

1.5 Strategy Chapters

The Strategy is presented in ten chapters. The content of these chapters are as follows:

Chapter 1: Introduction to the Strategy (this Chapter) introduces the reader to the background to and purpose of the Strategy, strategic considerations and the Richards Bay WSS.

Chapter 2: Overview of the Strategy Area provides an overview of the strategy area and the Richards Bay WSS and explains key operational issues that has an influence on the Strategy.

Chapter 3: Water Use and Requirements describes historical and current water use by urban, industrial and agricultural users and the development of the future water requirements scenarios.

Chapter 4: Water Availability and Balance describes the current and potential long-term water balance situations of the Richards Bay WSS.

Chapter 5: Interventions addresses the identification, evaluation and salient features of the potential interventions.

Chapter 6: Scenario Planning describes the water balance scenario planning process followed and its findings, aimed at assessing the options available to avert a future shortfall in water supply.

Chapter 7: Stakeholder Engagement and Capacity Building provides an overview of the key stakeholders, and describes the stakeholder engagement and capacity building process followed in the compilation of this strategy.

Chapter 8: Institutional Arrangements for Implementation addresses the establishment of the committees responsible for the implementation of the Strategy and their respective roles.

Chapter 9: Recommendations describes the recommendations of the strategy.

Chapter 10: Implementation Plan details the actions and associated responsibilities and provides a timeline for the implementation of the strategy recommendations.

2. Overview of the Strategy Area

2.1 Overview

The strategy area is predominantly rural and contains a mixture of land use types that reflect the natural environment as well as activities associated with commercial and subsistence farming and forestry. Sugar cane and to a lesser extent citrus are the dominant crops under cultivation. Tribal areas occupy a significant proportion of the area.

Richards Bay is the economic centre of the uMhlathuze Local Municipality which further comprises Empangeni, Ngwelezane, Nseleni, eSikhaleni and a number of rural villages. Richards Bay is one of the strategic economic hubs of the country and is located approximately 190km north of Durban and 300km south of Maputo. Though the water resources available to the uMhlathuze Municipality are currently sufficient to cater for the existing requirements, should anticipated growth and industrial development materialise the current water sources are likely to come under stress within a few years.

Richards Bay, with an estimated current population of 350 000, is an established city with well-developed industries, commercial areas and business centres. Significant industries include Mondi Richards Bay, RBM, Tronox, Foskor, Hillside and Bayside Aluminium (BHP Billiton), Tongaat Hulett Sugar Mill, Mpact and the Richards Bay coal terminal and port.

In the strategy area, water is currently sourced from the Goedertrouw Dam and the Mhlatuze River and from various natural lakes in the catchment, and is augmented by transfers from the Thukela River and the Mfolozi River. Water use has been fairly stable over recent years. Potential future growth is expected to be driven by industrial development, but also by growth in domestic water use.

The Strategy area is shown on the following page (Figure 2-1).

2.2 Socio-economic Profile

Richards Bay is a developing city with an industrial centre with a potential for growth. The primary infrastructure development which has transformed Richards Bay from a small harbour village into the largest coal export facility in the world was the conversion of the original Richards Bay harbour into a deep water port with and an oil/gas pipeline and rail linking the port to Johannesburg. This laid the foundation for large-scale industrial investment and development in the region.

The Richards Bay industrial development zone (IDZ) is aimed at developing areas in and around Richards Bay for industrial use. The industry is planned to be mostly heavy industrial with some light industrial and some commercial industries.

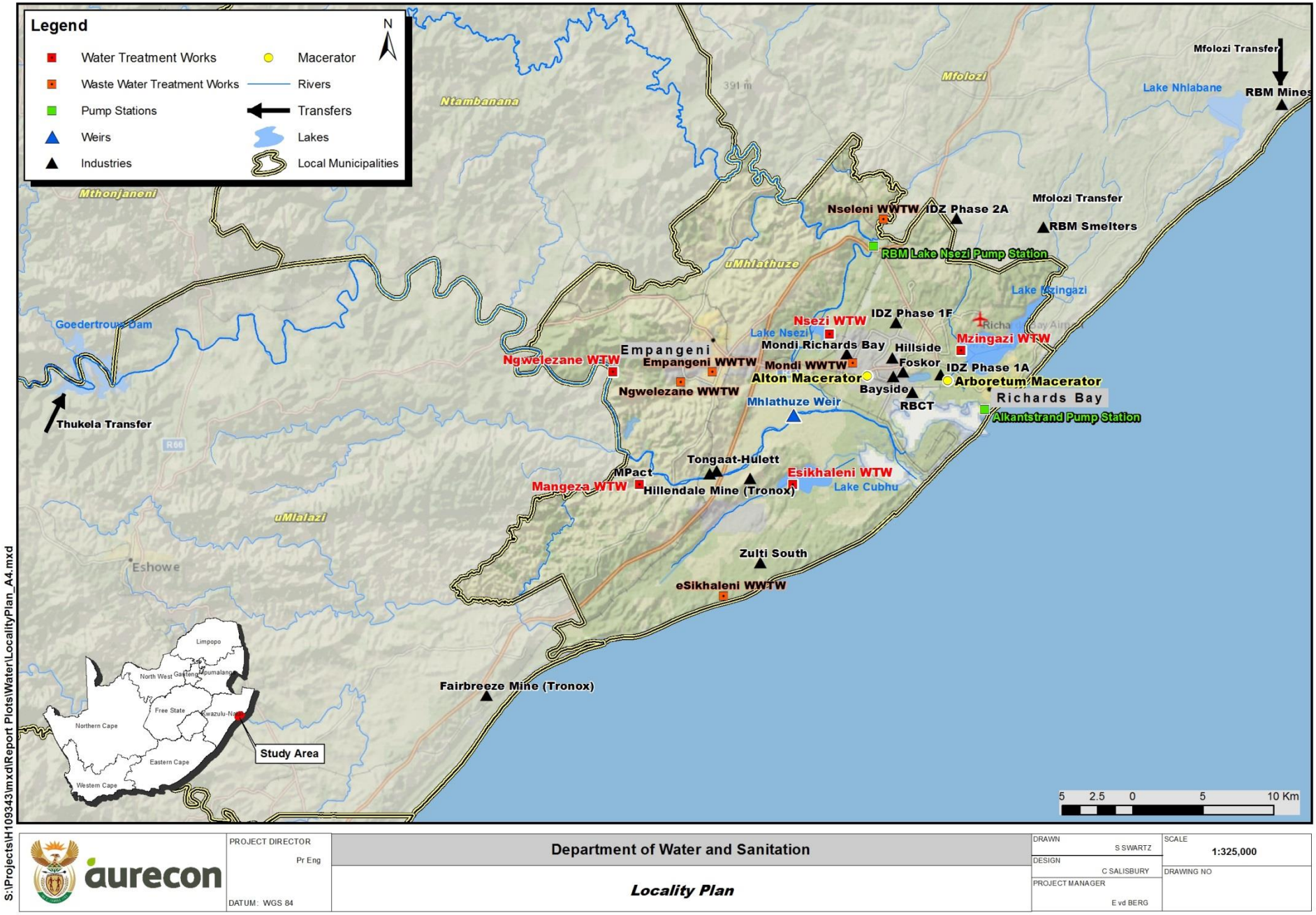


Figure 2-1 | Locality Map of the uMhlathuze Local Municipality

The tourism industry is a major part of the local economy, with Richards Bay seen as a gateway to the Zululand area which is popular with foreign tourists (game parks and wildlife diversity).

Commercial forestry and irrigation (primarily sugar cane) is practised in the study area. Although in a relatively favourable position compared to other parts of South Africa, no significant growth is foreseen for irrigation or for plantation forestry.

There is also a relatively high contribution from the transport sector which can be ascribed to the railways and harbour infrastructure, which support the export of coal, timber, metals, minerals and manufactured goods.

The manufacturing sector employs the majority of the population.

Decisions by the IDZ and by bulk industries that are considering establishment in the Richards Bay area, are directly influenced by the reality of the current and projected water and electricity situation for this region. Significant industries require assurance in the long-term that their investments will not be constrained or negated by shortfalls in water or power supply.

2.3 Climate

The area lies in the sub-humid rainfall region of South Africa. The Mhlatuze catchment has a mean annual precipitation (MAP) of 1010mm (varying from about 500mm inland to 1500mm at the coast). Gross Symon's pan evaporation over much of the area is 1400mm/a to 1500mm/a. Surface runoff is relatively high.

Water requirements and availability are *inter-alia* influenced by rainfall and evaporation, and its variability, as well as by changes in the climate over time. Since industries form a large part of the strategy area's water requirements, the WSS is influenced less by climate than most other areas in South Africa.

2.4 Richards Bay Water Supply System

The Richards Bay WSS is shown in Figure 2-2 on the following page.

2.4.1 Current Water Resources

Water is currently sourced from the Goedertrouw Dam and the Mhlatuze River and from various natural lakes in the catchment, and is augmented by transfers from the Thukela River and the Mfolozi River.

Natural Lakes

Lakes Cubhu, Mzingazi and Nhlabane are coastal lakes perceived to be extensions of the local groundwater, with the aquifers formed by extensive sedimentary deposits. Lake Nsezi, on the other hand, is a coastal lake fed by rivers originating in the granitic formation further inland. Lake Nsezi is augmented from the Mhlatuze Weir.

These lakes are sources for abstraction in this strategy area, as follows:

- **Lake Mzingazi** (Figure 2-3) supplies Bayside Aluminium and the Mzingazi WTW. Water treated at the Mzingazi WTW is distributed to Richards Bay and the industrial areas,
- **Lake Nsezi** *inter-alia* provides water to the Nsezi WTW which supplies industries and can further supplement supply to Richards Bay and RBM's smelter if needed,
- **Lake Cubhu** provides water to the eSikhaleni WTW, which supplies Esikhaleni and Vulindlela townships, the University of Zululand and the Mtunzini area in the uThungulu DM,
- **Lake Nhlabane** supplies RBM's ponds and smelter.

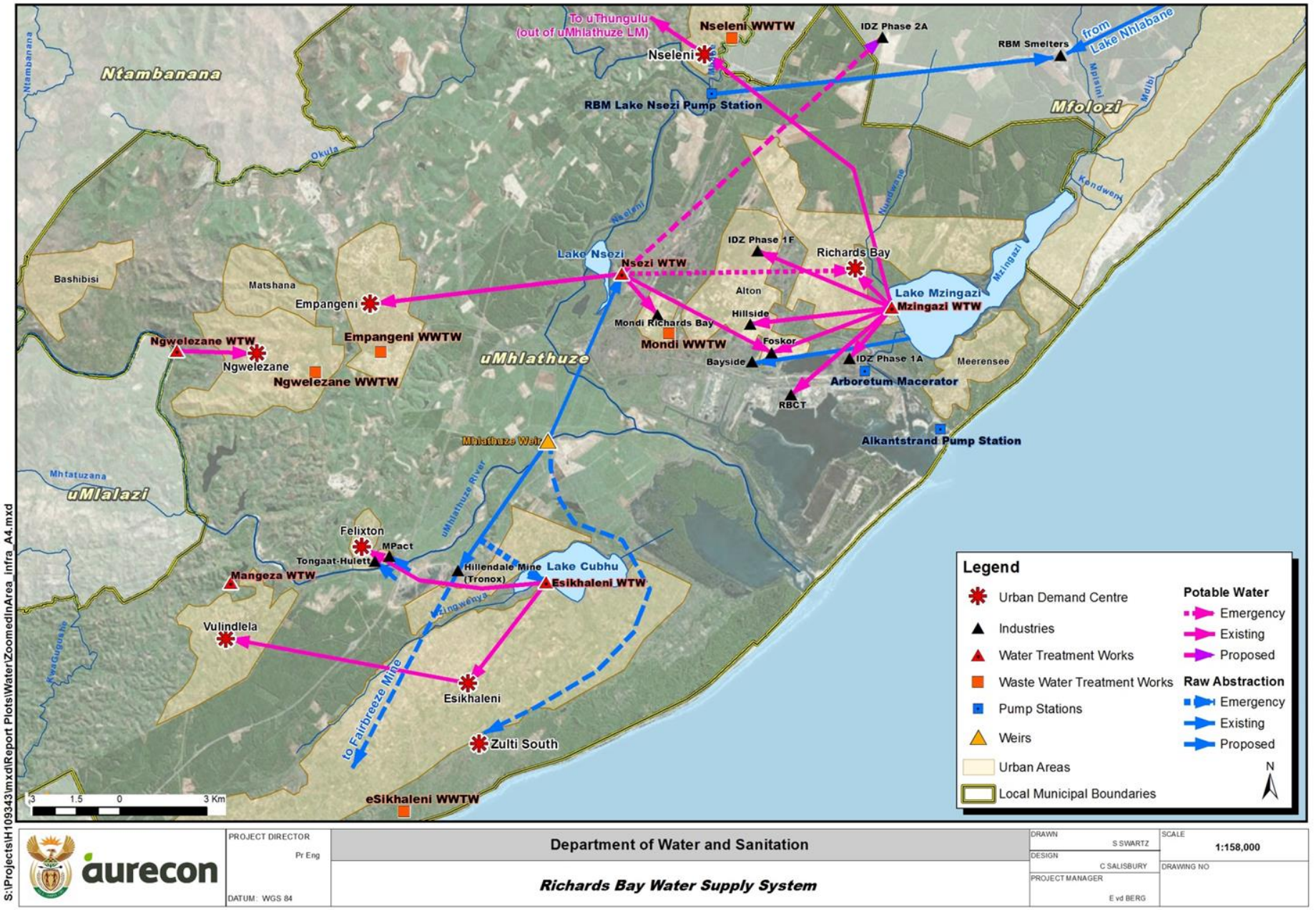


Figure 2-2 | Richards Bay Water Supply System

Figure 2-3 | Lake Mzingazi

Water from these lakes is generally of good quality, cheaper to treat than river water and is therefore a preferred source. Lake Nsezi experiences water quality problems though as a result of return flow from the Nseleni WWTW located upstream.

Key information about these lakes is shown in Table 2-1.

Table 2-1 | Characteristics of the WSS lakes

Location	Live storage (million m^3)	Natural inflow (million m^3/a)
Lake Nsezi	3.3	88.7
Lake Mzingazi	20.2	52.5
Lake Cubhu	3.6	18.0
Lake Nhlabane(1)	22.3	33.2

(1) Comprises Lake Nhlabane and RBM storage reservoir supported by inter-catchment transfers from the Mfolozi River, including physical constraints on conveyance channels

The science on which the sustainable yields of the lakes (especially that of lakes Mzingazi and Cubhu) were determined is weak. As a result the confidence of the stated sustainable yields is low, and requires revisiting.

Mhlatuze River

The Mhlathuze River rises in the highlands west of Babanango. The river flows south-eastwards through rolling grassland and extensively cultivated terrain before entering rugged broken country, until it reaches Goedertrouw Dam in the upper part of the catchment, having dropped 1400 m to the Lowveld in a direct distance of about 60 km. The directional trend then becomes almost due east and the gradient flattens to about 13:300 as the river flows the remaining 60 km across a wide alluvial plain to Richards Bay. A major tributary is the Mfule, which rises north of Melmoth.

The catchment is largely unregulated, apart from the Goedertrouw Dam which supports most of the catchment's water requirements.

Apart from small abstractions in the catchment for rural urban communities, the Nkwaleni, Mfule and Heatonville irrigators draw water from the river for the irrigation of sugar and citrus, between the Dam and the downstream weir. The flow in the Mhlathuze River is supplemented by the Mfule and a number of smaller tributaries.

Thukela River

The demand pattern of the Thukela River is significantly affected by the existing, and potential future transfer of Thukela River water to the Vaal River System. This includes the Drakensberg Pumped

Storage Project and the Zaaihoek Dam located in the headwaters of the catchment. A number of dams in the headwaters further supply local towns and industries. The Thukela-Mhlatuze transfer scheme is located about 100km from the river mouth, significantly further downstream, and the scheme has no regulating river storage at the abstraction point. Water can be released from the upstream Spioenkop Dam for transfer, should it be needed. The Thukela River is renowned for the heavy silt load that it carries. Further dam development in the catchment is possible, to make additional water available.

Mfolozi River

The Mfolozi River, which carries a high silt load is situated downstream of the confluence of the Black and White Mfolozi rivers near the south-eastern boundary of the Hluhluwe-iMfolozi Park. Only the upper Black Mfolozi River is dammed.

Recent updated WRYM analysis indicates that the natural MAR for the Mfolozi River System is 949 million m^3/a and the current day MAR is 857 million m^3/a. This indicates that water use from the river is relatively low, although low flows are fully utilised. Low river flows are typically experienced between July and October. Additional storage would be needed for increased use of Mfolozi River water.

Groundwater

Borehole developments are restricted to rural areas and privately owned farmlands. Information on the status of boreholes is limited and unreliable. Most boreholes are suspected to have fallen into disuse, following the progressive availability of alternative supply.

RBM can abstract from boreholes and the Sokhulu Wellfield, but is not currently accessing these sources.

2.4.2 Bulk Water Infrastructure

Goedertrouw Dam

The Goedertrouw Dam is located on the Mhlatuze River near Eshowe. The dam was completed in 1982 and consists of an earthfill embankment with a spillway section through a neck. The 160m long uncontrolled spillway is situated about 230m from the wall on the right flank. The dam is 88m high with a crest length of 660m and had a storage capacity of 321 million m^3 when it was constructed. The storage capacity of the dam has decreased to an estimated 301 million m^3 by the year 2000 due to siltation, and the storage capacity continues to decrease. The 1.7 mean annual runoff (MAR) dam is owned and operated by DWS.

The dam regulates the flow of the Mhlatuze River to make water available to downstream irrigators as well as to urban and industrial users in the Richards Bay area.

Mhlatuze Weir

Water is released from the Goedertrouw Dam, from where it flows for about 90 km to the Mhlatuze Weir (Figure 2-4) and is owned and operated by Mhlathuze Water. Because the yield of Lake Nsezi (which acts as balancing storage for Mhlathuze Water's Nsezi WTW) cannot meet the treatment requirements of the Nsezi WTW, the supply is supplemented by transfers from the weir to Lake Nsezi or the Nsezi WTW. The Mhlatuze Weir is central and vital to the operation of the WSS.

Thukela Transfer Scheme

During the drought of 1994 the Thukela emergency transfer scheme was implemented and aimed to deliver 37 million m^3/a ($1.2m^3/s$) to the Mvuzane stream, a tributary of the Mhlatuze River, from where the water flows down to Goedertrouw Dam. The scheme includes a run-of-river abstraction works in the Thukela River near Middledrift and a low-lift pump station, a high-lift pump-station (Madungela), a

13.7km long 1.5m diameter pipeline, and a second high-lift pump-station (Mkhalazi) to pump the water over the watershed, through a 3.5km, 800mm diameter rising main and a 1km, 600mm diameter gravity main.

Figure 2-4 | Mhlatuze Weir

Mfolozi Transfer Scheme

The mining ponds at RBM's Zulti North mine are currently supplemented by raw water from the Mfolozi River, in addition to the supply from Lake Nhlabane. The RBM run-of-river abstraction works is located close to the Mfolozi estuary. Water is pumped from RBM's Monzi pump station to their mining operation. Their Sokhulu off-stream storage dam has been demolished to allow re-mining but will likely be rebuilt in 2017.

Irrigation infrastructure

Irrigation is supplied from Goedertrouw Dam under the Government Water Scheme. The Nkwaleni Irrigation area is fed directly from Goedertrouw Dam. The Heatonville Scheme pumps water from the Mhlatuze River via a 1.0 m diameter pipeline into a system of 12.8 km of concrete-lined canals and balancing dams.

2.4.3 Water Treatment Works

WTWs in the strategy area include the Mzingazi, Ngwelezane and eSikhaleni treatment works, owned by the municipality and operated by Mhlatuze Water. Felixton and Nseleni treatment works are municipal-owned but are no longer functional. The Nsezi WTW (Figure 2-5) that treats water abstracted from Lake Nsezi and from the Mhlatuze Weir is owned and operated by Mhlathuze Water. Mhlathuze Water holds a 108.1 million m^3/a licence for abstracting from the weir for treatment. The water users

supplied by Mhlathuze Water are allotted volumes from this allocation. Mhlathuze Water's licence is not currently fully utilised.

Figure 2-5 | Nsezi WTW

An emergency pipeline links the Mhlatuze weir with the eSikhaleni WTW for use during times when the Lake Cubhu water level is too low to abstract from.

Mzingazi and Cubhu coastal lakes are currently the preferred municipal water source for the municipality, because of the lower operating cost. The water quality from the lakes are generally also better than water from the Mhlatuze River.

RBM abstracts and treats its own water, as it is relatively distant from any other WTW. Other industries including Bayside Aluminium and Tongaat-Hulett abstract raw water for use in their processes. MPact is supplied by Tongaat Hulett, who also treats raw water for potable use by both themselves and MPact. The other bulk industrial users (Mondi, Hillside Aluminium, Foskor and the Richards Bay Coal Terminal (RBCT)) are supplied with potable water (as well as clarified water in Foskor's case) for industrial processes and domestic use.

2.4.4 Wastewater Treatment Works

Richards Bay has no municipal WWTW. Empangeni has a WWTW with a design capacity of 5.48 million m^3/a (15Mℓ/d), which operates between 3.65 million m^3/a and 4.02 million m^3/a (10-11Mℓ/d).

Mondi has its own WWTW on-site.

All industrial and domestic effluent from Richards Bay is pumped via Alkantstrand Pump Station (Figure 2-6) which is owned and operated by Mhlathuze Water out to sea. Some elementary screening takes place beforehand at the Alton and Arboretum macerators (owned and operated by the municipality), but there is no further treatment beyond screening. At Alkantstrand the effluent is diluted with seawater, and is then pumped out through the sea outfall pipelines.

Figure 2-6 | Alkantstrand Pump Station

There are three sea-outfall pipelines from the Alkantstrand works, which extend more than 4km out to sea, at which point the effluent is discharged though diffusers under pressure. Pipeline A carries the buoyant effluent from domestic and industrial users (excluding Foskor). Pipelines B and C carry the dense effluent from Foskor (which contains gypsum) and is pumped out into the sea at a higher pressure to compensate for the greater density. The outfall discharge is approximately 51 million m^3/a (140Mℓ/d).

In 2009 the possibility of centralising and rationalising the effluent treatment infrastructure was explored. Several scenarios were considered, and a recommendation was made to increase the capacity of the Empangeni WWTW and transfer effluent from eSikhaleni WWTW there.

Figure 2-1 shows the location of the treatment works.

2.4.5 Ownership and Water Management

The CoU is the designated water services authority (WSA) in terms of the Water Services Act, 1997. It is responsible for the policy setting, planning, management and oversight of water service provision in its area of jurisdiction. The Municipality controls the Lake Mzingazi and Lake Cubhu supply schemes, as well as abstraction from the Mhlatuze River, except those at the Mhlatuze Weir, which are the responsibility of Mhlathuze Water, as is the supply from Lake Nsezi. The CoU is also the bulk water service provider (WSP) but it uses Umhlatuze Water to operate and maintain its municipal WTWs and WWTWs on behalf of the municipality. Because it also gets its bulk water supplies from Mhlathuze Water, the Water Board is a bulk WSP to the municipality for the supply of Richards Bay.

The operation of the retail and distribution infrastructure including the ownership of the distribution infrastructure is done by the local municipality. The Municipality owns and operates two macerators and Mhlathuze Water owns and operates a sea outfall pump station and pipelines, as well as the Mhlatuze Weir.

The Middledrift Transfer Scheme from the Thukela River and the Goedertrouw Dam is owned by DWS. Mhlatuze Water operates the Middledrift Transfer Scheme and DWS the Goedertrouw Dam.

Some of the bulk industries own and manage their own water supply and treatment infrastructure, notably Mondi Richards Bay, RBM, Tongaat Hulett and Bayside Aluminium. Bayside Aluminium owns and operates its own infrastructure for abstraction of raw water from Lake Mzingazi.

In terms of the National Water Act, 1998, the Irrigation Boards have been transformed into Water User Associations, Nkwaleni in 2007 and Heatonville, Mfule, the Tongaat Hulett Scheme, the emerging Biyela and Mzimela farmers, becoming the Central Mhlatuze Water User Association in 2010.

Supply to other water users located in the Mhlatuze catchment or located outside the Mhlatuze catchment, but supplied from it is the responsibility of uThungulu District Municipality.

The area to the north of the City of uMhlathuze falls under the Mtubatuba Local Municipality, whilst the Umkhanyakude District Municipality is responsible for bulk water planning services in the area. Some of their functions have been delegated to Mhlathuze Water, e.g. for the Mtubatuba WSS.

2.4.6 Key Operational Issues

Integrity of the Mhlatuze Weir

There is concern about the structural integrity of the Mhlatuze Weir. The failure of the Mhlatuze Weir could have significant implications for the sustainable water supply to the WSS, given the existing level of risk, and needs to be addressed.

Ensuring sustainability of lake yields

There is concern that the abstraction from the three coastal lakes, Mzingazi, Cubhu and Nhlabane, which are sustained by groundwater flows may be in excess of their sustainable yields. There is uncertainty about sustainable yield levels, especially for Lakes Mzingazi and Cubhu, and this is an important issue to be addressed. Contamination issues have been noted at Lake Nsezi, which has partially addressed with the option to also supply water directly from the Mhlatuze weir to the Nsezi WTW.

RBM is concerned about the sustainability of abstraction from Lake Nhlabane, from which they draw water for their mining ponds. RBM suggests that the increase in plantations in the catchment, which reduces runoff, has an adverse effect on the lake's water level and reduces groundwater augmentation potential.

Centralising water treatment

It has been suggested that the potential closure of the Mzingazi WTW and transfer of water from this lake to the Nsezi WTW for centralised treatment, could save operational costs due to centralised water treatment, optimisation of the Lake Mzingazi operating rule and saving on unnecessary operational expenditure.

3. Water Use and Requirements

3.1 Current Water Use

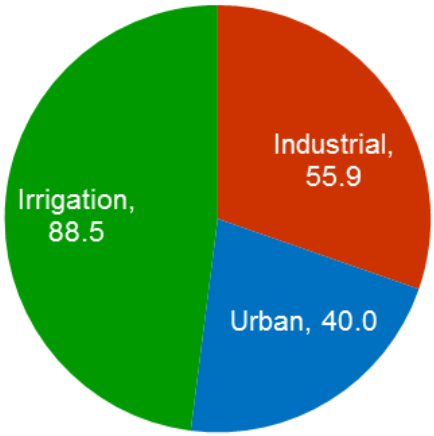
The water supply sectors in the study area consist mainly of bulk industrial, urban (residential, commercial and light industrial), irrigated agriculture and indirect water uses such as dryland agriculture, invasive alien plants and commercial forestry.

Bulk industrial users in the vicinity of the Richards Bay include Mondi Richards Bay, Foskor, Hillside and Bayside Aluminium and the RBCT. RBM is located outside of Richards Bay. Tronox mines the Hillendale and Fairbreeze mines. Other significant industrial water users include the Tongaat-Hulett sugar mill and Mpact (previously known as Mondi Felixton), both in Felixton.

The main **urban** centres in the study area are Richards Bay and Empangeni. These account for more than half of the non-industrial use of potable water. The remaining potable water supply is distributed to the smaller towns and rural areas. This includes eSikhaleni, Nseleni, Felixton and Ngwelezane while the latter mostly consist of tribal areas and farming communities. Eshowe is the largest water user in the Mhlatuze catchment outside the Richards Bay area.

The main **irrigation** crop is sugar cane, with citrus also being grown. The Nkwaleni, Mfule, Heatonville and lower Mhlatuze irrigators irrigate more than 14 000 ha with an allocation of 125 million m^3/a, which includes a small allowance for some future allocation to resource-poor farmers.

In addition to the industrial development in the area there is large-scale agricultural activity. This consists principally of citrus and sugar cane **dryland farming**, and **commercial forestry**, owned mostly by Sappi and Mondi.



The **Reserve** consists of an ecological component and a basic human needs component, both expressed as a percentage of the natural mean annual runoff that has to remain in the water bodies. The preliminary Reserve is a legal requirement that has to be complied with in the operation of the water supply system. The Reserve has been determined for rivers, the estuary as well as for some of the lakes, wetlands and groundwater in the area.

Figure 3-1 illustrates the best-estimate current water sector usages.

Figure 3-1 | Usage by Water Sector (million m^3/a)

shows the current water requirement for bulk industrial and urban water users, as well as their water allocations.

Table 3-1 | Summary of Current Water Uses and Allocations

Supply Sector	User	Current Usage		Allocation	
		Annual (Mm^3/a)	*Daily (Mℓ/d)*	*Annual (Mm^3/a)*	*Daily (Mℓ/d)*
Bulk Industry	Mondi Richards Bay	23.61	64.70	32.85	90.00
	RBM - Total	**15.34**	**42.02**	**30.00**	**82.19**
	RBM - Nhlabane	*12.95*	*35.49*	*23.00*	*63.00*
	RBM - uMfolozi	*0.00*	*0.01*	*20.99*	*57.50*
	RBM - Nsezi	*2.38*	*6.53*	*16.43*	*45.00*
	Tronox - Total	**5.30**	**14.52**	**11.48**	**31.46**
	Tronox - Hillendale	*3.75*	*10.28*	*11.48*	*31.46*
	Tronox - potable	*1.55*	*4.24*	*0.00*	*0.00*
	Foskor - Total	**7.09**	**20.04**	**10.44**	**28.60**
	Foskor - clarified	*4.12*	*11.28*	*6.21*	*17.00*
	Foskor - potable	*2.97*	*8.76*	*4.96*	*13.60*
	Mpact	2.22	6.07	2.48	6.79
	Tongaat Hulett	0.71	1.95	1.89	5.17
	Bayside - Total	**0.52**	**1.44**	**0.34**	**0.94**
	Bayside - raw	*0.34*	*0.94*	*0.34*	*0.94*
	Bayside - potable	*0.18*	*0.50*	*0.00*	*0.00*
	Hillside	0.72	1.97	0.75	2.05
	RBCT	0.43	1.19	0.00	0.00
	Total	**55.94**	**153.27**	**91.30**	**249.21**
Urban	Empangeni	9.34	25.58	13.51	37.00
	Richards Bay	14.24	39.02	9.13	25.00
	eSikhaleni	11.16	30.56	11.32	31.00
	Nseleni	4.28	11.71	0.00	0.00
	Ngwelezane	2.54	6.95	2.92	8.00
	Total	**40.00**	**109.58**	**36.87**	**101.00**
	GRAND TOTAL	**95.94**	**262.86**	**128.17**	**350.21**

Figure 3-2 and Figure 3-3 on the following page show the relative current usages for urban and bulk industrial users in the strategy area.

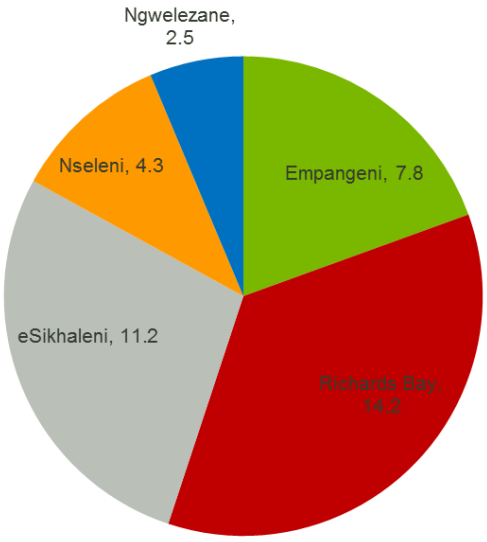


Figure 3-2 | Current Urban Usage (million m³/a)

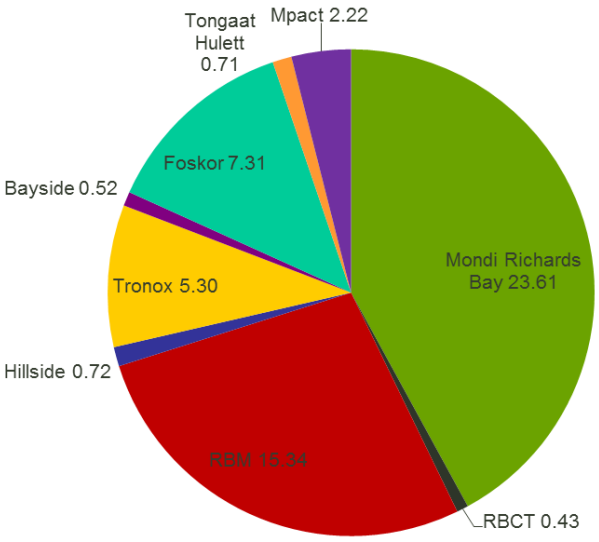


Figure 3-3 | Current Industrial Usage (million m³/a)

3.2 Historical Water Use

Historical annual water use is shown in Figure 3-4. The figure shows a slight decrease in use by bulk users in recent years; this is the result of WC/WDM measures being successfully implemented and the water savings being achieved. As a result of this, the scope for achieving further savings through water efficiency measures in the industrial sector is reduced, although there are still opportunities for improvement.

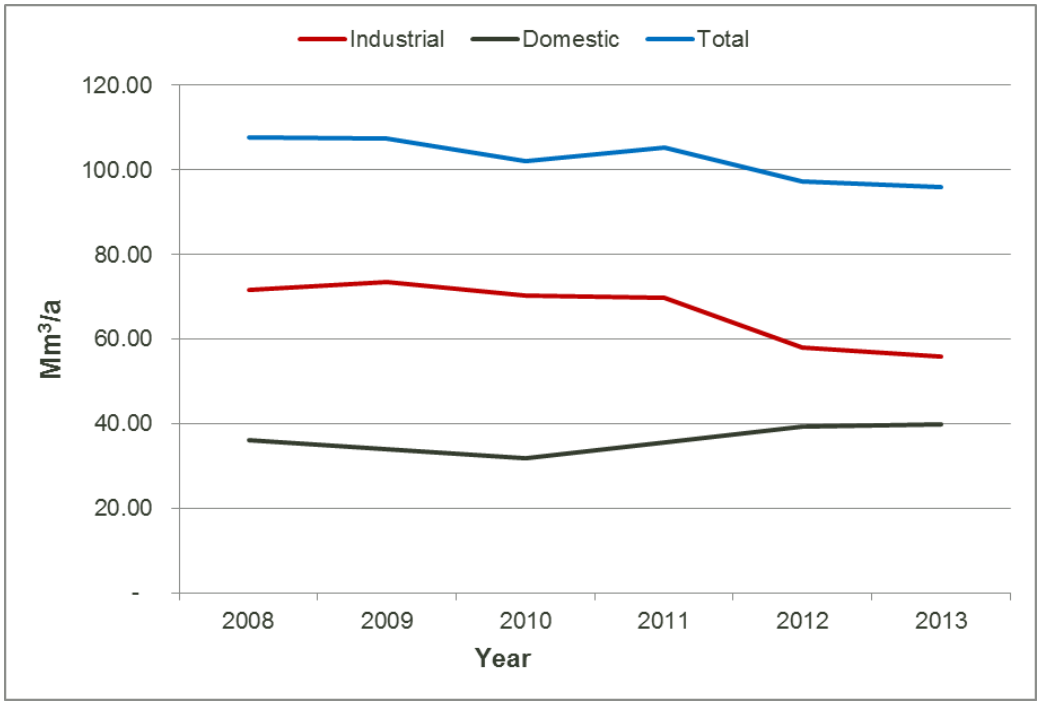


Figure 3-4 | Historical Water use

3.3 Future Water Requirements Scenarios

In recent years, Richards Bay has been one of South Africa's fastest developing cities a fast-growing industrial centre. The uMhlathuze Local Municipality has experienced an estimated population growth rate of about 1, 5% per annum between 2001 and 2011, and has a current population of about 350 000. The future demography will also largely be influenced by economic opportunities and potential. Moderate population growth in the uMhlathuze area is probable, influenced by migration from rural areas into Richards Bay in search of employment opportunities.

Due to a small local consumer base together with limited integration of industrial activities in the area (with limited supporting industries), it is expected that future industrial growth will, over the medium term, mainly be driven by the further development of large export-orientated industrial developments, rather than through generic growth as would be possible in a more integrated industrial environment.

Future urban water requirements have been assumed to be composed of the following:

a. Current and increased use by existing users from existing WTWs in the current strategy area,
b. Increased supply to other urban water users located in the Mhlatuze catchment or located outside the Mhlatuze catchment, but supplied from it,
c. Significant expansion of water supply outside the municipal boundary (potentially to the north).

Future water requirements scenarios have been compiled, composed of the various water use sectors and their components:

1) **Allocations** to existing and potential future heavy industries, current and estimated future urban water use and irrigation.

2) **Best-estimate** future **water requirements** for existing and potential future heavy industries, current and estimated future urban water use, and average irrigation use

The components that contribute to each scenario (allocations or estimated requirements) are illustrated in **Error! Reference source not found.**.

Table 3-2 | Future water requirement scenarios

Scenario	Water requirement component							
	Current industries	**New identified IDZ industries** (% of full identified potential realised)	**Jindal Mine**	**Further new industries** (cumulative growth on previous year's total)	**Municipal: urban & domestic** (% growth)	**Increased domestic supply in Mhlatuze catchment remainder** (% growth)	**Significant increased domestic supply to other areas** (No/Low/High)	**Irrigation**
Sc 1: Low growth	✓	25%	✓	0%	1%	1%	No	✓
Sc 2: Low-Medium growth	✓	50%	✓	0.25%	1.5%	2%	No	✓
Sc 3: Medium growth	✓	75%	✓	0.5%	2%	3%	Low	✓
Sc 4: High growth	✓	100%	✓	1%	3.0%	4%	High	✓

The future water requirements for the "*Allocations*" scenarios are as shown in Figure 3-5 and that of the "*Best-estimate Water Use*" scenarios in Figure 3-6. The expected sharp increases in future water requirements from 2016 to 2018 for the various scenarios is as a result of the Fairbreeze and Jindal mines going into production. The sharp increases in 2022 and 2032 are the result of potential IDZ expansion.

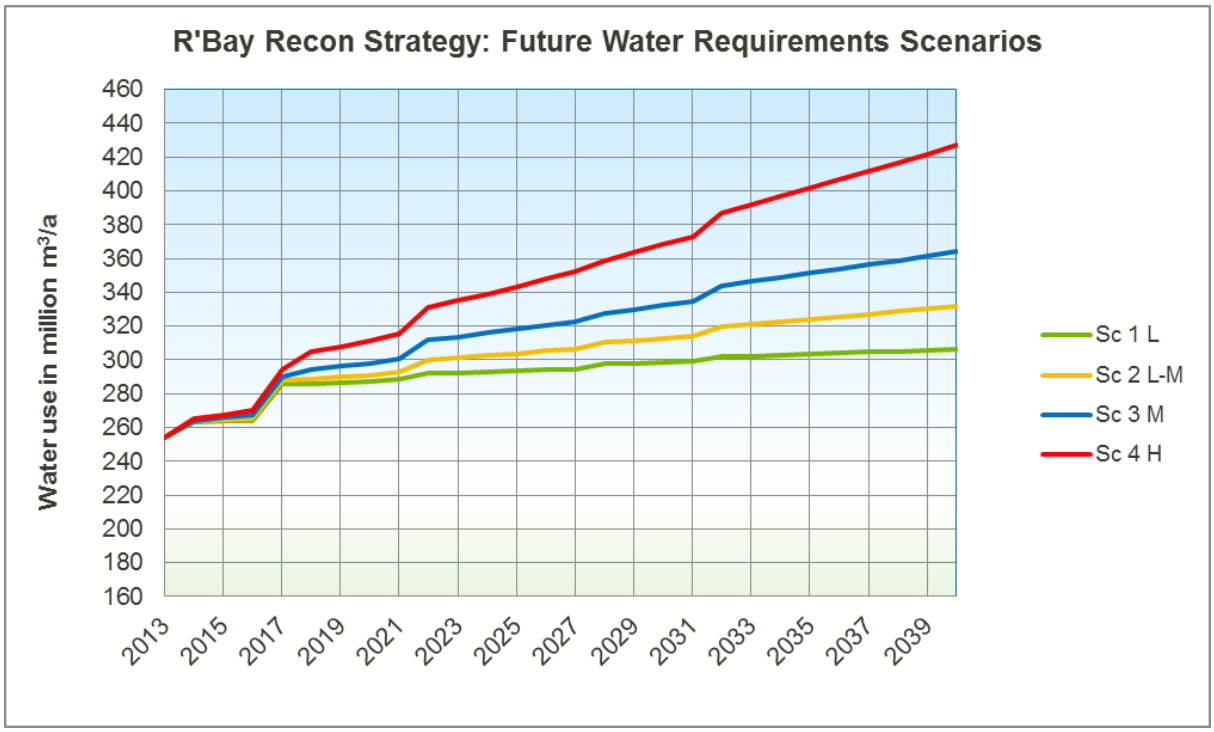


Figure 3-5 | **Future water requirements 'Allocation' scenarios**

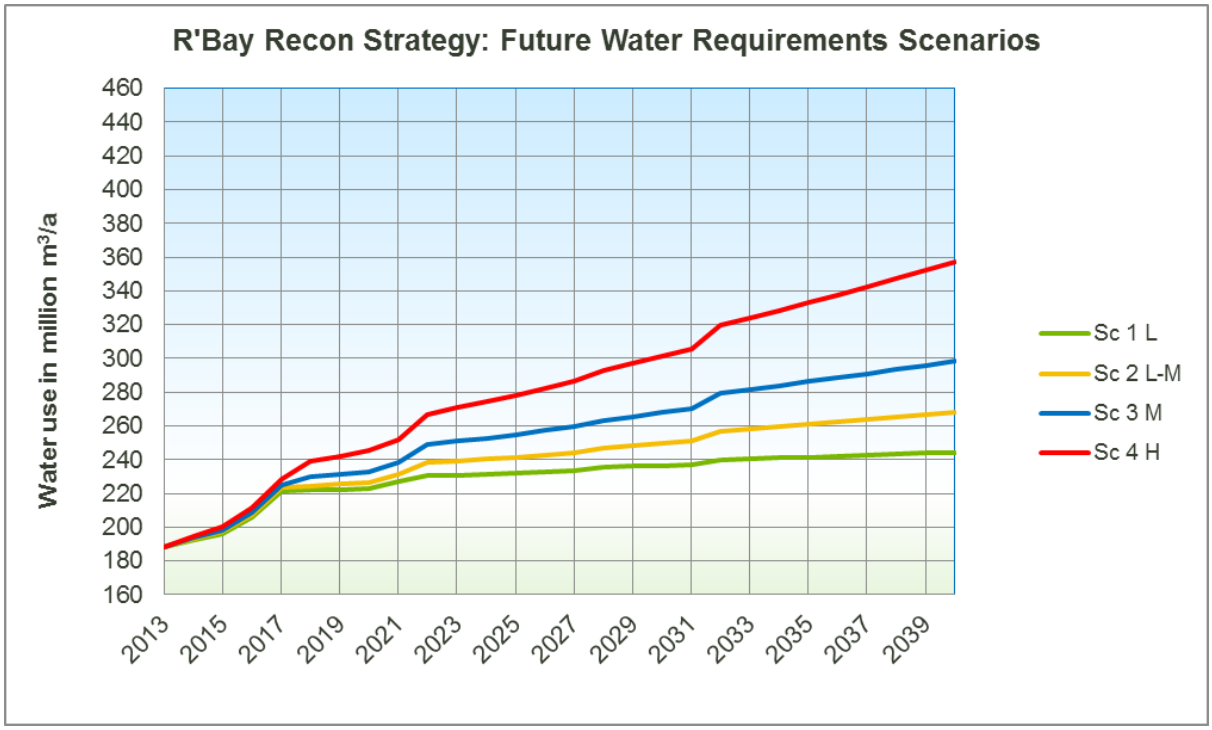


Figure 3-6 | **Future water requirements 'Best-Estimate' scenarios**

4. Water Availability and Balance

4.1 Assured Yield of System Storages

The water resources yield model (WRYM) simulation computer programme for the Richards Bay WSS was updated with the latest estimates for industrial and urban water use for the WSS. In addition the estimated irrigation use was amended according to the latest estimates. The WRYM was further updated to incorporate the final configurations of potential augmentation schemes.

The features of the WRYM includes:

- Inflow hydrology,
- Dam storage capacities and initial storage conditions,
- Network linkages and conveyance constraints, and
- Operating rules using “penalties” to prioritise sources and water demands.

The WRYM was used to determine assured yields, also called historic firm yields (HFYs) of individual WSS storages, as shown in Table 4-1 as well as of the WSS. The HFY is a conservative yield value, indicating an assured volume of water that could be provided each year from the WSS, without any shortages in supply being experienced.

Table 4-1 | Historical firm yields of individual storages

Dam / Lake	HFY (million m^3/a)
Goedertrouw Dam excl. the Thukela transfer	51.5
Goedertrouw Dam incl. the Thukela transfer	84.5
Lake Nsezi	6.6
Lake Mzingazi	10.5
Lake Cubhu	0.4
Lake Nhlabane: with support from Mfolozi	34.5
Lake Nhlabane: with no support from Mfolozi	7.9
Total yield from natural lakes (with support from the Mfolozi)	***52.0***
Total yield from natural lakes (with no support from the Mfolozi)	***25.4***

4.2 Abstraction from Lakes

In comparison to the modelled HFYs, the annual abstractions from the lakes over recent years are shown in Table 4-2, which are evidently very different from the modelled HFYs for the lakes as shown in Table 4-1.

Table 4-2 | Annual Abstraction Volumes from WTWs (million m^3)

Lake / Year	2008	2009	2010	2011	2012	2013
Lake Nsezi – Nsezi WTW	40.82	44.77	48.25	45.94	43.36	39.67
Lake Nsezi - RBM	5.10	7.80	8.51	8.20	1.62	2.38
Total: Lake Nsezi	**45.92**	**52.57**	**56.76**	**54.14**	**44.98**	**42.05**
Lake Mzingazi - Mzingazi WTW	21.26	22.00	16.10	11.92	18.33	22.40
Lake Cubhu - eSikhaleni WTW	10.15	9.98	10.34	11.37	11.36	11.16
Lake Nhlabane - RBM	12.48	8.86	5.23	3.77	11.37	12.95

RBM has recently undertaken an evaluation of the sustainable yield of Lake Nhlabane and has concluded that the sustainable abstraction from the lake has dropped to 10.95 million m^3/a as a result of land use changes, being almost the same as their annual water requirement. Based on the increasing trend in streamflow reduction, it is estimated that this may within another five years drop by a third unless there is a substantial increase in rainfall or the land use trends change.

Because the groundwater contribution to lake yields has not been taken into account in the modelling, it is likely that the modelled lake yields are too low or incorrect. Groundwater contributions to the lakes could not be quantified with an acceptable level of confidence to be included in the lakes' yields estimation in the past (MORFP study).

There is a significant concern that the existing levels of abstraction from the lakes in the strategy area may not be sustainable. The confidence in the sustainable lake yields should be improved, by monitoring and quantifying the groundwater contribution, as well as the interaction between groundwater and surface water. Yields for the lakes can then be determined at an acceptable level of confidence and refined lake operational procedures can be implemented.

4.3 WRPM Modelling

The Water Resources Planning Model (WRPM) obtained from the study "*Mhlathuze Catchment - Modelling Support for Licensing Scenarios"* was also updated with the latest estimates for irrigation, industrial and urban water use for the strategy area.

In addition, the WRPM has been enhanced to simulate system operation, including:

- The growth of water requirements over time,
- The addition of new bulk water infrastructure,
- The inclusion of an annual allocation routine which allows the curtailment of each demand type during droughts according to different reliability classification tables.

The WRPM enables planners to model the impact of interventions (reduction of demand or additional schemes) when the frequency of curtailment exceeds acceptable limits.

At least once a year, the annual allocation model is run, using the current storage of the system to assess whether the current demands on the system can be met or whether the less essential demands need to be curtailed to meet the demand. For the Mhlathuze catchment this allocation decision is made around the 1st of May, after the rainy season and prior to the dry winter period. The available supply from the system is assessed prior to the decision date by simulating the behaviour of the system under different initial storage conditions, under say 1000 alternative stochastic inflow sequences over the simulation period. On the decision date, the results from the closest set of initial storage conditions are used to estimate the behaviour for the initial conditions on the decision date.

The demands on the system are categorised into different reliability classes, as can be seen in Table 4-3. According to the table, 50% of the irrigation can be curtailed once every four years and all irrigation can be curtailed completely once every 50 years. 40% of the urban demand can be curtailed every twenty years. These criteria may be difficult to achieve in practice and may need to be revisited.

Table 4-3 | Assurance of supply criteria from the Licensing Scenario Study

Water use sector	% demand at indicated risk of failure				
	1 in 200 years	1 in 100 years	1 in 50 years	1 in 20 years	1 in 4 years
	0.5%	1%	2%	5%	25%
Irrigation			50%		50%
Urban	30%	30%		30%	10%
Industrial 1 (1)	70%	20%		10%	
Industrial 2	90%	10%			

From the "Mhlathuze Catchment - Modelling Support for Licensing Scenarios" study
(1) Tongaat Hulett irrigators

Allowance has been made for a continuous reduction in yield as a result of the decreasing storage in Goedertrouw Dam due to sedimentation.

The stochastic, curtailed yield of the existing WSS was estimated as 247.3 million m^3/a.

The potential shortages in water supply by 2040, for the various water requirements scenarios, when compared with the stochastic WSS yield are as indicated in Table 4-4.

Table 4-4 | Potential shortfall by 2040 for various water requirements scenarios

Water Requirement Scenario	Water requirement (million m^3/a)	Potential shortfall (million m^3/a)
Scenario 1: Low growth	244.4	2
Scenario 2: Low-Medium growth	267.8	23
Scenario 3: Medium growth	298.4	56
Scenario 4: High growth	356.9	115

5. Interventions

5.1 Introduction

An **intervention** can be any measure that could potentially make additional water available i.e. that improves the water balance of the Richards Bay WSS. It can therefore be demand-side (lowering water requirements) or supply-side (increasing the water supply) focussed.

Following the determination of the current and potential future water balances, it is necessary to identify the potential interventions or groups of interventions that could be implemented to avert potential future supply shortfalls. The most favourable interventions need to be evaluated to be able to devise the set of best possible alternatives to meet the water requirements of the Richards Bay WSS up to 2040.

5.2 Approach and Methodology

The following process has been followed:

a) Compilation of a Long List of potential interventions, screening of the Long List of interventions, and compilation of a Short List of interventions that could potentially address future water supply deficits, to be evaluated further,
b) Presenting preliminary evaluation findings to key stakeholders and reaching agreement on which interventions to evaluate in greater depth,
c) Undertaking the evaluation of the short-listed interventions and documentation of the evaluated interventions in a fairly standardised manner,
d) Holding an Interventions Workshop with key stakeholders to present the evaluation findings, inviting suggestions regarding variations of the interventions, or clarification of specific aspects. Evaluations were refined following the workshop.
e) Identifying the potential for making better use of existing supplies, and
f) Assessing the findings of the selected evaluated interventions, and making recommendations on the preferred interventions to be evaluated further or to be implemented.

5.3 Compilation of the Long List of Interventions

A significant number of potential interventions, which could contribute to meeting the future water requirements of the Richards Bay WSS, were identified from previous and on-going studies, liaison with officials and stakeholders, as well as formulating some new potential interventions. The list of these initial potential interventions has been termed the “Long List” of interventions. The Long List describes potential interventions that could be considered for the strategy area, classed under twelve categories of interventions:

About 45 potential interventions in total were identified under the categories of:

- Water conservation and water demand management (WC/WDM),
- Improved operation of the Richards Bay Water Supply System,
- Water reallocation,
- Reducing users' assurances of supply,
- Land care,
- Thukela River inter-basin transfer schemes,
- Mfolozi River inter-basin transfer schemes,
- Mhlathuze River dams,
- Groundwater schemes,
- Use of treated effluent,
- Desalination, and
- Water supply infrastructure.

5.4 Screening of Potential Interventions

Potential interventions in the Long List of interventions were interrogated by the Study Team to ascertain which of these could be seriously considered for further evaluation, and the reasons were documented. The Long List was then circulated for contributions and was reviewed by, and discussed with stakeholders at the 4th Study Stakeholder Meeting held on 13 August 2014. The outcome of this screening process was the identification of the interventions that should be evaluated further (the 'Short List' of interventions).

5.5 Selected Potential Interventions (Short List)

The following potential augmentation options were selected for further evaluation:

- Bulk industrial WC/WDM,
- Urban WC/WDM,
- Rainwater harvesting,
- Limiting supply from coastal lakes to their sustainable yields,
- Increased capacity of the Thukela-Mhlathuze Transfer Scheme,
- Coastal pipeline from the lower Thukela River,
- On-channel transfer scheme/s from the Mfolozi River: Kwesibomvu Dam,
- Off-channel transfer scheme/s from the Mfolozi River,
- Raising Goedertrouw Dam,
- Dam on the Nseleni River,
- Groundwater schemes,
- Arboretum Effluent Reuse Scheme, and
- Desalination of seawater.

5.6 Evaluation of Selected Interventions

Pertinent information on technical, financial, ecological and social aspects was assembled or generated and where necessary, improved at desktop level. In so doing, available information from many disparate sources and levels of confidence was brought to a more common level of understanding, in a fairly standard format.

Savings to be achieved as a result of WC/WDM measures were drawn from available information, best practice and practical achievable savings. Some yields of interventions were based on assumed scheme

size. Diversion curves were developed to determine diversion volumes of off-channel schemes. Indicative assured yields for surface water schemes were determined using the updated WRYM.

Where possible, capital costs were based on costs available from previous studies or costs of similar sized infrastructure. Costs were escalated to be representative of the base year costs, if such costs were not too dated. In some cases, costs have been estimated from basic principles, as some options have not been evaluated before or the costs were too outdated. Annual operating and maintenance costs were further determined for all schemes.

An evaluation period of 37 years (2014 to 2050) was selected for all water augmentation schemes, for determination of unit reference values (URV). The URV is a means of comparing different interventions on an equal base by calculating a cost per unit (here the cost per cubic metre of water, i.e. R/m^3) for each intervention, based on the same assumptions in terms of evaluation period, equipment replacement periods, electricity costs etc. It provides a comparative indication of the unit cost of (untreated) water supplied from the scheme during the lifetime of the scheme.

Table 5-1 provides descriptions of the selected interventions that were evaluated and costed.

Table 5-1 | Descriptions of evaluated interventions

Intervention	Description of intervention
Bulk industrial WC/WDM:	This involves WC/WDM by bulk industrial water users, of which Mondi, RBM, Tronox and Foskor account for 96% of current water use.
Urban WC/WDM:	This involves WC/WDM by the urban water supply sector (especially the CoU that includes Richards Bay, Empangeni, eSikhaleni, Nseleni and Ngwelezane as well as Uthungulu DM.
Rainwater harvesting:	This involves the collection and storage of rainwater for commercial, industrial or domestic use. The focus is on the harvesting of rainwater from roofs for outdoor and indoor non-potable domestic uses.
Limiting supply from coastal lakes to their sustainable yields:	This involves the determination of groundwater contributions to lake yields at an acceptable confidence, and revising of the operating rules of abstraction to ensure a sustainable supply from the three coastal lakes of the WSS, Lakes Mzingazi, Cubhu and Nhlabane.
Increased capacity of the Thukela-Mhlatuze Transfer Scheme:	Further phases of the increased transfer from the Thukela River at Middledrift have been incrementally evaluated (phases 1, 2 and 3) for a variety of infrastructure combinations, to transfer Thukela River water to a Mhlatuze River tributary that flows to Goedertrouw Dam. This would increase the transfer rate to 2.7m^3/s, 5.7m^3/s and 8.7m^3/s respectively (from the existing 1.2m^3/s installed capacity).
Coastal pipeline from the lower Thukela River:	This involves shared use of the bulk water abstraction and treatment infrastructure developed in the lower Thukela River at Mandini by Umgeni Water to transfer water to Richards Bay with either a raw water of clear water pipeline and to supply coastal communities along the way. Options of 110 Mℓ/day and 55 Mℓ/day transfers were investigated.
On-channel transfer scheme/s from the	The Kwesibomvu Dam is an on-channel earthfill dam on the Mfolozi River about 7 km upstream of the N2 road bridge, that would transfer water to Nsezi WTW and provide a

Intervention	Description of intervention
Mfolozi River: Kwesibomvu Dam:	regional water supply to Mtubatuba and other small towns. Two dam sizes were evaluated.
Off-channel transfer scheme/s from the Mfolozi River:	This involves pumping from a weir in the Mfolozi River about 4 km upstream of the Kwesibomvu Dam site to an off-channel earthfill dam at the Nkatha Pan. The scheme would transfer water to Nsezi WTW and provide a regional water supply to Mtubatuba and other small towns. Different rates of pumping from the Mfolozi River to the dam were investigated, as well as two dam sizes.
Raising of Goedertrouw Dam:	This involves a 2.8m raising of the dam wall by building a concrete wave wall on the existing earthfill dam wall, and increasing the capacity of the spillway through a labyrinth spillway configuration.
Dam on the Nseleni River:	A new earthfill dam on the Nseleni River tributary of the Mhlatuze River just upstream of the Bhejane township was evaluated, from where water could be released to flow down to Lake Nsezi for abstraction. Three dam sizes were evaluated.
Groundwater schemes:	Three wellfields were assessed, which are located to the west of Empangeni and to the south-west respectively and will supply into existing or new reservoirs.
Arboretum Effluent Reuse Scheme:	This firstly involves construction of a regional activated sludge WWTW and biological nutrient removal process with membrane bioreactors at the Arboretum pump station/macerator site that can accommodate both the existing and future domestic load of the Arboretum and Alton pump stations. The treated effluent will be sold directly to industrial users or alternatively pumped for discharge into Lake Mzingazi for indirect reuse.
Seawater desalination:	Seawater will be fed by an intake in the Richards Bay harbour or a marine intake to a site close to the Alkantstrand pump station, where the reverse osmosis desalination plant will be situated. Potable water will be pumped to the Mzingazi WTW for blending and distribution.

5.7 Preliminary Implementation Programmes

The planning and implementation of interventions takes time, often as long as 10 or more years for a large scheme for a conventional implementation approach. It is therefore imperative to clearly identify the steps to be taken in the process and to timeously plan for new longer term interventions. Preliminary implementation programmes were developed for each intervention, to be used in the scenario evaluation. The preliminary implementation programmes are notably dependent on the implementing organisation. This is shown in **Error! Reference source not found.**. It is possible to fast-track the implementation of projects, should circumstances require it. This usually comes with an associated higher cost and risks, but fixed institutional processes in some organisations may make this challenging to achieve.

5.8 Interventions Workshop

At the stakeholder workshop held on 4 February 2015 in Richards Bay, the findings of the Interventions evaluation were presented to a group of key stakeholders. The stakeholders provided comment and made suggestions regarding variations of the interventions, or clarified specific facts. The descriptions of the evaluated interventions were refined following the workshop.

Table 5-2 | Preliminary Implementation Programmes (years)

INTERVENTION	Pre-Feasibility	Feasibility			Construction / Implementation							TOTAL Maximum time to develop yield	
		Budget/ TOR / Appoint Consultant	Feasibility Study/ EIA/ Monitoring	DWS Reserve determination	Budget/ TOR / Appoint Consultant	DWS licensing process (incl Reserve)	DEA&DP approval process	Design / tender preparation & award	Construct /Implement/Council Bylaw	Warm up / first filling			
			Simultaneous	Simultaneous		Simultaneous	Simultaneous			Start	End	Start	End
Bulk industrial WC/WDM								1	4	0	5	**0**	**5**
Urban WC/WDM								1	9	0	10	**0**	**10**
Rainwater harvesting									1				**1**
Sustainable supply from coastal lakes		1	3	2					0.5				**4.5**
Increased capacity of the Thukela-Mhlathuze Transfer Scheme Ph 1		1	2	1	0.75	0.5	1.5	1.5	2				**8.75**
Increased capacity of the Thukela-Mhlathuze Transfer Scheme Ph 2		1	1.5	1	0.75	1	1.5	1.5	2.5				**8.75**
Thukela-Mhlathuze Transfer Scheme Ph 1 + Ph 2		1	2.5	1	0.75	1	1.5	2	3				**10.75**
Increased capacity of the Thukela-Mhlathuze Transfer Scheme Ph 3		1	1	1	0.75	1.5	1.5	1	2.5				**7.75**
Coastal pipeline from the lower Thukela River (55Ml/d)		1	1.75	1	0.75	0.5	1.5	1.5	2				**8.5**
Coastal pipeline from the lower Thukela River (110Ml/d)		1	1.75	1	0.75	1.5	1.5	2	2				**9**
Mfolozi River on-channel transfer scheme: Kwesibomvu Dam		1	2	2	0.75	1.5	1.5	2	3	0	1	**9.25**	**10.25**
Mfolozi River off-channel transfer scheme		1	1.5	1.5	0.75	1.5	1.5	2	2.5	0	1	**8.25**	**9.25**
Raising Goedertrouw Dam		1	0.5	0	0.75	0.5	0.5	0.5	1.25				**4.5**
Dam on the Nseleni River		1	1.5	1.5	0.75	1.5	1.5	1.5	2.25	0	1	**7.5**	**8.5**
Groundwater scheme	0.75	0.75	1.5	1	0.75	1.5	1.5	2	1.25				**8.5**
Arboretum Effluent Reuse Scheme		0.75	0.75	0	0.75	1	1.5	1	1.75				**6.5**
Desalination of seawater Ph 1		0.75	2	0	0.75	1	1.5	1	1.75				**7.75**
Desalination of seawater, further phases		0.75	1	0	0.75	1	1	0.75	1.5				**5.75**
Desalination of seawater Ph 1 + Ph 2		0.75	2	0	0.75	1	1.5	1.5	2.75				**9.25**
Desalination of seawater, double size, further phases		0.75	1	0	0.75	1	1.5	1.25	2.5				**7.75**
Thukela-Mhlathuze Transfer Scheme Ph 1 Fast Track		0.25	1.25	1	0.25	1	1	1.25	2				**6**
Thukela-Mhlathuze Transfer Scheme Ph 1 + Ph 2 Fast Track		0.25	1.5	1	0.25	1	1	1.5	2.5				**7**
Coastal pipeline from the lower Thukela River (55Ml/d) Fast Track		1	1.75	1	0.75	0.5	1.5	1.5	2				**8.5**
Mfolozi River off-channel transfer scheme Fast Track		1	1.5	1.5	0.75	1.5	1.5	2	2.5	0	1	**8.25**	**9.25**
Desalination of seawater Ph 1 Fast Track		0.75	2	0	0.75	1	1.5	1	1.75				**7.75**
Desalination of seawater Ph 1 + Ph 2 Fast Track		0.75	2	0	0.75	1	1.5	1.25	2.25				**8.5**

5.9 Summary of Intervention Features

The key features of the evaluated interventions are documented in Table 5-3 and scheme locations are shown in Figure 5-1 thereafter. The following aspects are shown:

- Intervention name,
- Intervention variation – several intervention variations have been tested in some cases, although this has been limited by the extent and nature of this study,
- Intervention description: A succinct explanation of the intervention,
- Yield: assumed scheme yields are shown for previous evaluations or assumed scheme sizes. These have been shown in both million m^3/a and Mℓ/d,
- Capital cost: This shows a scheme capital costs in R million or a range of costs in some cases,
- URV, being a particularly useful indicator to compare bulk water schemes over their lifetimes,
- Identifiable significant environmental and socio-economic impacts and an indication to what extent these can be mitigated or may potentially limit the development of a scheme,
- Preliminary implementation programme in years.

The schemes that can significantly increase the yield of the WSS are:

f) Increased capacity of the Thukela-Mhlathuze Transfer Scheme (up to 236.5 million m^3/a yield), but dependent on the future availability of water from the Thukela River at a feasible cost, which may be a limiting factor,

g) On-channel transfer scheme/s from the Mfolozi River: Kwesibomvu Dam (46.6 million m^3/a yield), after allowance of 20 million m^3/a to be supplied to the Mtubatuba WSS and surrounding areas,

h) Off-channel transfer scheme/s from the Mfolozi River (36.9 million m^3/a yield), after allowance of 20 million m^3/a to be supplied to the Mtubatuba WSS and surrounding areas,

i) Coastal pipeline from the lower Thukela River (15.0 or 35.0 (long-term only)) million m^3/a yield), taking into account water to be supplied to small coastal towns,

j) Desalination of seawater, which can appropriately be sized and phased as required.

It is noted that there are a number of interventions that provide limited yield. While these schemes should be considered to improve the water balance, they would not provide the significant increase in yield needed over the longer term. These interventions include:

c) Arboretum Effluent Reuse Scheme (11.0 million m^3/a yield).

d) (1 MAR) Dam on the Nseleni River (7.0 million m^3/a yield),

e) Raising Goedertrouw Dam (3.9 million m^3/a yield),

f) Urban WC/WDM (4 million m^3/a yield),

g) Bulk industrial WC/WDM (2.8 million m^3/a yield),

h) Groundwater schemes (1.55 million m^3/a yield),

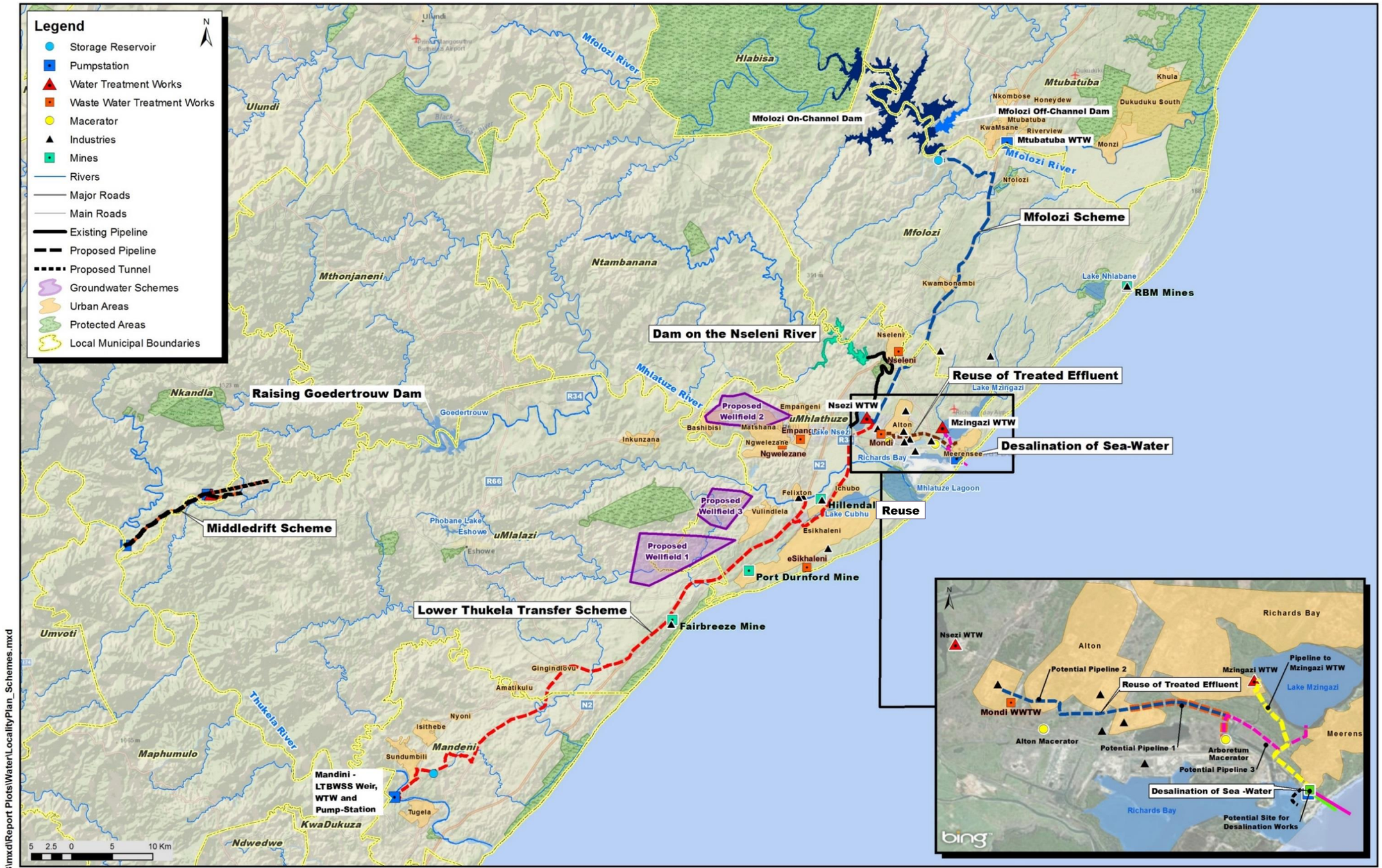
i) Rainwater harvesting (up to 200kl/a per household),

j) Sustainable supply from coastal lakes (likely negative yield).

Table 5-3 | Summary Interventions Table

Intervention	Variation	Intervention description	Yield (million m³/a)	Yield (Mℓ/d)	Capital cost (R million)	URV (8% discount rate)	Environmental and socio-economic impacts	Implementation programme (years)
Bulk industrial WC/WDM	-	WC/WDM applicable to bulk industrial water users, of which Mondi, RBM, Tronox and Foskor accounts for 96%.	2.8	7.7	*Range of costs*	*Range of URVs*	Minimal. Specific to type of WC/WDM	5
Urban WC/WDM	-	WC/WDM applicable to the urban water supply sector (supplied by the City of Mhlathuze) that includes Richards Bay, Empangeni, eSikhaleni, Nseleni and Ngwelezane as well as Uthungulu DM.	4.0	11.0	*Range of costs*	*Range of URVs*	Minimal. Specific to type of WC/WDM	10
Rainwater harvesting	*Non-potable conjunctive uses (garden and flushing toilets) investigated. Yields and costs dependent on a variety of factors, including roof area, tank size and target drawdown volume.*	This is the collection and storage of rainwater for commercial, industrial or domestic use. The focus is on the harvesting of rainwater from roofs for outdoor and indoor non-potable domestic uses	*Up to 200kl/a per household*	-	*R5,000 – R28,000*	*Minimum of R11.04/kl*	Limited. Main concern is that water need to be treated for potable use.	1
Sustainable supply from coastal lakes	*Increase abstraction levels to 50% of the difference between drought maintenance levels (current operation) and management maintenance levels*	This involves the determination of groundwater contributions to lake yields at an acceptable confidence, and revising of the operating rules of abstraction to ensure a sustainable supply from the three coastal lakes of the WSS, Lakes Mzingazi, Cubhu and Nhlabane.	-4.3	-11.8	0	0	Positive environmental impacts. Associated impacts of replacing yield from alternative sources.	4.5
	Increase abstraction levels to management maintenance levels from drought maintenance levels (current operation)		-9.9	-27.1	0	0		4.5
Increased capacity of the Thukela-Mhlatuze Transfer Scheme	**To augment to a final volume of 2.7m³/s**	Increased transfer of water from a weir in the Thukela River at Middledrift to a Mhlatuze River tributary that drains to Goedertrouw Dam. Development has been evaluated for 1, 2 or 3 phases of increased transfers for a variety of infrastructure combinations. Given here are the costs for augmenting the system to 2.7m³/s, 5.7m³/s and 8.7m³/s respectively with the tunnel being included, as it was cheaper in all cases than the corresponding scheme with the pipeline instead. For the options involving multiple phases, the capital cost of each phase is given as well as the sum of those capital costs. The incremental yield is given – i.e. not including the existing 1.2m³/s (37.8 million m³/a) transfer capacity.	**47.3**	**129.6**	**842.39**	**6.43**	Moderate. Generic impacts of inter-basin transfer of water, pipeline construction etc. Weir construction impacts. Pipelines will traverse environmentally sensitive areas, but will follow existing servitude. Options involving tunnel have lower environmental impacts. Outfall into small rivers can cause erosion - mitigatable Increased availability of water to local communities.	8.75
	To augment to a final volume of 5.7m³/s		**141.9**	**388.8**	**2432.29**	**6.72**		10.75
	First phase (augmentation to 2.7m³/s) - incremental		47.3	129.6	1032.51	6.56		8.75
	Second phase (augmentation to 5.7m³/s) - incremental		94.6	259.2	1417.67	4.74		8.75
	To augment to a final volume of 8.7m³/s		**236.5**	**647.9**	**3423.98**	**8.28**		-
	First phase (augmentation to 2.7m³/s) - incremental		47.3	129.6	1225.14	7.07		8.75
	Second phase (augmentation to 5.7m³/s) - incremental		94.6	259.2	1427.99	4.76		8.75
	Third phase (augmentation to 8.7m³/s) - incremental		94.6	259.2	787.90	3.92		7.75
Coastal pipeline from the lower Thukela River	*Raw water pipeline*	This involves shared use of the bulk water abstraction and treatment infrastructure developed in the lower Thukela River at Mandini by Umgeni Water to transfer water to Richards Bay and to supply coastal communities along the way. The pipeline would terminate at the Mhlatuze River, a short distance upstream of the weir. Options of 110 Ml/d and 55 Ml/d transfers were investigated.	15.0	55	522.84	4.39	Limited to moderate. Pipelines follow existing railway and road servitudes. Outfall of raw water option is into a large river (Mhlatuze), hence limited erosion potential. Use existing infrastructure at abstraction point.	55 Ml/d: 8.5 110 Ml/d: 9
			35.0	110	1014.25	4.96		
	Clear water pipeline	Similar to the raw water pipeline except that the pipeline would continue further north to reach the Nsezi WTW, from where it would be distributed to users of treated water. Options of 110 Ml/d and 55 Ml/d transfers were investigated.	15.0	55	584.05	4.28		
			35.0	110	1055.45	5.23		
	Raw Water utilising the Tronox pipeline to Fairbreeze mine	Similar to the previous options except that the pipeline currently being constructed to bring water from the Mhlatuze River to the Fairbreeze mine would be used for that part of the route. Only 110 Ml/d transfer was investigated, taking into account the requirement of the Tronox mines.	35.0	110	1209.47	4.58		
On-channel transfer scheme/s from the Mfolozi River: Kwesibomvu Dam	*26m high (144 million m³ capacity) , 17% MAR dam – pipeline to Nseleni River*	The Kwesibomvu Dam is an on-channel earthfill dam on the Mfolozi River about 7 km upstream of the N2 road bridge that would transfer water to Nsezi WTW and provide a regional water supply to Mtubatuba and other small towns.	66.6	182.5	1764.79	3.52	Significant. Inundation of land, including several pans and social infrastructure. Obstruction of water-course affecting movement of sediment, aquatic species and modification of downstream flow regime.	10.25
	26m high(144 million m³ capacity) , 17% MAR dam – pipeline to Nsezi WTW		66.6	182.5	2272.82	4.21		

Intervention	Variation	Intervention description	Yield (million m³/a)	Yield (Mℓ/d)	Capital cost (R million)	URV (8% discount rate)	Environmental and socio-economic impacts	Implementation programme (years)
	36m high (265 million m³ capacity) , 31% MAR dam– pipeline to Nseleni River		137.3	376.2	2271.29	3.70	Prohibitive, inclusive of flooding of lower portions of the Hluhluwe-iMfolozi Park which probably rules out the scheme.	-
	36m high (265 million m³ capacity) , 31% MAR dam – pipeline to Nsezi WTW		137.3	376.2	2880.56	4.26		
Off-channel transfer scheme/s from the Mfolozi River	*2 m³/s diversion, 28m high, 30 million m³ dam, pipeline to Nseleni River*	This involves pumping from a weir in the Mfolozi River about 4 km upstream of the Kwesibomvu Dam site to an off-channel earthfill dam at the Nkatha Pan. The scheme would transfer water to Nsezi WTW and provide a regional water supply to Mtubatuba and other small towns. Different rates of pumping from the Mfolozi River to the dam were investigated, as well as different storage capacities.	33	90.4	941.51	5.36	Moderate to significant. Inundation of one pan (Nkatha Pan).	9.5
	2 m³/s diversion, 28m high, 30 million m³ dam, pipeline to Nsezi WTW		33	90.4	1299.40	6.32		
	2 m³/s diversion, 38m high, 63.2 million m³ dam, pipeline to Nseleni River		47.1	129.0	1152.79	4.56		
	2 m³/s diversion, 38m high, 63.2 million m³ dam, pipeline to Nsezi WTW		47.1	129.0	1565.13	5.36		
	2.5 m³/s diversion, 32m high, 39 million m³ dam, pipeline to Nseleni River		40.8	111.8	1131.30	5.97		
	2.5 m³/s diversion, 32m high, 39 million m³ dam, pipeline to Nsezi WTW		40.8	111.8	1551.95	6.99		
	2.5 m³/s diversion, 42m high, 78 million m³ dam, pipeline to Nseleni River		56.9	155.9	1235.75	5.20		
	2.5 m³/s diversion, 42m high, 78 million m³ dam, pipeline to Nsezi WTW		56.9	155.9	1601.93	5.87		
Raising Goedertrouw Dam		A 2.8m raising of the dam wall by building a concrete wave wall on the existing earthfill dam wall, and increasing the capacity of the spillway through a labyrinth spillway configuration.	3.9	10.7	77.6	1.61	Minimal. Small increase in inundated area.	4.5
Dam on the Nseleni River	*1 MAR (43.1 million m³), 22.5m high*	A new earthfill dam on the Nseleni River tributary of the Mhlatuze River just upstream of the Bhejane township, from where water could be released down to Lake Nsezi for abstraction. Would also increase the assurance of supply to RBM, which has an abstraction point a short way downstream of the proposed dam site.	7.0	19.2	164.39	1.96	Significant, but mitigatable. Inundation of sections of the D857 road. Inundation of farm dam. Disruptions of ecosystems, some inundation of social infrastructure. Impacts as a result of obstruction of the watercourse.	1MAR: 8.5
	1.5 MAR (64.7 million m³), 26.1m high		10.6	29.0	173.19	1.37		
Groundwater schemes	*Mtunzini-North Groundwater Scheme (wellfield 1)*	Wellfield 1 with 18 production boreholes and 20 exploration boreholes is located in the south western portion of the uMhlathuze LM and extends in a westerly direction over the municipal boundary and into the uMlalazi LM.	0.71	1.95	26.7	6.42	Moderate. Potential over-pumping /over-utilisation during operation impacting on the groundwater table, vegetation, as well as on natural springs and seeps. Construction phase impacts, noise and the influence on the boreholes of other users.	8.5
	Empangeni West Groundwater Scheme (wellfield 2)	Wellfield 2 with 17 production boreholes and 20 exploration boreholes is located to the west of Empangeni and extends westwards towards the boundary of the uMhlathuze and uMlalazi LMs.	0.54	1.48	15.5	4.93		
	Lubisana Groundwater Scheme (wellfield 3)	Wellfield 3 with 19 production boreholes and 20 exploration boreholes is located to the west of Empangeni and extends across the boundary of the uMhlathuze and uMlalazi LMs.	0.30	0.82	19.4	10.69		
Arboretum Effluent Reuse Scheme	*Treated effluent can be reused either directly by supply to industrial users, or indirectly by being taken to the Mzingazi WTW*	This firstly involves construction of a regional activated sludge WWTW and biological nutrient removal process with membrane bioreactors at the Arboretum pump station that can accommodate both the existing and future domestic load of the Arboretum and Alton pump stations. From there the treated effluent will be pumped for discharge into Lake Mzingazi for indirect reuse or sold directly to industrial users.	10.95	30	569	6.97	Moderate. Negative social perceptions of reuse. Mainly sludge disposal. Impacts of indirect use operation on Lake Mzingazi, as yet unquantified.	6.5
Seawater desalination	*Sea intake pipelines*	Seawater will be fed by an intake in the Richards Bay harbour to a site close to the Alkantstrand pump station, where the reverse osmosis desalination plant will be situated. Potable water will be pumped to the Mzingazi WTW for blending.	21.9	60	2243.7	8.47	Limited to moderate. Marine construction and brine outfall. Selection of site(s) will have further specific impacts, as yet unquantified.	Harbour intake: 7.75
	Harbour intake pipelines		21.9	60	2089.7	7.82		



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aurecon	PROJECT DIRECTOR Pr Eng DATUM: WGS 84	Department of Water and Sanitation ***Locality Plan - All Schemes***	DRAWN S SWARTZ DESIGN C SALISBURY PROJECT MANAGER E vd BERG	SCALE 1:416,536 DRAWING NO

Figure 5-1 | Locality Plan of all schemes

6. Scenario Planning

6.1 Introduction to Scenario Planning

The driving factors for the identification of future water balance situations to evaluate are:

a. Which future water requirements should be considered, and what will the associated future shortfall in water supply be by 2040?

b. Are there potential interventions that are so attractive (so-called 'baseline' interventions) that they should form part of all future scenarios?

c. Which interventions should be considered in addition to the baseline interventions?

d. What other issues would influence the future water balance and would need to be considered further?

These driving factors are described in the following sections.

What is scenario planning? Scenario planning is:

- Evaluating various ways to maintain a long-term WSS water balance and learning lessons,
- Scenarios are combinations of selected interventions,
- They are useful to evaluate further influences on the water balance and to test stakeholder perspectives.

The key question is:

"Which interventions should be implemented and in what order to avoid a shortfall in supply?"

What scenario process was followed? The process followed is the following:

- ⇒ Identification and screening of potential water balance scenarios,
- ⇒ Updating the Water Resources Planning Model (WRPM) and confirming shortfall / scheme implementation dates,
- ⇒ Setting up the Reconciliation Planning Support Tool (RPST) for the strategy area and potential interventions in line with the WRPM findings,
- ⇒ Evaluation of selected scenarios with the RPST and refinement following stakeholder interaction.

Scenario planning helps to identify the more favourable interventions or groups of interventions that could be implemented to meet future supply shortfalls for potential future water requirements, and identifies when such interventions should be implemented.

What is important is that it is unknown which future water requirement will actually develop? The strategic approach for bulk water development should therefore aim to meet a future shortfall in water requirements, whether growth in requirements is low or high. Monitoring of actual water requirements would be essential to track of which water requirements scenario is actually developing.

The potential shortfall by 2040 for best-estimate future water requirements, when compared with the modelled 2040 WSS stochastic yield were shown in Table 4-4.

Scenario planning was done to determine the potential implementation dates of interventions for each water balance scenario within the strategy evaluation period, from now up to 2040, to avert any shortfalls in supply. This was done for (best-estimate) future water requirements and not for estimated future allocations, to avoid expensive investment in bulk water infrastructure long before it will actually be required.

6.2 Further Issues to Consider

Important further influences on the future water balance to consider are the following:

Climate change: The worst case scenario for the Richards Bay WSS is when high future water requirements are realised, in addition to a worst case climate change situation. Although there is no consensus in South Africa on how to incorporate climate change into the water resources planning process, an approach has been formulated on how to consider climate change for this strategy area. This was done by integrating the worst estimated case of climate change into the Worst Case Scenario. In all cases a 15% reduction in the available yield for all surface water options have been assumed, as well as a 5% reduction in yield from groundwater options and reuse and a 10% increase in irrigation demands by 2040. For analysis it has been assumed that these impacts are realised linearly.

Reducing storage capacity of Goedertrouw Dam: The reducing storage capacity of Goedertrouw Dam is leading to reduced water availability. The dam's storage capacity of 321 million m^3 in 1982 has decreased to an estimated 301 million m^3 by 2000 due to siltation. The capacity of the dam is decreasing further at an estimated 1.1 million m^3/a. It is estimated that the capacity of the dam will have reduced to 257 million m^3 by 2040. The estimated reduction in yield (from the year 2000) by 2040 as a result of siltation is estimated at 4.9 million m^3/a.

National perspective on the future allocation of Thukela River water: The strategic importance of the future allocation of water from the Thukela River must be considered in a broader, national strategic perspective. It is one of the current and potential future sources (phased transfer from the proposed future Mielietuin, Jana or Smithfield dams) of water for the Vaal River system. It is important to consider the most beneficial future allocation of water from the Thukela River, taking other potential future users into account. The strategic national importance of increased future transfer of water to the Mhlatuze catchment in the

future must therefore be compared to the importance of providing future transfers to other potential water users.

Future availability and cost of Thukela River water: The maximum volume of Thukela River water available for transfer to the Mhlatuze catchment at an affordable cost may be a limiting factor. It is not exactly clear how much more water is available from the Thukela River, and this will need to be clarified. It is likely that further phases of a Thukela transfer scheme would only be possible should new dams be developed in the Thukela River, and such water would then come at a high cost.

Fast tracking of intervention implementation programmes: The fast tracking of the implementation programme of the first significant scheme to be implemented is important to avoid a situation of shortfall in supply in the medium term. The ability of implementing organisations to successfully undertake such fast tracking would thus need to be considered.

6.3 Baseline Interventions

Four small, attractive interventions have been identified that are referred to as the 'baseline' interventions, which will be included in (almost) all the scenarios postulated, are shown in Table 6-1 and Figure 6-1.

Table 6-1 | Baseline interventions

Intervention	Prelim. Yield (million m^3/a)	URV (R/m^3)	Implementation Program (years)
Bulk industrial WC/WDM	2.8	varies	5
Urban WC/WDM	4.0	varies	10
Raising Goedertrouw Dam	3.9	1.61	4.5
Dam on the Nseleni River	7.0	1.96	8.5

1) *Note: The implementation programme is the expected time to first delivery of water, and may include a period for dams to fill*

The motivation for this is the following:

- Both WC/WDM interventions have comparatively low costs and are the most acceptable in terms of environmental sustainability.
- The raising of Goedertrouw Dam is very cost-effective, will have low impacts and is quick to implement.
- A dam on the Nseleni River is very cost-effective and its impacts can, to a reasonable extent be mitigated. In addition it could provide some operational advantages, as water can be released downstream to Lake Nsezi / Nsezi WTW. The RBM abstraction point for water pumped to the smelter plant is also located just downstream of the potential dam site. It is understood that irrigators may also be interested in the development of the dam. It was assessed whether a larger Nseleni Dam (~1.5MAR) could provide storage of 'surplus' additional water transferred from the Mfolozi River, but this was found to be too costly to be considered further.

The baseline interventions (Figure 6-1), shown in comparison to the low-growth, medium-growth and high-growth water requirements, can provide a combined yield of 17.7 million m^3/a, depending on the success achieved with WC/WDM measures.

In the graph, dotted red lines show the position of the various water requirement projections, before the implementation of WC/WDM measures, which lowers the lines. The height of the augmentation schemes (orange and yellow coloured blocks added on top of the existing system yield) are commensurate with the yield of each scheme.

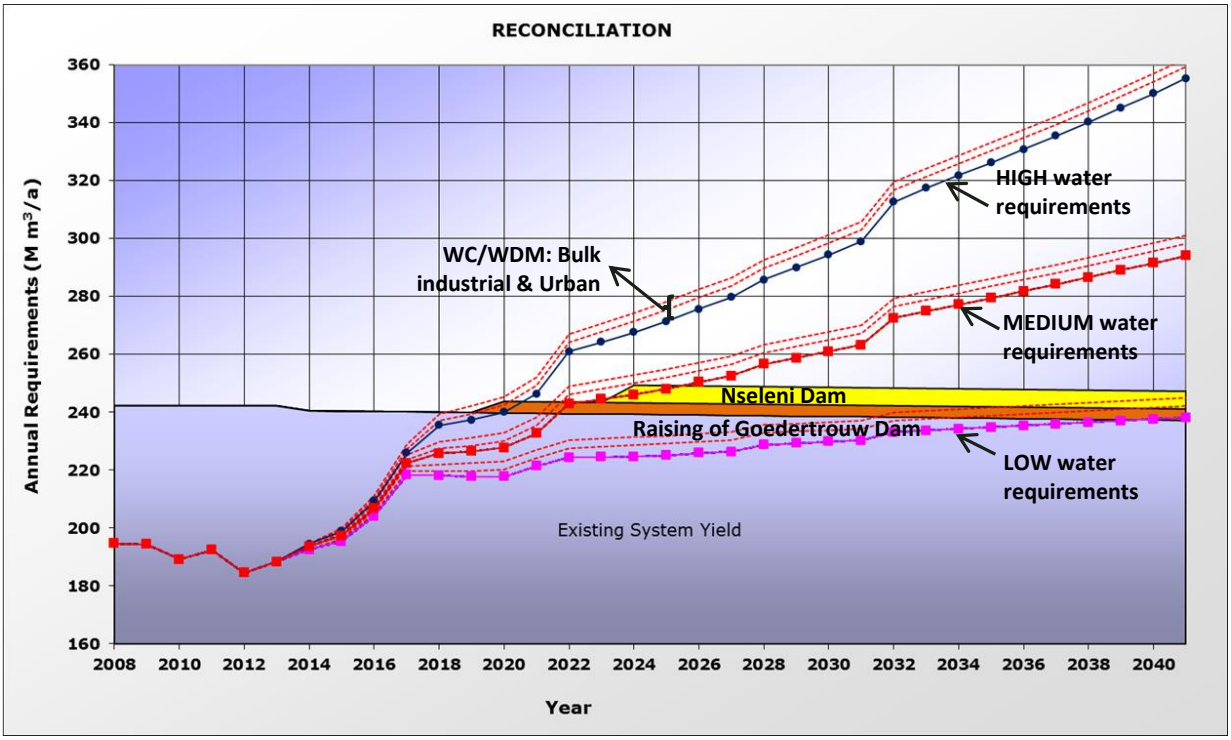

Figure 6-1 | Baseline interventions showing Water Use Scenarios

6.4 Identification and Selection of Scenarios

A series of scenario themes were postulated to test specific future situations or different approaches to meet the potential shortfall. These included:

- Testing of supply from only the Thukela River, or without it,
- Emphasis on increased system storage,
- Emphasis on increased assurance of supply,
- Implementing only non-conventional sources,
- A situation where WC/WDM interventions is not effective,
- Worst-case situation,
- Maximum variation of sources,
- Implementing all potential sources,
- Fast tracking of implementation, and
- Early desalination.

A significant range of scenarios that could address these various themes was developed. Because there is little point in evaluating scenarios where no specific lessons can be learnt from such evaluation or where the solution is so evident, some identified scenarios were not evaluated further.

Following initial assessment and screening of these scenarios, a range of scenarios was recommended for more detailed evaluation. These are shown in Table 6-2.

Table 6-2 | Scenarios identified for further evaluation

Sc No	Water Requirement Scenario	Theme	Notes
1	Sc 1: Low growth	Mfolozi	Demonstrates that the shortfall can be met by increased water efficiency
2	Sc 3: Medium growth	Mfolozi FT	Demonstrates that the shortfall can easily be met by one significant scheme. The medium-term benefit of fast-tracking the first significant scheme is further demonstrated
3	Sc 4: High growth	No Thukela	Demonstrates how the shortfall can be met without using water from the Thukela River
4	Sc 4: High growth	Non-conventional	Demonstrates how the shortfall can be met by only non-conventional sources (no surface water)
5	Sc 4: High growth	Worst case	Demonstrates how the shortfall can be met in the worst-case scenario, i.e. taking worst-case climate change into account in addition to high growth in requirements
6	Sc 4: High growth	Fast track Mfolozi	Demonstrates how fast tracking of the Mfolozi scheme improves the water balance in the medium term
7	Sc 4: High growth	Fast track Desalination	Demonstrates how the fast tracking desalination improves the water balance in the medium term
8	Sc 4: High growth	Fast track Thukela Middledrift	Demonstrates how the fast tracking of the Thukela Middledrift Phase 1 scheme improves the water balance in the medium term
9	Sc 4: High growth	Fast track Thukela Coastal	Demonstrates how the fast tracking of the Thukela 55 Mℓ/d Coastal scheme improves the water balance in the medium term
10	Sc 4: High growth	Early large desalination	Demonstrates a revised Baseline with early introduction of a larger seawater desalination scheme
11	Sc 4: High growth	Early larger desalination plus surplus storage	Demonstrates a revised Baseline with early introduction of seawater desalination, and in addition with storage of 'surplus' Mfolozi River water in a larger Nseleni Dam
12	Sc 4: High growth	Thukela Middledrift only	Demonstrates how the shortfall can be met from phased Thukela Middledrift transfer schemes

6.5 Evaluation of Selected Scenarios

6.5.1 Curtailed system yield analysis

A number of WRPM scenarios were analysed to determine the implementation date for the next augmentation scheme for the Mhlatuze WSS. These included:

- Starting with current (2015) storage conditions equating to 45% storage in Goedertrouw Dam as opposed to starting full.
- The medium-growth and high-growth future water use projections,
- Implementing baseline interventions (urban and industrial WC/WDM and the raising of Goedertrouw Dam by 2.8m to counteract the effect of ongoing siltation of the storage),
- Implementing a transfer of 1.5m^3/s from the Thukela River (Phase 1),

Interventions (demand reduction or additional schemes) are required when the frequency of curtailment exceeds acceptable limits.

It was estimated by this analysis that the next intervention is required (before WC/WDM interventions are implemented) by:

- 2020 for the high-growth water requirements.
- 2022 for the medium-growth water requirements.

6.5.2 The Reconciliation Planning Support Tool

The need for a water balance tool

The selection of projects, either to be studied further or to be implemented, to reconcile water availability with growing water demands, is a complex task, with many diverse issues and criteria to consider. The need for a customised planning tool, to provide support to water managers for this task, was identified during the Western Cape Reconciliation Strategy Study. To meet this need, a Reconciliation Planning Support Tool (RPST) was developed by Aurecon to assist the reconciliation planning process.

The RPST allows the user to compare potential projects, or groups of projects, with one another, and with one or more selected future water demand scenarios. The purpose of this Tool is to provide graphical interactive support, to assist managers in planning how best to meet future water demands from small or large systems. It facilitates the selection of a suite of potential interventions, for a particular water requirement curve and/or for a particular scenario, which is being evaluated, to ensure a future system water balance.

The RPST was customised for the Richards Bay WSS, to undertake scenario planning and to determine the implementation dates of interventions for the selected scenarios. The output from the RPST was used to guide the system modelling with the WRPM that followed.

Succinct overview of the Tool

Information is imbedded in the Tool, including various future water requirement scenarios, the current system yield, scheme implementation programmes and scheme yields. The Tool is run in Excel, with Visual Basic macro-programmes. It is interactive, and the user can adjust all input data. The Tool graphically shows when decisions regarding investigations for selected interventions need to be taken to achieve a water balance. It also shows the time-related implementation programmes, the effects of e.g. WC/WDM projects in reducing future water demands and the increases in system yield provided by selected interventions. Output from the Tool graphically shows when decisions to study selected projects need to be

taken to achieve a water balance, in order to implement demand management measures, or to make the yield from a new source available, by a certain date (year).

6.6 Scenario Findings

Water balance scenarios for four selected water balance scenarios are shown below:

- Low-growth Water Requirements Scenario,
- Medium-growth Water Requirements Scenario, and
- Two High-growth Water Requirements Scenarios.

6.6.1 Low-growth Water Requirements Scenario

This scenario (Figure 6-2) demonstrates that the shortfall can be met by effective industrial and urban WC/WDM.

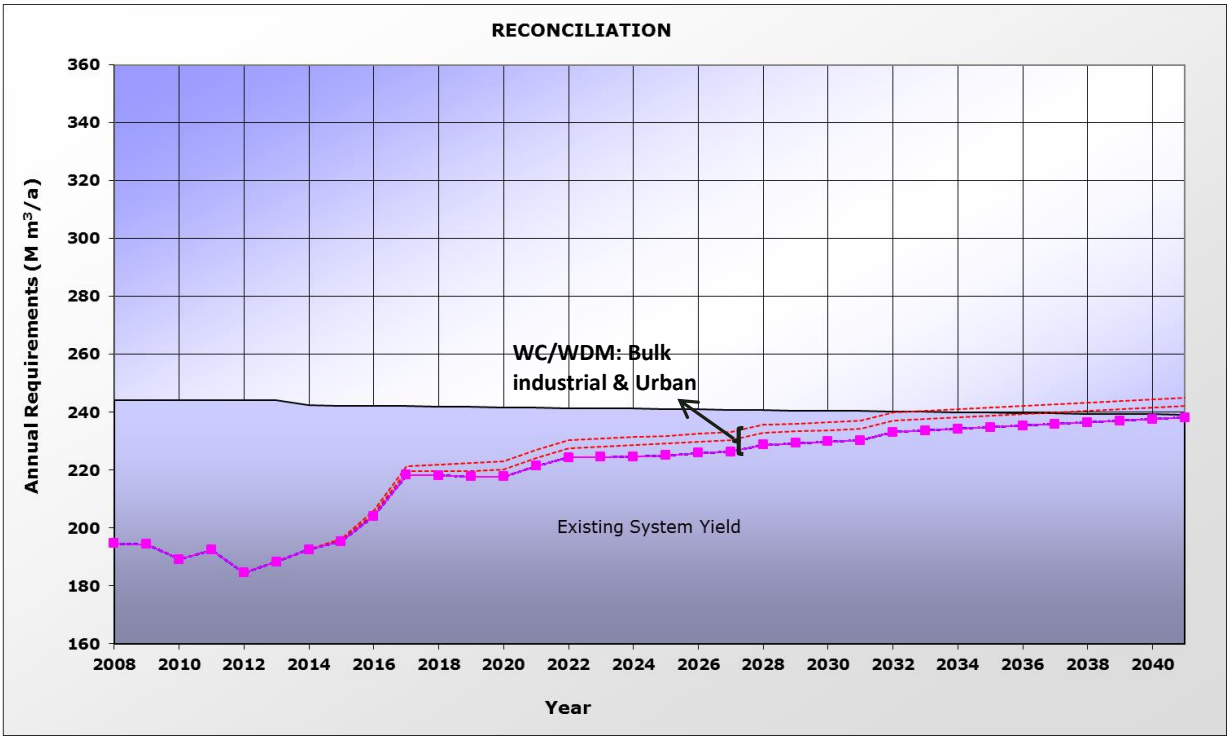

Figure 6-2 | Low-growth Water Requirements Scenario

6.6.2 Medium-growth Water Requirements Scenario

It is quite difficult to identify a scenario that represents the most likely scenario at this point in time, given the uncertainty regarding what future water requirements will actually be. The closest is likely this scenario (Figure 6-3) that illustrates the implementation of a fast-tracked Mfolozi River off-channel transfer scheme, in addition to the four baseline interventions. *Alternatively* a fast-tracked Thukela Middledrift transfer scheme could be considered, or a fast-tracked desalination scheme, instead of the Mfolozi Scheme.

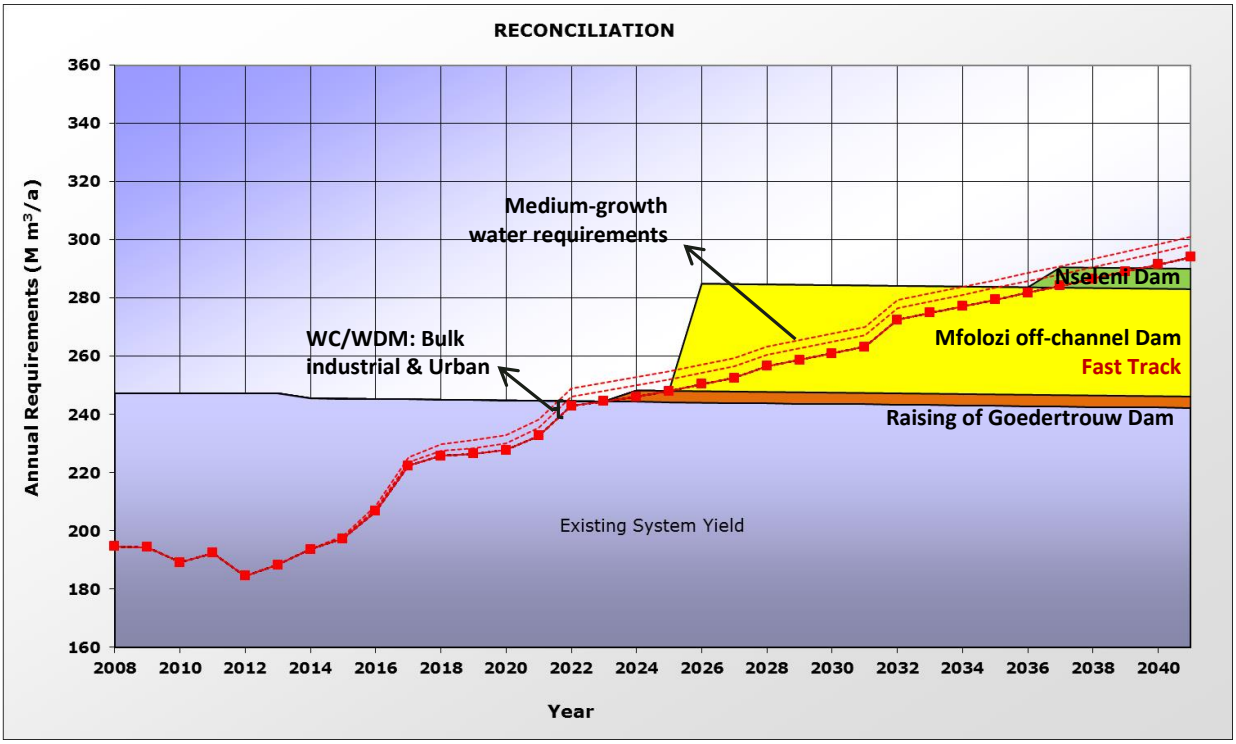

Figure 6-3 | Medium-growth Water Requirements Scenario

6.6.3 High-growth water requirements – theme Mfolozi fast-track

This scenario (Figure 6-4) demonstrates how fast tracking of the implementation of the Mfolozi off-channel scheme improves the water balance in the medium term by implementing the scheme earlier.

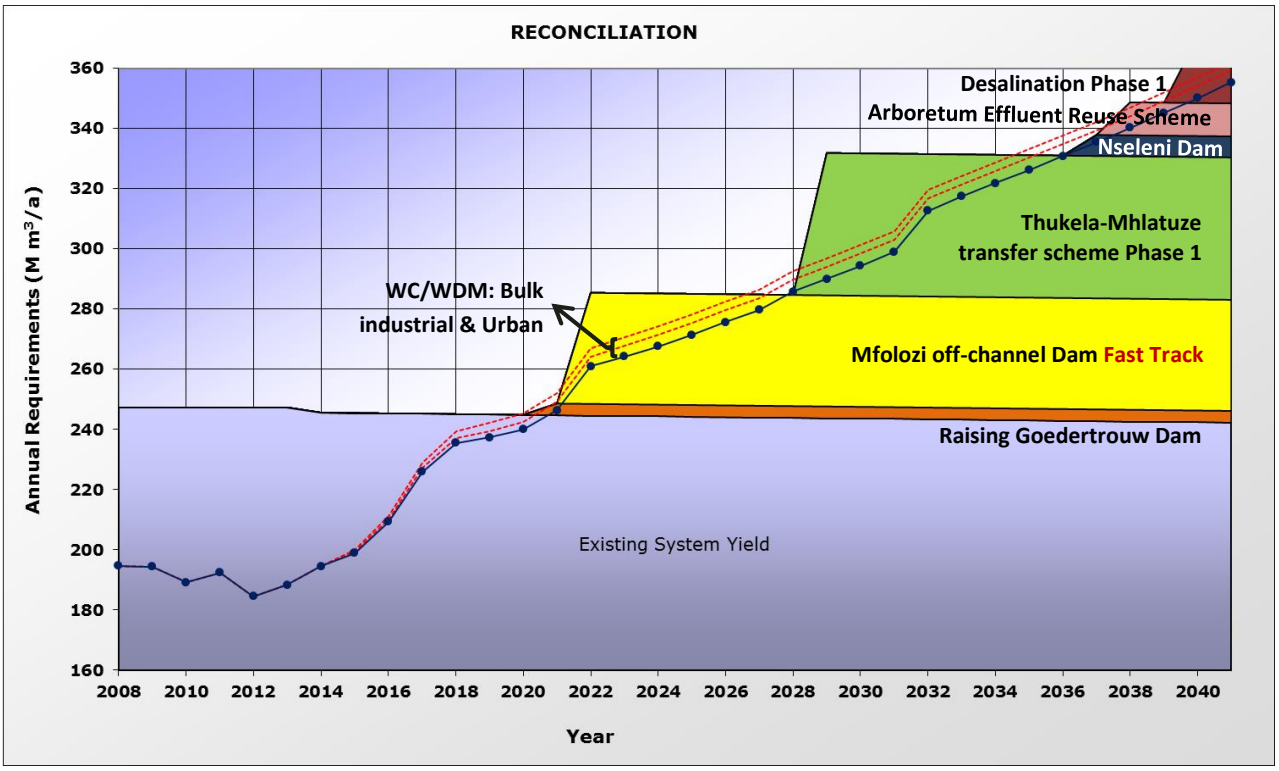

Figure 6-4 | High-growth Water Requirements Scenario – theme Mfolozi fast-track

6.6.4 High-growth water requirements – theme Thukela only

This demonstrates a scenario where only Thukela Middledrift transfer schemes are considered in addition to the baseline interventions, as shown in Figure 6-5.

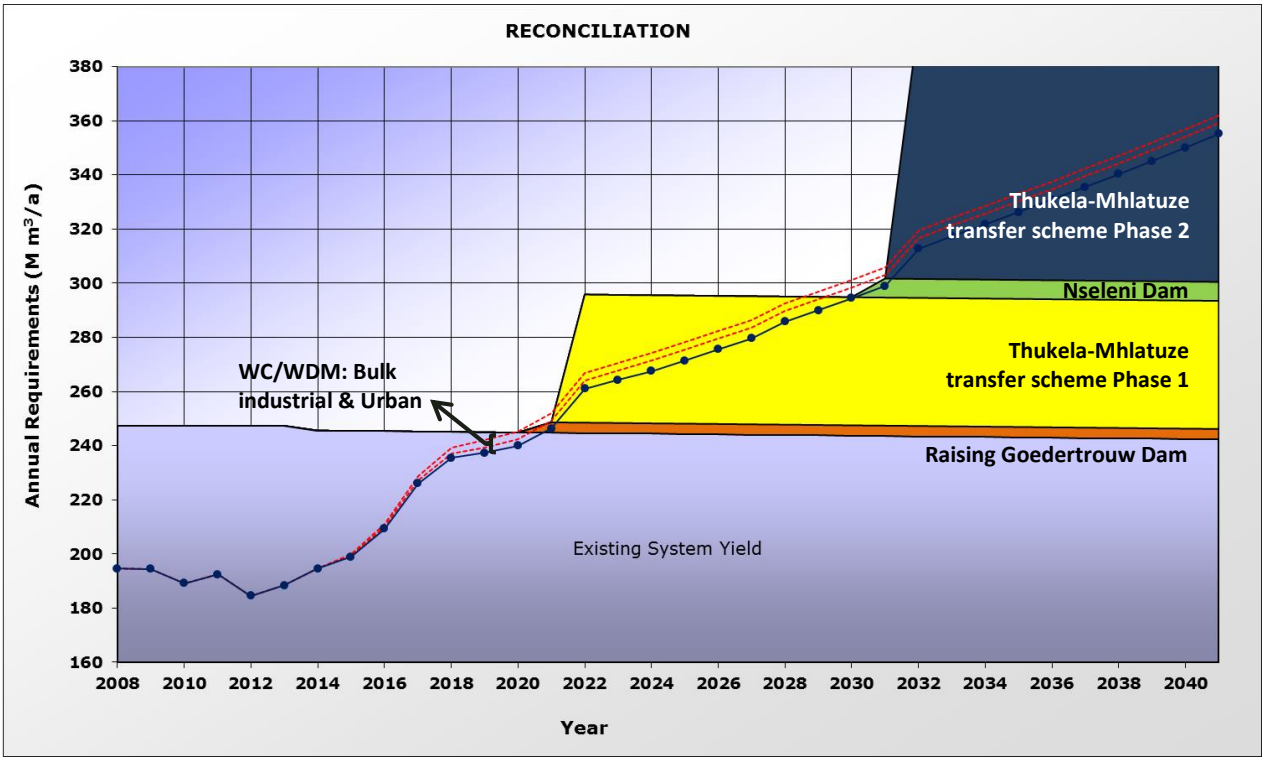

Figure 6-5 | High-growth Water Requirements Scenario – theme Thukela only

6.7 Conclusions

The most important observations and lessons learnt from the scenario assessment are:

b. Scenario planning was done to determine the potential implementation dates of interventions for selected water balance scenarios within the strategy evaluation period, from now up to 2040, to avoid a shortfall in water supply within the Richards Bay WSS.

c. The simulation models were updated for the strategy area to incorporate the potential interventions, and were used to confirm water balance shortfall dates. Interventions are required when the frequency of curtailment in accordance with the assurances of supply for the various user groups exceed acceptable limits.

d. The Planning Model indicated that the next intervention is required by 2020 (should WC/WDM interventions not yet be implemented) for high growth in future water requirements and by 2022 for medium growth in future water requirements. Concern was expressed about the practical implementability of urban water use curtailment for the 1:20 years and 1:4 years risk of failure and it is recommended that the assurance of supply for urban use be revisited.

e. A reconciliation (water balance) planning tool was set up for the Richards Bay WSS and was populated to assist with reconciliation evaluations and graphic presentation of water balance situations.

f. The more favourable interventions or groups of interventions that could potentially be implemented to meet the potential future supply shortfalls for the various future water requirement scenarios was identified, as well as when such interventions should be implemented.

g. Planning for the implementation of bulk water supply infrastructure within the strategy evaluation period (up to 2040) was done to meet future water use estimations / scenarios, and not to future water allocation scenarios.

h. Four small attractive options have been identified that can provide smaller yields to increase the water availability of the region. These so-called *baseline* interventions, which are recommended for all water balance scenarios are:

- *Bulk industrial WC/WDM* initiatives which should continue and be improved.
- *Urban WC/WDM* initiatives should which continue and be improved.
- The *raising of Goedertrouw Dam* seems very promising as can be implemented fairly quickly, apart from being very cost effective. It appears beneficial to a get a feasibility study underway as soon as possible.
- A *new dam on the lower Nseleni River* would be beneficial from a cost perspective. It could further offer operational benefits, but could likely not be implemented quickly. It appears beneficial to a get a feasibility study underway as soon as possible.

i. Should low growth in future water requirements realise in the long-term, the scenario evaluation demonstrates that the shortfall can be met by improved water efficiency.

j. Should medium growth in future water requirements realise in the long-term, scenario evaluation demonstrates that the shortfall can be met by the implementation of one significant bulk water supply scheme, in addition to the baseline interventions, and that there would be medium-term benefit to fast-track the first significant scheme to be implemented.

k. Should high growth in future water requirements realise in the long-term, scenario evaluation demonstrates that several bulk water supply schemes would need to be implemented over the strategy evaluation period, of which the first significant scheme to be implemented would need to be fast-tracked.

l. Three significant available schemes (that would make large quantities of water available) have been identified to meet the future water requirements of the Richards Bay WSS. These are:

- A transfer scheme from an off-channel dam situated close to the Mfolozi River,
- A transfer scheme/s from the Thukela River, either the Thukela Middledrift Phase 1 Scheme or the Lower Thukela 55Mℓ/d Coastal Pipeline, or
- Seawater desalination, which can be appropriately sized and located as well as phased.

All of these significant schemes will have long implementation times, even if it is possible to fast-track their implementation. Although each of these schemes have their respective strong and weak points, it is not yet clear which of these three schemes are preferable. The choice of project needs to be confirmed with higher resolution analysis, such as a pre-feasibility study.

m. The Arboretum Effluent Reuse Scheme is a medium-sized scheme that seems promising and should be compared with the three promising significant schemes. This scheme has already been evaluated at 'feasibility' level, although all the aspects of the full scheme were not addressed. The full scheme should be evaluated and compared with the three significant schemes at pre-feasibility level.

n. There is still significant uncertainty regarding the potential influence of climate change on the WSS. Only the worst possible situation of climate change has been assessed, although climate change

may even have a positive influence on the water balance. An adaptation approach to climate change is recommended until there is more clarity.

o. The reducing capacity of Goedertrouw Dam as a result of siltation has a negative influence on the yield of the WSS.

p. A national perspective on the likely future allocation of water from the Thukela River needs clarification, including the future availability and cost of Thukela River water for transfer to the Mhlatuze River.

7. Stakeholder Engagement and Capacity Building

7.1 Stakeholder engagement

The primary intention of the stakeholder process followed for the development of the Reconciliation Strategy was to create awareness of the project at a broad-based level throughout the RBWSS and potentially affected areas. Specific aims of the stakeholder process were as follows:

- Establish a database of stakeholders with potential interest in the Strategy, and regularly update the database,
- Engage with significant water users to obtain improved information on actual and projected future water use,
- Engage with relevant water management institutions,
- Establish a mechanism for informing stakeholders on progress with the development of the strategy, invite/receive comments on study deliverables or documentation, respond to these and enable stakeholders to contact the project team, and
- Identify potential problems, disputes, or other negative elements emerging from the stakeholder process and escalate these timeously to decision makers, with recommendations on how to address these.

The stakeholder process continued throughout the study, although stakeholder interaction was mainly concentrated around:

⇒ Targeted meetings with staff from water management institutions and significant water users,

⇒ Stakeholder meetings and strategy deliverable workshops held in Richards Bay with key stakeholder representatives,

⇒ Providing contributions to selected Mhlathuze Catchment Management Forum (MCMF) meetings,

⇒ Distribution of draft and final reports by email, inviting comment and contributions,

⇒ Presentation of the Strategy to DWS middle-management staff.

The study team compiled a stakeholder database for the study from existing information, and from input from DWS, UW and CoU staff and other key stakeholders. Distribution of deliverables resulted in inputs and amendments to the database.

Targeted meetings were held with officials from Mondi, RBM, IDZ, and the DWS KZN Regional Office in Durban, Mhlathuze Water and the CoU. Most of the existing and potential future water sources and existing bulk water infrastructure was visited by the study team along with officials. A questionnaire was distributed to the large water users and the study team engaged extensively with significant water users.

The following meetings and workshops were held with the key study stakeholder representatives:

Inception Meeting:	22 Oct 2013
Stakeholder Progress Meeting:	06 Feb 2014
Water Requirements Workshop:	20 May 2014
Stakeholder Progress Meeting:	20 May 2014
Presentation to MCMF Meeting:	21 May 2014
Stakeholder Progress Meeting:	13 Aug 2014
Interventions Workshop:	4 Feb 2015
Scenarios and Strategy Workshop:	27 Jul 2015

The participation at the stakeholder meetings and workshops was regarded as a success because participants were generally satisfied with the level of information provided by the study team. The participants demonstrated a good level of understanding. The existing owners of the RBWSS infrastructure, namely DWS, uMhlathuze Water and the CoU generally demonstrated a good working relationship during the formulation of the Strategy.

Invitations, meeting agendas and/or workshop background information documents were disseminated by email before meetings or workshops to the identified representative stakeholders, although the meeting and workshop organisers were amenable to wider stakeholder attendance. Following the meetings or workshops, minutes and/or presentations were distributed to the stakeholder database.

Draft versions of the following strategy and supporting reports were distributed to key stakeholders by email, inviting comments and contributions, and final reports were disseminated:

- Inception
- Water Requirements
- Water Balance
- Interventions
- Scenarios Evaluation
- Reconciliation Strategy

A reconciliation strategy briefing presentation was made to DWS middle management on 19 October 2015.

7.2 Capacity Building and Training

Identified participants from the DWS KZN regional office, uMhlathuze Water and RBM were trained in the background to and selected aspects of reconciliation strategy development.

The first capacity building and training session was held at the offices of Mhlatuze Water on 19th May 2014, where the following topics were addressed:

- Overview of reconciliation strategies, with examples,
- Focus on the Richards Bay Reconciliation Strategy,
- Water requirements methodology (aligned with the water requirements workshop), and
- Stakeholder participation and the value of the public process.

The second training session was held on 3rd February 2015. The training focussed on the identification and evaluation of interventions, and prepared participants for the Interventions Workshop held the following day.

The third capacity building and training session was held on 27th July 2015 at the offices of Mhlathuze Water. Staff from DWS KZN office, Mhlathuze Water and RBM were trained in the use of the Richards Bay Reconciliation Planning Support Tool, which has been specifically configured for the Richards Bay Water Supply System. This also informed participants on the scenario evaluation proves, and prepared them for the Scenario Evaluation and Strategy Workshop, that was held the following day.

8. Institutional Arrangements for Implementation

8.1 Introduction

Any strategy is as good as its practical implementation. Alignment of the key role-players and continuous monitoring are required to ensure performance and compliance in meeting the objective of the strategy, to reconcile future water supply and requirements. The strategy could only be kept alive by a decision-support framework which would enable timely decisions to be made on water resource interventions. A technical support team would need to monitor water requirements, and the implementation programs for all measures, as well as their effectiveness. This team would also make recommendations on measures to be investigated or implemented as well as the programs for implementation.

The planning scenarios in the strategy rely on certain assumptions and generalisations. In reality, there are often deviations from the adopted planning scenarios. These deviations are often temporary in nature, (i.e. due to weather patterns or major sporting events) and thereafter water use and availability would again follow the long-term predicted trajectories. A deviation can also be a longer-term change such as a change in water-user behaviour, adaptation to climate change, the introduction of cheaper new technologies, new knowledge or increased confidence in certain types of technologies.

In order to maintain the strategy, keep it relevant and adapt it in response to changing external factors, regular revision and adequate financing will be necessary. A number of institutions are involved in the planning and operation of the system. These institutions should take part in the strategy revisiting process, should be consulted and should take the responsibility to steer the strategy implementation in the right direction. The establishment of appropriate implementation committees would facilitate this.

The co-operation of all the institutions responsible for the entire water supply chain is essential to achieve the intended objectives. The creation of an environment where partnerships can be formed to tackle specific recommended actions should be encouraged.

8.2 Strategy Steering Committee

8.2.1 Constitution and Functions

It is recommended that a Richards Bay Strategy Steering Committee (SSC) be established. Organisations to be represented on the SSC would need to be identified and would be invited to nominate representatives on the SSC. Meetings should be held on a six-monthly basis.

The SSC would have as its main functions and objectives:

a. To ensure that the strategy remains relevant and is regularly updated,

b. To monitor and co-ordinate the implementation of the relevant actions identified in the strategy, and

c. To make recommendations on long-term planning activities required to ensure reconciliation of requirements and supply in the RBWSS area (e.g. recommending a feasibility study for a particular intervention to ensure its timely implementation).

The suggested functions of the SSC are the following:

i. Obtain agreement on implications of altering the assurances of supply to different sectors,
ii. Monitor how closely the relevant WC/WDM targets and objectives are met,
iii. Be informed or request updates on changes in system yield,
iv. Provide updates on the strategy as required,
v. Liaise with departments involved in developing provincial strategies and provide agreed input,
vi. Provide annual updates to all local authorities on the strategy,
vii. Brief relevant municipalities on imminent decisions,
viii. Inform politicians of press releases prior to release,
ix. Provide and update information for Richards Bay and DWS websites,
x. Liaise with the relevant Richards Bay/Mhlatuze or other Committees as appropriate,
xi. Make recommendations on activities required to ensure long-term reconciliation of requirements and supply,
xii. Review and revise the Reconciliation Strategy and ensure monitoring and co-ordination of implementation.

8.2.2 Representation

It is proposed that the institutions/agencies as shown in Table 8-1 be invited to be represented on the SSC. It is likely that representation will fairly quickly be sorted out, but it is important that stakeholder organisations feel that they have been given a fair chance to be represented.

Table 8-1 | Proposed representation on the Strategy Steering Committee

Organisation type	Organisation	No of representatives
Local Government	City of uMhlatuze	2
(5 representatives)	uThungulu District Municipality	1
	uMkhanyakhude District Municipality	1
	SALGA	1
Water Board (2 representatives)	Mhlatuze Water	2
Department of Water and Sanitation	KZN Regional Office	2
(7 representatives)	Integrated Water Resource Planning: • National Water Resource Planning • Options Analysis • Water Resource Planning Systems • Water Use Efficiency	4
	Water Resource Infrastructure Branch	1
Catchment Management Agency (CMA) (1 representative)	Pongola Umzimkulu CMA	1
Irrigation / WUAs	Tongaat-Hulett Sugar	1
(3 representatives)	Irrigation/WUA representatives	2
Business (1 representative)	Richards Bay Business Chamber	1
KwaZulu-Natal Provincial Government	Department of Co-operative Governance and Traditional Affairs	1

Organisation type	Organisation	No of representatives
(4 representatives)	Department of Agriculture and Rural Development	1
	Ezemvelo KZN Wildlife	1
	Department of Economic Development, Tourism and Environmental Affairs	1
Industry, Mining and Manufacturing (7 representatives)	Richards Bay IDZ, Mondi, RBM, Tronox, Foskor, BHP Billiton, ZCCI/RBCT	1 each
Civil society (1 representative)	NGOs	1
Rural communities under traditional authorities (1 representative)	To be determined	1

8.3 Administrative and Technical Support Group

It is further recommended that an Administrative and Technical Support Group (ATSG) be constituted, to provide administrative and technical support to the SSC.

8.3.1 Constitution and Functions

Representation on the ATSG should be confirmed at the first SSC Meeting. The ATSG will be responsible for general administrative and technical support and will arrange SSC meetings. They would be responsible for updating the planning scenarios. These updates should include all new information relating to revised yields, water requirements and the benefits of WC/WDM interventions implemented by organisations. They would further assist with the drafting of press releases and newsletters and any technical tasks required by the SSC.

Some suggested functions of the ATSG are the following:

a. Obtain agreement on implications of altering assurance of supply to different sectors,
b. Communicate climate change research priorities to the Water Research Commission and other research institutions,
c. Understand how water allocated to the agricultural sector is used and how the corresponding assurances of supply are implemented,
d. Review and update requirement scenarios based on findings of further studies (including climate change),
e. Update water requirement scenarios, and define and update monitoring indicators and thresholds of acceptable change to prompt review of projections,
f. Compare recently recorded requirements with scenarios to guide the choice of scenarios for planning,
g. Decide on comparison scenario/s to be used for planning of future interventions: low, medium and high,
h. Investigate the flexibility of the system in terms of changes in usage patterns and the ability to restrict water use,
i. Interpret and clarify the way the system is operated in terms of assurance of supply for long-term planning,
j. Ensure that the way in which the requirements and availability are compared is user friendly and easy to understand,
k. Participate in the development of relevant catchment management strategies,
l. Participate in classification processes that may impact on the RBWSS,

m. Promote and provide input into the prioritisation of invasive alien plants clearing programmes,
n. Participate in the planning for implementation of ecological Reserves,
o. Compile appropriate press releases,
p. Ensure that relevant contact details are provided on information that is disseminated,
q. Set up and keep updated a list of relevant media contacts,
r. Ensure the utilisation of an efficient system to distribute information,
s. Set up a system for efficient distribution of common information,
t. Brief relevant municipalities on imminent decisions,
u. Provide annual strategy updates to local/district authorities,
v. Liaise with departments involved in developing provincial strategies and provide agreed strategy steering committee input,
w. Provide updates of the strategy as required,
x. Provide and update information for DWS and other relevant websites,
y. Advise on the development of monitoring and information regulations under the National Water Act,
z. Support the information management actions identified to support the reconciliation strategy for the RBWSS,
aa. Facilitate the identification and gathering of data and information from other government agencies and sectors which influence the RBWSS.

8.3.2 Representation

The institutions/agencies that are proposed to be represented on the ATSG are as follows:

Table 8-2 | Proposed institutions/agencies to be represented on the ATSG

Organisation type	Organisation	No of representatives
Local and Regional Authorities	City of uMhlatuze	2
(6 representatives)	Mhlatuze Water	2
	uThungulu District Municipality	1
Department of Water and Sanitation	KZN Regional Office	3
(8 representatives)	Integrated Water Resource Planning: • National Water Resource Planning • Options Analysis • Water Resource Planning Systems • Water Use Efficiency	4
	Water Resource Infrastructure Branch	1
Agriculture and WUAs	Tongaat-Hulett Sugar	1
(2 representatives)	Irrigation Boards/WUAs representative	1
Bulk Industries	Richards Bay IDZ	1
(7 representatives)	Mondi	1
	RBM	1
	Tronox	1
	Foskor	1
	BHP Billiton	1
	ZCCI/RBCT	1

9. Recommendations

Based on the findings of the study, the following recommendations are put forward to ensure on-going reconciliation of water supply and requirement within the RBWSS.

9.1 Institutional

A **Strategy Steering Committee**, supported by an **Administrative and Technical Support Group**, should be formed as soon as possible in order to make recommendations, on an annual basis, on long-term planning activities required to ensure continued reconciliation of water requirements and available supply in the RBWSS area. Particularly important are:

- The monitoring of water supplies and requirements including the annual updating of the likely future requirements,
- Ensuring that studies of interventions are undertaken in sufficient time to enable the responsible authorities to take the necessary actions to timeously implement the identified interventions to meet the growth in the future water requirements,
- Annually updating the Strategy,
- The issuing of an annual newsletter to keep the public informed.

9.2 Interventions

The long implementation times required for the implementation of new water schemes, the potential available yields, and the extent of the additional infrastructure that would be required make it impractical to implement only a single solution. A suite of interventions is therefore recommended to ensure that the growing water requirements of the RBWSS can be met in the long term.

The Reconciliation Strategy recommends the implementation of the following interventions:

- **Urban WC/WDM,** comprising a range of measures and the continuation of existing initiatives,
- **Bulk industrial WC/WDM**, comprising the continuation of existing initiatives essentially aimed at the significant industrial water users, but also at other industrial water users,
- **Raising of Goedertrouw Dam** by 2.8m, following confirmation by feasibility evaluation.

The Reconciliation Strategy recommends that the following studies be undertaken **as a priority**:

- A catchment and development **Mfolozi River study**, that involves the updating of the Mfolozi catchment hydrology, assessment of water requirements, system modelling, identification of catchment development needs and options, evaluation of development scenarios, identification of recommended development options and feasibility studies of selected development options. This

should include a pre-feasibility level evaluation for the inter-basin transfer scheme options to the Mhlatuze WSS, before proceeding to feasibility level evaluation.

- A **Comparison Pre-feasibility Study**, to *inter-alia* compare the following development options, and to select one or more augmentation schemes to evaluate further at feasibility level:
    a) Increased capacity of the Thukela-Mhlathuze Transfer Scheme at Middledrift and potential phasing thereof,
    b) Coastal transfer pipeline from the lower Thukela River at Mandini,
    c) The preferred Mfolozi River transfer scheme,
    d) A dam on the Nseleni River,
    e) Use of treated effluent from the Arboretum macerator site, and
    f) Seawater desalination.

  Under the Pre-feasibility Study, also consider the current ***availability of Thukela River water*** and the water available for later transfer phases, considering existing and planned developments for transfer to the Vaal River System, the frequency of Thukela water being transferred to the Vaal System, as well as other water requirements from the Thukela River.

- **Feasibility Study/ies of selected options**. This could potentially be investigated by different organisations.

It is further recommended that studies of the following interventions or combinations thereof should be initiated, or that policies with regard to these should be developed or that specific actions should be implemented:

a) Rainwater harvesting to augment municipal supplies for outdoor and indoor non-potable domestic uses,
b) Determination of groundwater contributions to lake yields at an acceptable confidence, and revising of the operating rules of abstraction to ensure a sustainable supply from the three coastal lakes of the WSS, Lakes Mzingazi, Cubhu and Nhlabane,
c) Removal of invasive alien plants, especially in the catchments above dams in the WSS,
d) An investigation of the reduction of illegal/commercial afforestation in the immediate vicinity of the coastal lakes and the implementation of practical measures to curb illegal afforestation,
e) Encouraging the responsible development of groundwater for local use.

Detailed descriptions of all the interventions are provided in the *Screening of Options Report* of this study.

10. Implementation Plan

The Strategy Implementation Plan identifies the actions to be taken, the responsible authorities and the timing, in support of the implementation of the reconciliation strategy.

Action items have been identified under the following categories:

- Implementation of the Reconciliation Strategy,
- Operational Improvements,
- Land Care,
- Water Conservation and Water Demand Management,
- Thukela River Transfer Schemes,
- Mfolozi River Transfer Scheme,
- Raising Goedertrouw Dam,
- Nseleni Dam,
- Groundwater,
- Use of Treated Effluent,
- Seawater Desalination.

For some actions, responsibilities would still need to be assigned at the appropriate time.

In terms of the timing of implementation items, the plan distinguishes between essential actions, very high, high or medium priorities.

Table 10-1 | Strategy Implementation Plan

	Action	Responsibility	Timing
1.	**IMPLEMENTATION OF THE RECONCILIATION STRATEGY**		
1.1	Establish a Richards Bay Water Supply System (RBWSS) Strategy Steering Committee to make recommendations, on an annual basis, on long term planning activities required to ensure reconciliation of requirement and available supply in the RBWSS area.	DWS: D: NWRP	Upon commencement of continuation study Priority: Essential
1.2	The RBWSS Strategy Steering Committee must ensure that the following monitoring is undertaken to ensure the reconciliation of supply and requirement over the longer term: a. The success of the WC/WDM interventions implemented. This is of particular importance as the volume and implementation date of anticipated water-saving interventions have a significant impact on future supply intervention study start and scheme implementation dates. b. Actual water use (agricultural, industrial and urban). c. Population growth and economic growth rate figures in order to be able to develop a better understanding of future water requirements. d. Hydrological and geo-hydrological monitoring. e. Water quality monitoring. f. Reconciliation of water requirements and available supply in the RBWSS area.	RBWSS Strategy Steering Committee	Upon commencement of continuation study; continuation study will support the SSC Priority: Essential
1.3	Establish a RBWSS Administrative and Technical Support Group to give support to the Strategy Steering Committee, and implement the decisions of the Strategy Steering Committee.	DWS: D: NWRP SSC	Part of continuation study Priority: Essential
1.4	The Scenario Planning process should be updated on a regular basis to cater for: a. Revised future water requirement projections. b. Updated information on the implementation of the ecological Reserve and the potential for climate change impacts. c. Updated information from recently completed studies (reconnaissance level, pre-feasibility level and feasibility level) for WC/WDM and supply-side interventions to feed into the scenario planning process. d. Any other changes to the input data. e. Revision of the CoU WC/WDM strategy and initiatives. f. Revision of bulk water users' WC/WDM strategies and initiatives.	Administrative and Technical Support Group	Part of continuation study Priority: Essential

	Action	Responsibility	Timing
1.5	Communication: The Strategy Steering Committee should continue with effective communication to stakeholders after the study is completed and should: a. Distribute at least one newsletter or news release per year to stakeholders. b. Regularly report on progress on the implementation of the strategy as well as strategy initiatives and updates, at the Mhlatuze Catchment Management Forum and other relevant stakeholder platforms.	Administrative and Technical Support Group	Part of continuation study Priority: Essential

	Action	Responsibility	Timing
2.	**OPERATIONAL IMPROVEMENTS**		
2.1	Determine the sustainable yields of coastal lakes of the WSS (especially groundwater contributions), and revisit the operational practice of the coastal lakes to focus on maximising the yield of the RBWSS, instead of the current operational approach of limiting costs. This may potentially reduce the overall requirements from and reliance on the lakes. This includes: • Undertaking measurements of the impedance of the sediment layers in the coastal lakes. • Undertake a study to determine the sustainable yields of the lakes in the Mhlathuze WSS, including the interaction between surface water and groundwater. It is suggested that a detailed study be conducted on at least one of the coastal lakes (Lake Mzingazi) rather than limited studies on all of them. • The approach followed in the revisiting of the yield of Lake Nhlabane by RBM should be reviewed. • Once improved information is available, update the sustainable lake yields. • Implement a practical operating rule for especially Lake Cubhu (but also for other lakes of the Mhlatuze WSS as necessary) to ensure conjunctive use at a sustainable rate from the lakes such that the lakes are operated at an acceptable assurance of supply. The strategy continuation study must provide a focused scope of work. Once updated lake yields have been established, the Reserve requirements for the coastal lakes should be revisited. Take into consideration relevant aspects of the Situation Assessment Report and Lake Zonation and Management Plan for Lake Mzingazi produced by the CoU in 2014.	DWS: D: NWRP	Part of continuation study Priority: Very high
2.2	RBM could consider the artificial recharge of Lake Nhlabane from the Mfolozi River to replace lost lake yield as a medium-term intervention, potentially through a natural filtering system. Both water and environmental licensing should be considered. Reconstruction of the Sokhulu Reservoir is planned for storage of water pumped from the Mfolozi River.	RBM	RBM decision. Sokhulu by ~2019
2.3	Establish additional reliable flow monitoring between the Goedertrouw Dam and Mhlathuze Water's weir. The aim of this is to determine the contribution of the Mfule River; perhaps a weir on the Mfule River could be considered. This should be considered under the DWS hydromet optimisation study.	DWS: Hydrological Information Services	ASAP Priority: High
2.4	Ensure compliance with the ecological water requirements of the approved preliminary Reserve for the Mhlatuze River.	DWS, MW	Ongoing
2.5	Continue with the adaptation approach to climate change and continue monitoring. Consider undertaking an improved climate change, vulnerability and risk assessment for the strategy area once the CORDEX models are freely available and probability estimates of future climate scenarios have been approved.	DWS, MW	Longer-term Priority: Medium

	Action	Responsibility	Timing
3.	**LAND CARE**		
3.1	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.	MW implements clearing programmes DWS, CoU, KZN EDTEA (WfW), SANBI, all stakeholders	Ongoing Priority: High
3.2	Investigate the reduction of illegal/commercial afforestation in the immediate vicinity of the coastal lakes and implement practical measures to curb illegal afforestation.	DWS (SFRA and unlawful water use), uThungulu Coastal Working Group	Part of continuation study Priority: High

	Action	Responsibility	Timing
4.	**WATER CONSERVATION AND WATER DEMAND MANAGEMENT**		
4.1	Industries (inclusive of manufacturers, mines and industries) should continue to implementing their WC/WDM Action Plans, and continuously consider and implement further water efficiency initiatives. Continue to ensure that optimum operational efficiency is maintained. Smaller industries might have more capacity to reduce water use.	All industries	Ongoing. Report-back on progress at least annually Priority: High
4.2	Local and District municipalities should continue improving and implementing their WC/WDM Action Plans: • The savings that can be achieved through the various actions of their WC/WDM Strategies should be quantified and regularly reported on. • Identify WC/WDM interventions that will limit UAW to less than 15% of total water use. • Prioritise the interventions in the WC/WDM Action Plans to obtain the maximum benefit and provide appropriate annual budgets to effectively execute interventions.	Local and district municipalities	Ongoing. Report-back on progress at least annually Priority: High
4.3	Appoint appropriate and technically qualified staff/professional service providers to expedite implementation of the CoU's existing WC/WDM Action Plan. The State should dedicate additional resources to assist the CoU, their existing consultants and their contractors to expedite those components of the WC/WDM Action Plan that will provide the most significant savings in as short a time frame as possible. It is essential that DWS support the CoU with the implementation of their WC/WDM Plan.	DWS:KZNRO Water Use Efficiency and CoU	Ongoing Priority: High
4.4	Prepare a draft policy in support of WC/WDM bylaws, which should inter-alia address penalties for excessive water use, promotion of rain water tanks for especially new houses and buildings and the use of private boreholes etc.	Municipalities	Part of continuation study Priority: Medium
4.5	Ensure that an appropriate and effective water tariff structure is in place and is maintained.	Municipalities	2016 and annually thereafter Priority: High
4.6	Reinstate the billing of irrigators for actual water use.	DWS: NWRI	ASAP Priority: High
4.7	Encourage stormwater harvesting at local scale.	Municipalities	Ongoing Priority: Medium
4.8	Develop a rainwater harvesting policy and promote the use of rainwater tanks, especially for new developments, to stimulate changes in people's water-use habits.	CoU assisted by DWS: KZNRO: Water Use Efficiency	Ongoing Priority: Medium-Low

	Action	Responsibility	Timing
5.	**THUKELA RIVER TRANSFER SCHEMES**		
5.1	Initiate a Comparison pre-feasibility study, to *inter-alia* compare the following Thukela transfer options with other options: • Increased capacity of the Thukela-Mhlathuze Transfer Scheme at Middledrift and potential phasing thereof. • Coastal transfer pipeline from the lower Thukela River at Mandini.	DWS: D: OA	ASAP Priority: Very high
5.2	Under the pre-feasibility study, consider the current availability of Thukela River water and the water available for later transfer phases, considering existing and planned developments for transfer to the Vaal River System, the frequency of Thukela water being transferred to the Vaal System, as well as other water demands from the Thukela River.	DWS: D: OA	
5.3	Under the pre-feasibility study, for the Thukela-MhlatuzeTransfer Scheme at Middledrift: • Evaluate the possibility that the existing licence for abstraction from the Thukela River at Fairbreeze could be transferred to the Middledrift site if needed, which would expedite the implementation process should it be a preferred option. • Verify the assumptions, on which the scheme is based, potential phasing of the transfer scheme and pipeline and tunnel routes, along with other considerations such as environmental and social impacts. • Consider the potential cost implications of future water available for transfer, taking the potential development of dams in the Thukela River into account. • Evaluate how to separate local existing and planned future rural infrastructure from the transfer scheme.	DWS: D: OA	
5.4	Under the pre-feasibility study, for the 55Mℓ/d coastal pipeline transfer pipeline from the lower Thukela River at Mandini: • Revisit the decision to not consider the 110Mℓ/d transfer scheme further at this time and under what conditions it should be reconsidered. • Verify the assumptions on which the scheme is based, bulk infrastructure components and requirements, the pipeline route and offtakes, the location and duties of pump stations, along with other considerations such as environmental and social impacts. These may include the feasibility of exchanging use of the Tronox pipeline for water transferred from the Thukela, as well as the division of costs amongst the concerned parties, and factors such as the suitability of the Fairbreeze pipeline for reverse flows. • Other aspects to be further explored include the relative merits of transferring treated and raw water and the distribution and growth of the future requirements in the rural communities between the Thukela and Mhlatuze rivers. • The division of costs would need to be thoroughly investigated and discussed amongst the various stakeholders, including the Umgeni and Mhlathuze Water Boards and DWS who might contribute a portion of the capital cost, and users such as Tronox.	DWS: D: OA	

	Action	Responsibility	Timing
	• Should water be transferred to the Mhlatuze River, impacts relating to the inter-basin transfer of water would need to be investigated.		
5.5	Depending on the findings of the pre-feasibility study, initiate a feasibility study of the preferred Thukela River Inter-basin Transfer Scheme.	DWS: D: OA	Following completion of the pre-feasibility study
5.6	Should this scheme compare favourably with the Mfolozi Transfer Scheme and Desalination of Sea Water, consider the fast-tracking of the implementation of this scheme.	To be determined	Following completion of an Implementation Ready Report

	Action	Responsibility	Timing
6.	**MFOLOZI RIVER TRANSFER SCHEME**		
6.1	Initiate an Mfolozi River catchment and development study that involves the updating of the catchment hydrology, assessment of water requirements, system modelling, identification of catchment development needs and options, evaluation of development scenarios (including a pre-feasibility level evaluation for the inter-basin transfer scheme options to the Mhlatuze WSS), and identification of recommended development options and feasibility studies of selected development options. As part of the Mfolozi River Inter-basin Transfer Schemes pre-feasibility evaluation, take the following into consideration: • Consider supply to the Mhlatuze WSS as well as the Mtubatuba WSS and surrounds. • Consider the desirability of locating a new WTW at Mtubatuba, along with the development of the scheme, due to the limited capacity of the existing WTW at Mtubatuba, vs. treatment at the Nsezi WTW. • Consider the Kwesibomvu in-channel dam, identified off-channel dam site and other potential off-channel dam sites that could also be considered for future phases of such a scheme. • Confirm the components and layout of the preferred transfer scheme, and potential future phasing. • Verify the assumptions on which the identified scheme is based, its bulk infrastructure components and requirements, environmental flows and sedimentation aspects, the Mfolozi River abstraction site and associated infrastructure, off channel dam, pipeline routes and offtakes, the location and duties of pump stations, along with other considerations such as environmental and social impacts, and cost the scheme.	DWS: D: NWRP DWS: D: OA	ASAP Priority: Very high
6.2	Should this scheme compare favourably with the Thukela Transfer Scheme Phase 1 and Desalination of Sea Water, fast track the implementation of this scheme. Current sentiment is that this potential scheme has the highest priority of the large bulk augmentation schemes identified.	To be determined	Following completion of an Implementation Ready Report

	Action	Responsibility	Timing
7.	**RAISING GOEDERTROUW DAM**		
7.1	Initiate a full feasibility study to evaluate the Raising of Goedertrouw Dam.	DWS: D: OA	ASAP Priority: Medium
7.2	Implement this scheme as soon as possible should it still seem as favourable.	DWS	Following completion of an Implementation Ready Report

	Action	Responsibility	Timing
8.	**NSELENI DAM**		
8.1	Evaluate a dam on the Nseleni River at feasibility level: • As a first phase, verify the selection of the dam site. • It may be necessary to evaluate a refined EWR for the Nseleni tributary. • Potential operational benefits need to be carefully quantified. • Undertake an EIA should the decision be taken for the scheme to proceed.	MW, DWS: OA	ASAP Priority: Medium
8.2	Implement this option should it still seem as favourable.	Potentially users of this water	Following completion of an Implementation Ready Report

	Action	Responsibility	Timing
9.	**GROUNDWATER**		
9.1	Encourage the responsible development of groundwater for local use. The availability and water quality of boreholes in this area is not particularly good.	CoU, Uthungulu DM, DWS KZNRO, industries	Ongoing Priority: Medium

	Action	Responsibility	Timing
10.	**USE OF TREATED EFFLUENT**		
10.1	Initiate a Comparison pre-feasibility study to inter-alia evaluate the use of effluent from the Arboretum macerator site. 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. 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.	CoU	ASAP Priority: Very high
10.2	Undertake a feasibility study for the use of effluent from the Arboretum macerator site should the scheme seem favourable. • Undertake an EIA should the decision be taken for the scheme to proceed.	CoU	Following completion of the pre-feasibility study

	Action	Responsibility	Timing
11.	**SEAWATER DESALINATION**		
11.1	Initiate a pre-feasibility study, to evaluate the desalination of seawater: • Revisit the site location and identify a preferred desalination site in close cooperation with key stakeholders. • Take into account potential synergy with the existing sea outfall pipelines and potential effluent reuse at the Arboretum macerator site. • Confirm the components and layout of the preferred desalination scheme, and potential future phasing. • Evaluate intake/outfall requirements, storage, pre/post treatment, desalination plant and associated bulk infrastructure components, pipelines and offtakes, the location and duties of pump stations, along with other considerations such as environmental and social impacts, and cost the scheme. • Carefully consider the operational integration of the scheme within the existing Richards Bay WSS and future operating approach. • Consider the institutional requirements and implications regarding the operation and maintenance of specialist desalination plant equipment. • Consider funding models for the scheme.	To be established	Upon approval of the strategy Priority: very high
11.2	Consider implementing seawater quality monitoring for at least two years to provide baseline data for plant process design. • Agree on the parameters to be measured (water currents, organic content, temperature, turbidity, dissolved oxygen, pH, conductivity and salinity etc.) and an implementer. • Install an appropriate monitoring instrument such as a buoy or probe.	To be established	Asap once a preferred desalination site has been determined Priority: High
11.3	Depending on the findings of the pre-feasibility study, initiate a feasibility study of the preferred Seawater Desalination Scheme. • Evaluate the climate change independence of seawater desalination and quantify the relative economic benefit compared to other bulk water schemes, also taking emerging desalination technologies that can save energy into account.	To be determined	Following completion of the pre-feasibility study and availability of seawater baseline monitoring data

11. References

No	Reference	Review notes
1.	**Client**: DWS **Date:** June 2011 **Document Title:** Development of a Reconciliation Strategy for All Towns in the Eastern Region: First Order Reconciliation Strategy for the Richards Bay WSSA **Author:** Water for Africa	**Document content** This report documents the findings of the water situation assessment for the Richards Bay and the surrounding areas that are supplied from the Mhlatuze River, and proposes a Reconciliation Strategy. It formed part of a suite of reports that were produced for towns falling outside metropolitan municipal areas. **Relevance to the Study** While the evaluation has limitations because it addressed only some water requirements and at a fairly simplistic level, it provides the study with very useful background information.
2.	**Client**: DWA **Date:** Nov 2009 **Document Title:** Mhlathuze Water Availability Assessment Study **Author:** WRP	**Document content** This is a set of seven reports. This study focuses on a technical water resource analysis of the Mhlatuze, Amatikulu and Mlalazi river basins. It addresses Rainfall Data Analysis, Water Use, Water Requirements and Return Flows, Hydrology Assessment (including Groundwater and Water Quality), Monitoring Assessment, Modelling Approach and Procedures for Water Availability Assessment Studies and Systems Analysis. **Relevance to the Study** These are probably the most relevant reports for the study. The Water Resources Yield Model and Water Resources Planning model descriptions will further prove particularly useful.
3.	**Client**: Mhlathuze Water **Date:** Jun 2010 **Report:** Integrated Water Services Master Planning – Final Planning Report, City of uMhlathuze **Author:** Bigen Africa	**Document content** This is a fairly standard WSMP. It provides a general overview of mainly the uMhlathuze Municipality supply area and relevant statistics, elaborates on water sources, spatial planning and water demands. It further addresses Master Planning Scenarios and presents the Master Plan. **Relevance to the Study** The report is a source of information on water sources, use, demographics and water use. It further provides information on water supply schemes envisaged by Mhlathuze Water.

No	Reference	Review notes
4.	**Client**: DWA **Date:** Nov 2009 **Document Title:** Water Reconciliation Strategy for the KwaZulu-Natal Coastal Metropolitan Areas **Author:** WRP *et al*	**Document content** This is the Water Supply Reconciliation Strategy that was developed during the Water Reconciliation Strategy Study for the KwaZulu Natal Coastal Metropolitan Areas, which consists of the area from Pietermaritzburg to Durban from west to east and from Kwadukuza (Stanger) in the north to Amanzimtoti in the south. It includes the eThekwini Metropolitan and the Msunduzi and Ilembe Municipalities. The main bulk water resources comprises the Mgeni, Mdloti, and Mvoti river systems with support by a transfer scheme sourcing water from the Mooi River. **Relevance to the Study** This provides an example of the only Reconciliation Strategy Study in KwaZulu-Natal which had previously been undertaken for a metropolitan area.
5.	**Client**: City of Mhlathuze **Date:** 2012 **Document Title:** uMhlathuze IDP 2012-2017 + 2013/14 Review **Author:** City of uMhlathuze	**Document content** The 2012 IDP, as well as the updated IDP provides background, an approach and projects for development over the 5-year period from 2012. **Relevance to the Study** The IDPs provides background information, information on growth and development, spatial planning information and information on a variety of municipal project being planned, some also in relation to initiatives of bulk industrial users.
6.	**Client**: Mhlathuze Water **Date:** 2013 **Document Title:** Mhlathuze Water – historical data 2008-2013 **Author:** Mhlathuze Water	**Document content** This is an Excel spreadsheet containing historical water use information of Mhlathuze Water's customers. **Relevance to the Study** Extremely relevant for especially the Water Requirements Task.
7.	**Client**: City of uMhlathuze **Date:** 2013 **Document Title:** 5-Year Strategic Management Plan for the Reduction of Non-Revenue Water in the City of uMhlathuze **Author:** City of uMhlathuze	**Document content** This is a strategic Non-Revenue Water Reduction Master Plan that covered a 5-year outlook in terms of minimizing water losses through the Municipality's area of supply. This Master Plan is concerned with volumes only – revenue collection and debt analysis did not form part of the scope of this appointment. The study determined the baseline situation, identified areas of possible NRW reduction, prepared a consolidated NRW Reduction Intervention programme, establish targets in terms of NRW by volume, addressed internal NRW reduction programme requirements and identified problems and corrective actions for the Municipality's billing database. The evaluation covered Richards Bay, Empangeni, Esikhaleni and Ngwelezane. **Relevance to the Study** This report will be very important for the evaluation of potential WC/WDM interventions in the strategy area, as it seems to have addressed WC/WDM quite comprehensively.
8.	**Client**: RBIDZ **Date:** 2012 **Document Title:** Preliminary Design Report on Provision of Civil Engineering Services for Development of Phase 1a **Author:** Ilifa Africa Engineers	**Document content** Concept design and the relevant design criteria in conformance with the requirements of the Richards Bay Industrial Development Zone and the Local Authority. This reflects the scope of work required for the installation of the civil engineering services to this development. **Relevance to the Study** Provides information related to potential future industrial expansion, the location thereof and the potential extent of development and possible additional future industrial water requirements.

No	Reference	Review notes
	Client: RBIDZ **Date:** July 2013 **Document Title:** Preliminary Design Report – IDZ, Alton North Phase 1F **Author:** Endecon Ubuntu **Client**: RBIDZ **Date:** October 2013 **Document Title:** Richards Bay IDZ 50-year Integrated Master Plan, Engineering Services Report: Phase 2 **Author:** SMEC	**Document content** This preliminary design report addresses the civil engineering services required for the development. **Relevance to the Study** Provides information related to potential future industrial expansion, the location thereof and the potential extent of development and possible additional future industrial water requirements. **Document content** This Master Plan analysis involved a Zone Options Analysis that entailed the investigation of existing municipal infrastructure available for Industrial development for 10 identified zones within the confines of uMhlathuze and Mbonambi Municipality, as well as preliminary costing of the required bulk and internal infrastructure for each site. A conclusion was then made on the findings in the report, as well as recommendations on the most preferable sites for development from an engineering perspective, in terms of the services required. investigated: **Relevance to the Study** Provides information related to potential future industrial expansion, the location thereof and the potential extent of development and possible additional future industrial water requirements.**to the Consultancy**
9.	**Client**: City of uMhlathuze **Date:** 2014 **Document Title:** WSSA abstraction and treatment volumes for Mzingazi, Esikhaleni and Ngwelezane TW **Author:** WSSA	**Document content** These are 3 working spreadsheets received from WSSA containing information related to the WTWs they are managing for the municipality. These are: • Abstraction and treatment volumes • Monthly performance Report for Water and Sewage Treatment Works • Rainfall 2008-2013 **Relevance to the Study** Information related to the treatment of water at municipal WTWs and WWTWs. This will be used for the Water Requirements Task as well as for the Interventions Task.
10.	**Client**: DWAF **Date:** Mar 2004 **Document Title:** Internal Strategic Perspective: Usutu to Mhlathuze WMA **Author:** Tlou & Matji	**Document content** The report provides the DWS' perspective on water management in the Usutu To Mhlathuze Water Management Area in 2004. **Relevance to the Study** This report is now quite old but contains some background information that could still be useful.
11.	**Client**: DWAF **Date:** Sep 2003 **Document Title:** Usutu to Mhlatuze WMA: Overview of Water Resources Availability and Utilisation **Author:** BKS	**Document content** This report is one of a series of similar reports covering all 19 water management areas in the country, and results directly from work performed in preparation of the First Edition National Water Resource Strategy. It provides an overview of the 2003 and expected future water resources situation in the Usutu to Mhlatuze WMA, highlights the key issues of relevance and provide broad strategies with regards to the management of water resources in the WMA. **Relevance to the Study** This report is focussed on a much larger area than the strategy area, is getting outdated and is of limited value.

No	Reference	Review notes
12.	**Client**: DWAF **Date:** Jan 2003 **Document Title:** Mhlathuze Catchment: Ecological Reserve and Monitoring Programme **Author:** IWR Environmental	**Document content** During the 2002 Mhlathuze Monitoring study, additional Reserves were undertaken in the rest of the catchment and a detailed monitoring programme was designed. This report focusses on the design of the monitoring programme. The monitoring programme was addressed for the following parts of the catchment: • Rivers: Mhlatuze River, Nseleni River, Mfule River (9 IFR sites). • Lakes: Cubhu, Mzingazi, Nhlabane, Mangeza and Nsezi Lakes. • Estuaries: Mhlathuze, Nhlabane. **Relevance to the Study** This will be a very useful report for the Environmental Considerations Task to be undertaken, which is an evaluation of the gaps in the available information and the need for determination of the environmental flow requirements and the classification of the water resource.
13.	**Client**: Uthungulu DM **Date:** 2009 **Document Title:** Uthungulu District Municipality WSDP **Author:** Aurecon	**Document content** This report documents the review of the WSDP. An annual review of the WSDP must be carried out and is essentially an assessment of the progress made by the Municipality in attaining the goals and priorities set out by its existing water service development policies. The deliverables in accordance with the Terms of Reference for this review include: • Update the town master plans for KwaMbonambi, Buchanana, Mtunzini, Eshowe, Nkandla, Gingindlovu and Melmoth • Update the borehole development plan • Determine the district municipality's progress according to the master plan rollout • Compile the municipality's capital budget for completion of the remaining master planning • Update the WSDP document **Relevance to the Study** The report contains information related to current water use and potential further development of water supply from the City of uMhlathuze for water users located outside the City of uMhlathuze municipal area, but within the uThungulu DM area
14.	**Client**: DWA **Date:** Dec 2007 **Document Title:** Water Allocation Plan to Guide Compulsory Licensing in the Mhlathuze Catchment - Opportunities Report **Author:** Iliso Consulting *et al*	**Document content** The purpose of this section of the water use opportunities is to investigate the marketing opportunities for the HDI group in terms of Irrigation, Commercial Forestry, Mining and Industry. As far as irrigation is concerned a number of crops that are at present cultivated were investigated in terms of not only marketing opportunities but also as far as suitability for new entry farmers is concerned. **Relevance to the Study** As the focus of the study on irrigation will be very limited, the report holds little value for the study
15.	**Client**: DWA **Date:** Dec 2007 **Document Title:** Water Allocation Plan to Guide Compulsory Licensing in the Mhlathuze Catchment - Regional Economy Report Final **Author:** Iliso Consulting	**Document content** This report outlines and calculates the current economic returns of use of water from the Mhlatuze River. This data is then used to estimate future growth on the assumption that water will be available. **Relevance to the Study** The report provides information on the drivers of water growth and on the local and regional economy. Its water use predictions are outdated.
16.	**Client**: DWA **Date:** Dec 2012	**Document content** This was follow-on from the MWAAS study. The main objective was to provide support to the KZN DWA Regional Office to apply the above described model to assist with water reallocation in the catchment, provide analytical support in the management of the water resources and perform a support function in the evaluation of water use licenses.

No	Reference	Review notes
	Document Title: Mhlathuze Catchment: Modelling Support for Licensing Scenarios Study **Author:** WRP *et al*	**Relevance to the Study** This documents the latest available modelling work, which will form the basis for the current 2014 modelling. They is therefore a key report
17.	**Client**: DWA **Date:** 2011 **Document Title:** First Stage Reconciliation Strategy for Middledrift WSA – Umlalazi Local Municipality **Author:** Water for Africa *et al*	**Document content** The Department of Water Affairs (DWA) has initiated a study to develop water reconciliation strategies for selected towns in the Eastern Region, with a view to addressing the towns which have, or may experience water supply deficits over the planning horizons. The objective of the study for the towns in the Eastern Region was to develop water reconciliation strategies for the selected towns to ensure effective and efficient use of the available water supplies, while determining optimal and sustainable ways to source additional water supplies for the selected towns. For the selected towns which were carried forward into Phase 2 of the study, more detailed assessments were undertaken in the development of their water reconciliation strategies. **Relevance to the Study** The area falls partly in the Mhlatuze River catchment area and schemes have been conceptualised to obtain water from Goedertrouw Dam and transferred water, notably the Middledrift Water Supply Scheme in the future. The Middledrift Regional Water Supply Scheme area is supplied using the Thukela Transfer scheme abstraction works from where water is pumped to a water treatment works (WTW) which supplies the various villages in the Middledrift supply area. This is therefore particularly relevant to the future planning of the Thukela Transfer Scheme.
18.	**Client**: DWAF **Date:** Mar 2000 **Document Title:** Strategic Environmental Assessment for Water Use, Mhlatuze Catchment **Author:** DWAF	**Document content** Strategic Environmental Assessment of the Mhlatuze catchment undertaken by Departmental staff. **Relevance to the Study** Mostly outdated, but contains some useful summarised information.
19.	**Client**: DWAF **Date:** Dec 2001 **Document Title:** Mhlathuze Operating Rules and Future Phasing (MORFP), Main Report **Author:** BKS and Knight Piesold	**Document content** This study (MORFP), followed on from previous investigations of DWAF and Mhlathuze Water in 1998. The main tasks of the study were: • Update the surface hydrological database using all available rainfall data with the aim to improve the confidence of the streamflow time series that are used in the water resource models. • Undertake an assessment to determine the interchange between the groundwater and lakes. This was undertaken by specialists of the University of Zululand. • Determine and revise the water demand projections for existing and possible future users supplied from the system. • Determine the system operating rule and in particular the operation of the transfer from the Thukela River. This also involved the re-evaluation of the yield capability of the system as a whole, as well as of selected components. • Schedule the implementation of future augmentation schemes based on selected scenarios of demand projections The list of reports published as part of this study are: Hydrology; Water Demand; Groundwater (Coastal Lakes); Water Demand Management; System Analysis; Water Quality; Phasing Analysis; Operating Rules and Main Report. **Relevance to the Study**

No	Reference	Review notes
		Although several years old, some findings of this study still represents the latest information.
20.	**Client**: DWAF **Date:** Aug 2002 **Document Title:** Mhlatuze River Catchment WCDM Strategy Study, Main Report **Author:** WRP *et al*	**Document content** The report provides a framework for a water conservation strategy which, when considered along with the possible further development of the water resources in the future, will ensure adequate and equitable allocation of these resources both for the present situation and for possible future development scenarios. Assessments were undertaken of potential water conservation measures applicable to specified user sectors and individual consumers on the basis of the following user sectoral consultation groups : 1. Domestic and commercial; 2. Industry and mining; 3. Irrigation; and 4. Dryland agriculture (which includes both commercial and subsistence agriculture). **Relevance to the Study** Mostly outdated
21.	**Client**: DWA **Date:** July 2012 **Document Title:** National Water Resource Strategy **Author:** DWA	**Document content** 2nd National Strategy developed for South Africa. Overarching core strategies have been developed for the 2nd Edition of the NWRS to address the water resource concerns and to guide future water management and development. These core strategies include outcome, tactical, water business and governance strategies and they set out a different approach to water resources management. They form the framework and context for specific technical and enabling strategies. The core strategies are aligned with the purpose of the NWRS as stated in the National Water Act. **Relevance to the Study** Generic guiding principles on water resource management, with succinct notes on KZN catchments.
22.	**Client**: Mhlathuze Water **Date:** Mar 2010 **Document Title:** Water Resources Analysis Study: Hydrological Yield Analysis **Author:** Arcus Gibb	**Document content** This entailed a water resources assessment study some systems located within the Usutu – Mhlathuze WMA. This focussed on analysing the water sources within the WMA to attain which sources have available yield for possible future allocation. The following relevant systems were analysed: • Klipfontein Dam within the Mfolozi River System; and • Mfolozi River System. **Relevance to the Study** This provides information relevant to the evaluation of the potential Mfolozi River interventions.
23.	**Client**: Mhlathuze Water **Date:** Apr 2010 **Document Title:** Nsezi WTW Study Future Growth for the 2030 Planning Horizon: Feasibility Report **Author:** Nathoo Mbeyane	**Document content** Evaluation of water demand of the Nsezi WTW to 2030, assessment of the existing works capabilities and design of a future upgrade to accommodate the 2030 requirements, beyound the 205 Ml/d treatment capacity. This includes an analysis of the existing raw water resources and its potential to supply the demand up to 2030. **Relevance to the Study** Some information relative to the operation of the Nsezi WTW and other MW operational aspects
24.	**Client**: Mhlathuze Water **Date:** May 2013	**Document content** This describes system analysis for the Mhlatuze River catchment, and the assessment in terms of the hydrology, yields and possible pipeline conveyance from Goedertrouw Dam to improve system efficiency. The pipeline was assessed at conceptual level and a pipeline route was

No	Reference	Review notes
	Document Title: Development of an Operating Rule for the Mhlatuze Weir **Author:** Royal Haskoning DHV *et al*	selected. The report further identifies the further potential need for a lower dam on the Mhlatuze River and/or a dam on the Mfule River, to boost yields and serve as in-stream reservoirs. The evaluation included the re-evaluation of the structural and general integrity of the abstraction weir. **Relevance to the Study** Very relevant as a potential WC/WDM intervention option.
25.	**Client**: DWA **Date:** Jul 2013 **Document Title:** National Water Policy Review – Water Policy Positions **Author:** DWA	**Document content** The mandate of the policy review is to determine any unintended oversight and gaps in the current water policies to provide amendment to address these. The key policy issues that need to be addressed are discussed in this policy review, with recommendations on revised or updated policy positions. **Relevance to the Study** It contains some interesting views on the recognition of historical entitlement to water under customary law and on the impact of climate change on water resources.
26.	**Client**: Mhlathuze Water **Date:** 2013 **Document Title:** Mhlathuze Water Annual Report 2012-2013 **Author:** Mhlathuze Water	**Document content** Report produced by MW on their activities during the 2012/13 financial year. **Relevance to the Study** The "Operational Performance" Chapter provides insight into the workings of MW, and specific information of some of their activities such as their Working for Water programme. It contains information on the Thukela Transfer Scheme / Middledrift Regional WWS, useful insight into operational efficiency and potential improvements, planned bulk water supply schemes and WC/WDM at schools.
27.	**Client**: DWA **Date:** Mar 2011 **Document Title:** Water Quality Planning Studies in Support of Water Quality Planning in the Mhlathuze WMA **Author:** DWA	**Document content** This is a report by DWA that: • Provides a list of available reports and studies in the Mhlathuze WMA that addressed water quality issues; i.e. a list of titles together with concise descriptions of the listed documents" contents; • A methodology and processes followed in collection of the reports and relevant documents. Executive summaries of the identified reports are provided. **Relevance to the Study** Useful reference document for any water quality related issues.
28.	**Client**: DWAF **Date:** Feb 2004 **Document Title:** Summary of Available Reports, Data and Water Resource-Related Models Relating to Catchment W100 (produced as part of the study: Development of the TOR for the Provision of Water Resource Modelling and Water Resource Evaluation Services Towards the Assessment of Water Availability in the Mhlathuze	**Document content** This report is the result of a survey of available water resources planning, management and modelling data and reports on the study area. Many organisations and individuals were liaised with during the compilation of this report, to obtain information and reports and to clarify issues. Summarised relevant details of the existing models were prepared, including their capabilities, their geographic coverages, dates of their calibration and other attributes and shortcomings. Summarised details of existing schemes and potential schemes for which modelling may be required in the W100 catchment area was also included. **Relevance to the Study** Mostly superseded by other reports, but still contains useful data sources and background information.

No	Reference	Review notes
	Catchment to Support Integrated Water Resources Planning) **Author:** Ninham Shand	
29.	**Client**: DWAF **Date:** 1994/5 **Document Title:** Report on the Proposed Thugela-Mhlatuze River GWS **Author:** DWAF	**Document content** Thukela - Mhlathuze Transfer Scheme White Paper. **Relevance to the Study** Key information document on the Thukela Transfer Scheme.
30.	**Client**: n/a **Date:** unknown **Document Title:** Tugela transfer scheme **Author:** unknown	**Document content** Location maps and synopsis on the existing Emergency Transfer Scheme and the Future Planned Tugela Transfer Scheme. **Relevance to the Study** Useful for the Thukela Transfer Scheme intervention.
31.	**Client**: **Date:** Unknown **Document Title:** Mondi Effluent Scheme diagram **Author:** BKS	**Document content** Diagram that provides an overview of the effluent disposal system at Mondi. This formed part of the technical report "*Effluent Disposal System Efficiency Improvement Technical Investigations – Technical Report*" which was not provided by Mondi. **Relevance to the Study** May be useful for the reuse intervention evaluation.
32.	**Client**: City of uMhlathuze **Date:** 2011 **Document Title:** Key Statistics and Information on the City of uMhlathuze **Author:** City of uMhlathuze	**Document content** Various statistics of the City of Umhlathuze **Relevance to the Study** Background information and relative location of areas.
33.	**Client**: n/a **Date:** 2011 **Document Title:** uThungulu DM Population Stats 2001-2011 **Author:** Aurecon	**Document content** Spreadsheet containing an extract of population statistics for the 6 Local Municipalities within the uThungulu DM. **Relevance to the Study** Indication of population growth in the uMhlathuze LM.
34.	**Client**: City of uMhlathuze **Date:** undated **Document Title:** Augmentation of Esikhawini Sewage Treatment Plant: Summary Report **Author:** Bigen	**Document content** Detailed studies were undertaken for the future Esikhawini Sewage Treatment Plant and included for the following alternatives : a. Augmentation of the plant in its current location; b. Relocating the plant beyond, but bordering the RBM mining lease area; c. Relocating the plant to Felixton; d. Transfer of Esikhawini effluent to the Empangeni Sewage Treatment facility. Costs were determined and option d) was recommended **Relevance to the Study**

No	Reference	Review notes
		Information regarding to future wastewater operational aspects and for the reuse intervention.
35.	**Client**: WRC **Date:** Jul 2005 **Document Title:** The Development of a Computerised System for Auditing Real Time or Historical Water Use from Large Reservoirs in order to Promote the Efficiency of Water Use **Author:** CPH Water	**Document content** The Mhlathuze Catchment was chosen as a research area: • To develop a water audit system for large dams • To increase the understanding and knowledge of the practicalities, strengths and weaknesses, and potential costs and benefits of developing and implementing a "water audit system" for use by CMAs • To transfer knowledge/technology to decision makers and stakeholders • To assess the feasibility of implementing the water audit system for the management of South Africa's water resources **Relevance to the Study** As the study promotes the use of the MikeBasin and ACRU surface water resources models, the study has limited use in terms of the modelling aspects. It contains some useful comments on good operational practices for the release of water from large dams and monitoring the use thereof.
36.	**Client**: City of Mhlathuze **Date:** Nov 2013 **Document Title:** eSikhaleni Water Supply System **Author:** Bhovungane Consulting	**Document content** The report provides a qualitative overview of the water supply system. It provides where feasible, a visual portrayal of work completed and planned and illustrate the impacts of issues related to the system. **Relevance to the Study** Information on the Esikhaleni WSS and planned future expansion of the WSS, water supply infrastructure and WC/WDM.
37.	**Client**: City of Mhlathuze **Date:** 2014 **Document Title:** Bulk Water Master Plan - Draft **Author:** CSIR *et al*	**Document content** BWMP exercise for the City of uMhlathuze's bulk water supply system that: • Proposes a rational bulk WSS for the study area based on DWA's water supply guidelines and existing studies • Identify financing models and options. **Relevance to the Study** Bulk water infrastructure plans and recommendations for re-use of wastewater. Also information on current WC/WDM measures being implemented
38.	**Client**: City of Mhlathuze **Date:** 2013 **Document Title** City of uMhlathuze Water Consumption **Author:** City of Mhlathuze	**Document content** Excel spreadsheet which seems to be a database extract of water use by consumers for the last 5 years. **Relevance to the Study** Interrogation of the spreadsheet indicates that something seems odd with this information and it has not been used for this study.
39.	**Client**: City of Mhlathuze **Date:** Dec 2013 **Document Title:** Mhlatuze Feasibility Study for reuse of effluent DRAFT **Author:** CSIR	**Document content** Focus on utilising waste water from its two macerator stations Alton and Arboretum. The investigation: • Advises on the legislative process for the utilisation and/or disposal of sludge & waste water • Conducted an economic assessment of the PPP process illustrating some of the risks and benefits to the municipality • Propose beneficial use opportunities and/or methods of disposal of sludge & waste water • Developed Waste Water Management Plan for the municipality **Relevance to the Study**

No	Reference	Review notes
		Very relevant to the reuse intervention evaluation.
40.	**Client**: City of Mhlathuze **Date:** Feb 2007 **Document Title:** Revision of Spatial Development Framework **Author:** SiVEST Selatile Moloi	**Document content** The Spatial Development Framework (SDF) is a sector plan of the municipal IDP (Integrated Development Plan). The SDF is the visual representation of a municipality's vision, goals and strategies. It is a planning document that reflects the current situation and future development options. **Relevance to the Study** Information on municipal spatial planning, although now somewhat outdated.
41.	**Client**: City of Mhlathuze **Date:** 2014 **Document Title:** Revision Of Umhlathuze Spatial Framework Plan: Status Quo Report **Author:** SiVEST Selatile Moloi	**Document content** Visual representation of a municipality's vision, goals and strategies. It is a planning document that reflects the current situation and future development options. **Relevance to the Study** Information on municipal spatial planning. It indicates area for future IDZ industries.
42.	**Client**: City of Mhlathuze **Date:** May 2012 **Document Title:** uMhlathuze Municipal Human Settlements Plan 2012/13 **Author:** Unknown	**Document content** Information on human settlement within the municipal area. **Relevance to the Study** Limited usefulness
43.	**Client**: Umkhanyakude DM **Date:** 2013 **Document Title:** Umkhanyakude DM IDP Review 2013-2014 **Author:** Umkhanyakude DM	**Document content** Integrated Development Plan of this DM **Relevance to the Study** Mtubatuba LM falls within this DM. Information about the supply to Mpukyoni and Mtubatuba has been included. Refers to "Nsezi Feasibility Study".
44.	**Client**: City of Mhlathuze **Date:** June 2013 **Document Title:** Water Services Development Plan (2013 update) **Author:** CSIR	**Document content** Water Services Development Plan for the City of uMhlathuze: situation assessment of infrastructure, resources, usage and WC/WDM, as well as future trends, goals and implementation strategies **Relevance to the Study** Includes list of projects/ interventions as well as information on the current and potential infrastructure etc. that can inform interventions, water balance and strategy
45.	**Client**: City of Mhlathuze **Date:** June 2014 **Document Title:** Bulk Water Master Plan – Final **Author:** CSIR	**Document content** Evaluation of current bulk water system/ sub-system situation, future requirements and programme for augmentation of bulk water system **Relevance to the Study** Bulk water infrastructure plans and recommendations for re-use of wastewater. Also information on current WC/WDM measures being implemented
46.	**Client**: DWA **Date:** June 2011	**Document content**

No	Reference	Review notes
	Document Title: Development of a Reconciliation Strategy for All Towns in the Eastern Region: First Order Reconciliation Strategy for Mtubatuba Town and surrounding areas **Author:** Water for Africa *et al*	Water balance for the Mtubatuba water supply area, including requirements, treated volumes and consumption. Assessment of water supply issues (including exceedance of registered water use from Mfolozi river) and losses. **Relevance to the Study** Similar aim and objectives to the current study, as well overlap in water resources and supply systems. Recommendations for interventions include WC/WDM measures, increase of abstraction licence, upgrades of treatment works, off-channel storage and investigation of groundwater potential. The applicability of these interventions to Richards Bay can be considered, given the proximity of the areas, as well as any synergies in implementing interventions.
47.	**Client**: Exxaro KZN Sands **Date:** July 2011 **Document Title:** Proposed Raw Water Supply to Fairbreeze Mine: Draft Basic Assessment Report **Author:** KZN Dept. of Agriculture, Environmental Affairs & Rural Development	**Document content** Gives some background to the plans for the construction of the Thukela pipeline (Mandini scheme) and development of Fairbreeze mine and its water-supply options and issues. Specifically, assessment of the impacts of the infrastructure, rather than the abstraction, given that this forms part of Mhlathuze Water's licence for abstraction from the Mhlatuze River. **Relevance to the Study** Gives an indication of any possible environmental issues that might compromise the scheme's feasibility, and the likelihood of the pipeline being built, which is important given that this is likely to be a significant option amongst the possible interventions.
48.	**Client**: KZN Provincial Treasury **Date:** Feb 2014 **Document Title:** Report on Water Use Licence Status - City of uMhlathuze Local Municipality **Author:** Municipal Crack Team, Anthony Wagenaar	**Document content** Summary of the current Water Use Registration and Licensing status for the City of uMhlathuze LM. Options on the way forward. **Relevance to the Study** Gives values for and comments on abstraction volumes and storage applied for in the Richards Bay Water Supply System, as at February 2014, although the licensing process has since reached completion, and final values may be different.
49.	**Client**: DWA **Date:** May 2014 **Document Title:** Esikhaleni Bulk Water: Business Plan **Author:** Mbona Saunders & Wium	**Document content** Plan for the augmentation of the bulk supply of water to the south and south-western communities in the City of uMhlathuze LM supplied from eSikhaleni WTW, to meet medium-term requirements of the area. Includes current water demands and future projections, as well as situation assessment for the eSikhaleni bulk systems and its capacity, and the supply options. **Relevance to the Study** Can be included in the assessment of options/ interventions for addressing water requirements and supply issues. Also highlights the need for WC/WDM measures, and the need for water source security and flexibility of supply.
50.	**Client**: DWA **Date:** 1988 **Document Title:** Goedertrouw Dam (Brochure) **Author:** DWA	**Document content** Background information on the construction of the dam and the context in which it is operated. **Relevance to the Study** General information on the area and the historical situation in the area.
51.	**Client**: possibly DWAF **Date:** May 2003	**Document content**

No	Reference	Review notes
	Document Title: Level of Reserve Determination Required for the Groundwater Component – Mhlathuze Catchment (Report 7 out of a Series of 8) **Author:** Groundwater Group, Dept. of Earth Sciences, University of the Western Cape	Identification of critical groundwater issues in the Mhlatuze River catchment. These include the characteristics of the main aquifers, report on the status quo (at the time) of groundwater abstraction and exploitation potential in the catchment. It contains some information on the interaction between the groundwater and the freshwater lakes in the catchment, which is an issue requiring attention, as well as references to other studies on the subject, some of which are included in this list. **Relevance to the Study** Inform the contribution of groundwater to coastal lakes of the WSS.
52.	**Client**: DWA **Date:** Sep 2013 **Document Title:** Drought rules for those scheduled from the Goedertrouw Dam, Letter **Author:** DWA	**Document content** Breakdown of restrictions to be applied to irrigation use in the catchment during various levels of drought. **Relevance to the Study** Informs the modelling of the water balance under different conditions
53.	**Client**: RBM **Date:** Aug 2012 **Document Title:** Draft Scoping Report: Richards Bay Mining: Zulti South Project – EMP Amendment, EIA, WULA, NNR Certification and Planning and Development Act **Author:** SRK Consulting	**Document content** Breakdown of the components of and processes included in the mining operation, their environmental impacts and the controls and mitigation measures to limit the impacts. This report covers the necessary legislation and documentary requirements for authorisation for the project. **Relevance to the Study** Informs the future planning for water requirements and use in the area, as well as highlighting important environmental issues associated with this type of mining and the kind of measures that can be implemented.
54.	**Client**: DWA **Date:** Aug 2004 **Document Title:** State of the Mhlathuze Catchment (Output 5) - Describe the Existing Socio-economic Situation (Draft) **Author:** Unknown	**Document content** Although focussing primarily on the socio-economic aspects of water supply - domestic water provision, small-scale irrigation and economic returns from water used in the catchment – a short description of the aquatic ecosystems in the catchment is also included. **Relevance to the Study** Provide background and context to the situation and the socio-economic aspects, the specific angle being the need (at the time) for the compulsory licensing process to be undertaken.
55.	**Client**: n/a **Date:** July 2008 **Document Title:** uMhlathuze Development Update – Edition 8 (Newsletter) **Author:** Garth Macartney	**Document content** Outlines some of the planned developments in the City of uMhlathuze LM from 2008. These included a power station in the KwaMbonambi/ Nseleni area, the Pulp United development, and Tata Steel's extension, both under the RBIDZ umbrella. Also smaller developments such as a substation, a bakery ingredients manufacturing operation and hotel/ conference facility as well as many other smaller developments, some of which have advanced towards realisation since the publish date, and some of which have not. **Relevance to the Study** Information on the potential future demands on the water supply system, and expansions in industrial and infrastructural developments

No	Reference	Review notes
56.	**Client**: DWAF **Date:** 2008 **Document Title:** Usutu to Mhlathuze Water Management Area: WC/WDM Study: City of Umhlathuze LM **Author:** Water for Africa	**Document content** This report consists of several module sub-reports, each focussing on a different sector or aspect in the WMA. This includes a situation assessment and business plan development study for each of Foskor, KZN Sands (Tronox), Mondi and RBM as well as a water balance assessment and strategic business plan for three urban areas in the WMA, including Richards Bay, Empangeni, eSikhaleni, Nseleni and Ngwelezane. Before WC/WDM measures can be developed or implemented for these sectors a situation assessment is carried out – this establishes the potential for and scope of possible WC/WDM measures, and the reports feed into the wider strategy and plans for the WMA. **Relevance to the Study** Provides information on different sectors and potential for WC/WDM measures.
57.	**Client**: Umgeni Water **Date:** January 2012 **Document Title:** Lower Thukela Bulk Water Supply Scheme – Detailed Feasibility Study **Author:** Aurecon	**Document content** Detailed feasibility study and preliminary design of all infrastructure required for the scheme, including an abstraction works and low-lift pump-station, desilting works with the possible addition of a balancing dam, a water treatment works, and a high-lift pump-station at the WTW linked to bulk supply pipelines, and associated potable water storage reservoirs **Relevance to the Study** This scheme is one of the potential intervention options for the current study, and the content of the feasibility study will inform the assessment of the scheme in the study.
58.	**Client**: City of uMhlathuze **Date:** July 2013 **Document Title:** eSikhaleni Bulk Water Intervention Study. Draft Feasibility Report. **Author:** Mbona, Saunders & Wium CC	**Document content** Assessment of current bulk infrastructure in the area supplied by eSikhaleni WTW, as well as options and recommendations for increasing supply to meet future demands. This includes the upgrade of the eSikhaleni WTW and associated infrastructure and the supplementation of the supply to the area by the Nsezi WTW. **Relevance to the Study** Inform analysis of options and potential interventions for the area in the current study
59.	**Client**: Department of Environmental Affairs **Date:** September 2012 **Document Title:** Umgeni Water Ngcebo Water Treatment Plant Upgrade Basic Assessment Report **Author:** Umgeni Water?	**Document content** Basic assessment of environmental impacts of the project, which involves the upgrade of the WTW, which abstracts from the Thukela River. **Relevance to the Study** Although the WTW does not supply any area in this study's footprint, the planned upgrade will include an abstraction from the Middledrift weir, which would have an indirect effect on the Mhlatuze supply system, as decreasing the water available in the river at that point. However, the volume planned to be abstracted for the Ngcebo WTW is relatively small, and is unlikely to have a significant effect.
60.	**Client**: Ticor South Africa [Tronox] **Date:** November 2005 **Document Title:** Environmental Management Programme Report Amendment. Fairbreeze C Extension **Author:** Ticor SA and SRK Consulting	**Document content** Amendment to the Hillendale and Fairbreeze EMP of 1998. An additional EIA was required for a section of the mine that was not included in the original EIA, and this is included in the contents of the document. **Relevance to the Study** Provides further detail on the mining plans and potential impacts of the mining activities.
61.	**Client**: Umgeni Water	**Document content**

No	Reference	Review notes
	Date: March 2012 **Document Title:** Umgeni Water Infrastructure Master Plan 2012 (Volume 1) **Author:** Umgeni Water	Describes UW's plans for the 2012/2013-2042/2043 period. Provides detailed information on the organisation's current infrastructure and future development plans. **Relevance to the Study** Although Umgeni Water's supply area does not include the uThungulu DM or uMhlathuze LM, it does include the lower Thukela area, and so has an indirect effect on this study's area. Information on the characteristics of the lower Thukela River/ area is included, as well as the various abstractions and usages from the river, which will influence the availability of water to the Mhlathuze WSS.
62.	**Client**: DWA **Date:** May 2012 **Document Title:** Middledrift Regional Water Supply Scheme. Sub Supply area 2: Phase 4: Raw Water Transfer **Author:** ECA Consulting	**Document content** Describes the scheme for supplying the Middledrift area, which is provided with water from the Middledrift to Mhlatuze pipeline. Options for augmenting the scheme are detailed, including off-channel storage and an additional pipeline abstracting from the Thukela River. This will allow for maintenance of the existing infrastructure, which is currently problematic. **Relevance to the Study** One of the options being considered in the current study is augmenting the transfer from the Middledrift scheme, and the availability of water in the Thukela River, which will be influenced by the augmentation of the Middledrift scheme, will in turn influence this.
63.	**Client**: RBM **Date:** July 2014 **Document Title:** Zulti South Mining Lease Area. Final Environmental Impact Assessment and Environmental Management Programme for the Mine's Services **Author:** SRK Consulting	**Document content** Includes the establishment of servitudes for the provision of electricity, a water supply, an access road and the transport by pipeline of heavy mineral concentrate from the Zulti South area to the RBM smelter **Relevance to the Study** Gives background on the Zulti South development, the area in which it is taking place, and some of the associated issues
64.	**Client**: Mhlathuze Water **Date:** January 2002 **Document Title:** Raw Water Supply from Hillendale (Mhlathuze). Preliminary Design Phase. Preliminary Design Report. Volume 1. **Author:** Ninham Shand	**Document content** Describes preliminary design of proposed water supply from the Mhlatuze River to Fairbreeze Mine. **Relevance to the Study** Gives details on water requirements for the mine, as well as the infrastructure planned to service it. This will aid understanding of the system and inform the development of options.
65.	**Client**: Mhlathuze Water **Date:** May 2005 **Document Title:** Fairbreeze Mine Raw Water Supply: Mhlathuze Option. Addendum to Preliminary Design Report. Volume 1. **Author:** Ninham Shand	**Document content** Contains a review of the conceptual design and update of the preliminary design for the raw water supply to the Fairbreeze mine, as a result of changes in the requirements. Includes modifying and extending the Hillendale supply system terminating in a new balancing dam near Hillendale, and new infrastructure to draw water from the balancing dam and pump it onto Fairbreeze. **Relevance to the Study** Background information to the Thukela Coastal Pipeline Scheme, as well as providing additional information on the water requirements and infrastructure to the Fairbreeze and Hillendale mines at the time.
66.	**Client**: Mhlathuze Water **Date:** April 1998	**Document content** Looks at different scenarios for augmenting the Mhlathuze system from the Thukela River. These scenarios include the construction of the tunnel near Middledrift, increasing the existing scheme's capacity and construction a coastal pipeline from the lower Thukela at Mandini.

No	Reference	Review notes
	Document Title: Greater Richards Bay/ Empangeni Bulk Water Augmentation. Thukela/ Mhlathuze Transfer Scheme. Evaluation of Alternative for Phase 1. Final Report **Author:** Ninham Shand	**Relevance to the Study** Although the study is not recent and the costing etc. is out of date, the options presented in it are still relevant and can be included in possible scenarios for the future.
67.	**Client**: Mhlathuze Water **Date:** June 2003 **Document Title:** Mhlathuze Weir Upgrading. Preliminary Design Report **Author:** Ninham Shand	**Document content** Looks at the existing weir on the Mhlathuze River as well as the problems with it, including a lack of stability as a result of scouring beneath the weir, and general bad repair. Explores two options for improving the situation, including upgrading the existing weir and constructing a new weir just downstream, which was the ultimate recommendation from this report. **Relevance to the Study** Since the publishing of this report the weir has not been upgraded or replaced, so the recommendations from this report have still to be carried out and the weir is still in an unstable condition.
68.	**Client**: DWA **Date:** Apr 1996 **Document Title:** Mhlatuze Basin Augmentation: Operation of emergency pumping scheme **Author:** Knight Piésold	**Document content** Describes the simulations and analyses done to prepare graphs that can be used by the pump operator to decide when water should or should not be pumped from the Tugela to Goedertrouw Dam through the Middledrift pipeline. **Relevance to the Study** Informs the modelling of the Mhlatuze system and includes some historical demands in the system, as well as some MAR for sub-catchments within the Mhlatuze catchment
69.	**Client**: DWA **Date:** Mar 1996 **Document Title:** Mhlatuze Basin Augmentation: Assessment of when additional augmentation is required **Author:** Knight Piésold	**Document content** Discusses the further augmentation of the Mhlatuze basin, after the construction of the Middledrift pipeline. The conclusion was that further augmentation would be required by 1997, without significant restrictions being placed on the irrigation supply, and 2000 with restrictions being put in place. **Relevance to the Study** Information on the investigation of augmentation options, now somewhat outdated.
70.	**Client**: Development Bank of Southern Africa **Date:** Feb 1994 **Document Title:** Economic Assessment of the Mhlatuze Basin Augmentation Scheme **Author:** Economic Project Evaluation	**Document content** Examines the economic viability of the augmentation scheme for the Mhlatuze basin. The overall outcome of the study was that the scheme should have been constructed as soon as possible, which it was. **Relevance to the Study** Provides an overview of how the abstraction scheme was expected to affect the Tugela and Mhlatuze catchments, and might provide some insight into how further transfers might affect the catchments.
71.	**Client**: Mhlathuze Water **Date:** Sep 1997 **Document Title:** Mhlathuze Basin Bulk Water Augmentation **Author:** Knight Piésold	**Document content** Appraises the possibility of augmenting the Mhlatuze system from the lower Thukela, and produced unit reference costs for different diameter pipelines, including the Iscor (Tronox) pipeline at the time. **Relevance to the Study**

No	Reference	Review notes
		Gives information about the lower Thukela scheme and its feasibility, as well as the possibility of incorporating supply to the Tronox mines. This is unlikely to be relevant here as the Tronox Thukela pipeline is already close to being implemented.
72.	**Client**: Zululand Joint Services Board / Development Bank **Date:** Jun 1994 **Document Title:** Greater Mhlathuze Development Plan: Final Consolidated Perspective Report **Author:** Seneque Smit & Maughan-Brown	**Document content** The report covers the current (~1993) situation in the region, the factors which have produced it and which are influencing the ways in which it changes. **Relevance to the Study** Gives some background on the drivers of development in the area, and the potential developments at the time.
73.	**Client**: DWAF, Mhlathuze Water **Date:** Oct 1993 **Document Title:** Mhlathuze Basin Augmentation Feasibility Study. Vol 1, Main Report **Author:** WLPU	**Document content** Looks at the feasibility of the two possible Tugela transfer schemes. The Mandini scheme was found to have the potential for greater regional benefit, but to be significantly more expensive than the Middledrift scheme. The Middledrift scheme was recommended, but was never constructed as a result of the emergency scheme that was put in place. **Relevance to the Study** Gives some background to the feasibility of the two schemes and advantages and disadvantages of each option. Can inform the evaluation of the options in the current day.
74.	**Client**: Mhlathuze Water Board **Date:** Nov 1982 **Document Title:** Richards Bay Ocean Outfalls Engineering Design Aspects, Volumes III and IV **Author:**	**Document content** Vol III: Dilution calculations and the design of the diffusers Vol IV: Pipeline design criteria **Relevance to the Study** More detailed information on the outfall pipelines could be relevant to the seawater desalination and re-use schemes.
75.	**Client**: Directorate of Water Affairs **Date:** Jul 1981 and Nov 1977 **Document Title:** Ondersoek en eliminasie van damterreine in die Mfolozi-Opvanggebied **Author:** DWA	**Document content** First and second reports carried out to investigate dam-sites in the Mfolozi catchment. **Relevance to the Study** Directly relevant to any inter-basin transfer scheme from the Mfolozi River catchment.
76.	**Client**: Department of Water Affairs **Date:** **Document Title:** A Guide to Water Allocation Reform and Compulsory Licensing **Author:** DWA	**Document content** Explains what water allocation reform is and why compulsory licensing for water is being introduced, as well as how compulsory licensing will be implemented. **Relevance to the Study** Compulsory licensing affected the water requirements in the area, and influences future water restrictions and allocations.
77.	**Client**: DWAF/ DFID **Date:** Apr 2001	**Document content**

No	Reference	Review notes
	Document Title: Design of a Decision Support System and Scenario Generator for the Assessment of Land Use Impacts on Water Resources within a Water Management Area **Author:** CPH Water	The aim of this project was to design a Decision Support System (DSS) which links a set of modelling, manipulation and display tools to a structured database that has the facility to store both observed and simulated data. **Relevance to the Study** In the recommendation of potential developments and options the impact of land-uses on the water resources will need to be taken into account, and this report will help to inform this.
78.	**Client**: DWAF **Date:** Sep 2001 **Document Title:** A Guide to SEA for Water Use in Catchments (Draft) **Author:**	**Document content** This guide describes the application of Strategic Environmental Assessment (SEA) to Water Use in Individual Catchments. It describes the purpose of SEA, and explains how to carry out and use an SEA. **Relevance to the Study** In developing the strategy for Richards Bay environmental considerations will need to be taken into account, with approaches such as SEA providing a valuable input to the process.
79.	**Client**: - **Date:** - **Document Title:** Implementation of a Water Resource Classification System (brochure) **Author:** DWA	**Document content** Defines the classification of water resources according to the level of use and the ecological condition of the resource, as well as the procedure for determining the class. The ultimate aim of the process is to assist in managing and protecting the water resources. **Relevance to the Study** Gives objectives in terms of quality and management that the strategy can aim to achieve.
80.	**Client**: Mhlathuze Water **Date:** Oct 2012 **Document Title:** Singlebeam Hydrographic Survey of Lake Nsezi to aid in the Estimated Water Volume Determination **Author:** Subtech Group	**Document content** Highlights the findings of the survey, which aimed to determine the depth of the lake and hence the water volume within the lake. The current water level was found to be 6.98 MSL and the volume to be 2,350,116,7m^3. **Relevance to the Study** Informs the calculations concerned with yields from lake and water availability in the catchment
81.	**Client**: - **Date:** Aug 1998 **Document Title:** National Water Act **Author: -**	**Document content** Sets out the strategies, objectives, guidelines etc. of the Minister and institutional arrangements relating to the protection, use, development, conservation, management and control of water resources. **Relevance to the Study** Provides the legal and institutional structure within which the strategy will be developed.
82.	**Client**: Umgeni Water **Date:** Apr 2014 **Document Title:** Umgeni Water Infrastructure Master Plan 2014 (Volumes 1 and 2) **Author:** Umgeni Water	**Document content** This describes Umgeni Water's infrastructure plans for the financial period 2014/2015 – 2044/2045. It is a comprehensive technical report that provides detailed information on the organisation's current infrastructure and on its future infrastructure development plans. Volume 1 describes the most recent changes and trends within the primary environmental dictates that influence Umgeni Water's infrastructure development plans. Volume 2 documents the current water supply infrastructure that Umgeni Water utilises for operational purposes and describes the most recent infrastructure plans that have been developed to address the future water demand requirements. **Relevance to the Study** Details of the development on the lower Thukela, which could supply the Richards Bay area.

No	Reference	Review notes
83.	**Client**: - **Date:** **Document Title:** Proposed Modelling Approach and Procedures for Water Availability Assessment studies **Author:** van Wyk et al	**Document content** Presents a preliminary framework on the proposed modelling approaches and procedures to be applied for the assessment of water availability in the WAA studies. **Relevance to the Study** Gives background to the determining of available water in the catchment, and the interpretation of other studies evaluating water availability.
84.	**Client**: DWA **Date:** Feb 2010 **Document Title:** Water Availability Assessment in the Lower Thukela River **Author:** WRP	**Document content** Analysis of water availability (requirements and water balance) in the lower Thukela River. Concluded that currently (2010) there were 77 million m^3/a available, including 32 million m^3/a licenced to Mhlathuze Water for the Fairbreeze Mine, and from the remaining 45 million m^3/a the 110Ml/day (40 million m^3/a) was taken for the LTBWSS. **Relevance to the Study** This informs the Coastal Pipeline from the Thukela option for augmenting the Mhlatuze system.
85.	**Client**: RBM **Date:** Jan 2014 **Document Title:** Nhlabane Sustainability Assessment **Author:** Kelbe, Taylor & Mander	**Document content** Describes the changes in the Nhlabane catchment and their effect on the water balance. The findings of the study included that the change in land-use to over the past 40 years has had a significant impact on the water table elevation profile and streamflow, resulting in a lower availability of water from Lake Nhlabane. **Relevance to the Study** Informs the assessment of availability of supply from Lake Nhlabane, and the evaluation of options for supply.
86.	**Client**: - **Date:** 2004 **Document Title:** National Guideline for the Discharge of Effluent From Land-based Sources into the Coastal Environment **Author:** Department of Environmental Affairs	**Document content** Gives guidelines on managing disposal of effluent into the coastal environment. **Relevance to the Study** In consideration of the desalination option the disposal of the brine to the ocean would be required to be compliant with all relevant regulations and guidelines, such as this.
87.	**Client**: DWS **Date:** Sep 2010 **Document Title:** Assessment of the Ultimate Potential and Future Marginal Cost of Water Resources in South Africa **Author:** BKS (Pty) Ltd	**Document content** This report assesses the remaining potential for water resource development in South Africa as well as means to extend the utility of the resources, all with associated costs and estimated energy requirements. **Relevance to the Study** Gives context to the study and provides background information on costs.
88.	**Client**: uThungulu DM/ DWS **Date:** Feb 2011 **Document Title:** Eshowe Sub-Supply Area 1 Bulk Water And Rural Reticulation Project Feasibility Report **Author:** Aurecon	**Document content** Examines the feasibility of a scheme to supply Eshowe and surrounding areas from Goedertrouw Dam through a WTW, as part of the 'Goedertrouw Regional Scheme'. **Relevance to the Study** Eshowe and surrounding areas are in the Mhlatuze catchment and are supplied with water from Goedertrouw Dam, and this report informs the evaluation of water supply and demand in the catchment.

No	Reference	Review notes
89.	**Client**: DWAF **Date:** Nov 2003 **Document Title:** Goedertrouw Dam Operation and Maintenance Manual SCANNED **Author:** DWAF	**Document content** Manual for Goedertrouw Dam. Contains information on capacity and usage from the dam. **Relevance to the Study** Informs discussion of supply for the area.
90.	**Client**: DWAF **Date:** Nov 1994 **Document Title:** Technical Proposal: Design of a Gravitational WSS (Tugela-Mhlatuze) **Author:** TMT Consortium	**Document content** Proposal for a gravity scheme comprising an abstraction works on the Thukela River, a series of canals, tunnels and syphons that eventually discharge into the Mvuzane stream leading to Goedertrouw Dam. **Relevance to the Study** Informs the evaluation of the Middledrift scheme options, as this is one of the options for conveying the water to the Mhlatuze catchment.
91.	**Client**: Council for Geoscience **Date:** Dec 1993 **Document Title:** Middledrift Transfer Tunnel. Engineering Geological Feasibility Report. **Author:** Council for Geoscience Geological Survey	**Document content** Investigation into geological conditions for two of the original tunnel alignments planned. The relative merits of the two alignments were discussed in the context of their geological characteristics, and recommendations were made for further investigation. **Relevance to the Study** Informs the discussion of the infrastructure options for Middledrift transfer.
92.	**Client**: DWS **Date:** 2009 **Document Title:** Water Reconciliation Strategy Study for the KwaZulu-Natal Coastal Metropolitan Areas, Rainwater Harvesting specialist report **Author:** Prof J Blignaut and Ms M de Lange	**Document content** Specialist sub-study focused mainly on 'urban rainwater harvesting', and particularly the potential of rooftop rainwater harvesting for household use in different user categories across the study area. It also touched on possibilities for stormwater storage and utilisation on business premises and for home food production. **Relevance to the Study** Directly relevant for the rainwater harvesting intervention.
93.	**Client**: Paper funded by Norad Appropriate Technology Project **Date:** Not dated **Document Title:** Rain Water Harvesting: A Neglected Rural Water Supply Option **Author:** P.C. Houston And D.A. Still	**Document content** Paper that presents illustrations of case studies from different parts of South Africa. The economics of rain water harvesting are discussed. **Relevance to the Study** Directly relevant for the rainwater harvesting intervention.
94.	**Client**: Conference paper **Date:** Not dated **Document Title:** Climate Change and Rainwater Harvesting in South Africa: A Case Study **Author:** L.M. Bulcock and R.E. Schulze	**Document content** Paper that focuses on the collection and storing of rainwater from the rooftops of houses and models how often a typical family's daily household water needs can be fulfilled under present and future climate change conditions. **Relevance to the Study** Directly relevant for the rainwater harvesting intervention.

No	Reference	Review notes
95.	**Client**: MEng dissertation **Date:** 2012 **Document Title:** Tank sizing from rainfall records for rainwater harvesting under constant demand **Author:** Ms JE Allen	**Document content** This study investigates the possibility of simplifying the process of sizing a rainwater tank for optimal results. It uses daily data for four rainfall stations in South Africa. **Relevance to the Study** Directly relevant for the rainwater harvesting intervention.
96.	**Client**: None **Date:** Jan 2015 **Document Title:** General Update, Developments on the cards for uMhlathuze and immediate surrounds, including Mtunzini, Mtubatuba, etc. **Author:** Frans van der Walt	**Document content** Compilation of potential future infrastructure developments in Richards Bay and surrounding towns. **Relevance to the Study** General information on potential bulk infrastructure developments that may affect the future water requirements.
97.	**Client**: DWS **Date:** 2005 **Document Title:** Mhlathuze Water licence for lower Thukela **Author:** DWS	**Document content** Water use licence (taking and storing of water) issued to Mhlathuze Water for lower Thukela River abstraction of 47 million m^3/a, at the time mainly for use by the planned Fairbreeze Mine. **Relevance to the Study** Directly relevant for any abstraction scheme from the Thukela River.
98.	**Client**: DWA **Date:** 2008 **Document Title:** Mokolo and Crocodile (West) Water Augmentation Project Feasibility Study, Technical Module, Main Report Feasibility Stage (Summary Report) **Author:** Africon in association with Kwezi V3 Engineers, Vela VKE, WRP Consulting Engineers and specialists	**Document content** Feasibility Study is to determine the optimum solution for the timely supply of the required quantities of water to the various proposed developments in the Lephalale area. The details of the River Abstraction Works are given in the study Supporting Report 11 – Technical Module: Phase 1 Feasibility Stage and are summarised in this report. **Relevance to the Study** The design of the abstraction works (weir and associate infrastructure) in the Crocodile River is of a similar complexity and size as the abstraction works planned for the Thukela Middledrift transfer scheme. The design and costs for the two sites evaluated at Pre-Feasibility Study level served as good examples for the Thukela Weir infrastructure components and costing.
99.	**Client**: DWS **Date:** 2014 **Document Title:** Continuation of Reconciliation Strategies for All Towns (CRSAT) in the Eastern Region: Update of the Water Reconciliation Strategy of the Mtubatuba Supply Area - 2012 to 2040 **Author:** Tlou Consulting (Pty) Ltd in association with WR Nyabeze & Associates	**Document content** Updated reconciliation strategy for the Mtubatuba water supply area. This *inter-alia* provides information on the Mtubatuba WSS and future water demands. **Relevance to the Study** Relevant for the potential Mfolozi dam intervention options, which can also supply water to the Mtubatuba WSS and surrounding areas.

No	Reference	Review notes
100.	**Client**: Mhlathuze Water **Date:** 2014 **Document Title:** Mhlathuze Water Climate Adaptation Study: Background Technical Information Report, Draft 1 **Author:** WSP Environmental	**Document content** Background report aimed at identifying and understanding the underlying issues and major climate change risks relevant to Mhlathuze Water's operations. **Relevance to the Study** Climate change was taken into consideration during the intervention scenario evaluation. This evaluation by Mhlathuze Water can provide a guide on how to integrate climate change into the scenario analysis.
101.	**Client**: Mhlathuze Water **Date:** 2014 **Document Title:** Preparing for the Future: Mhlathuze Water Climate Change Adaptation Strategy 2015 – 2020 **Author:** WSP Environmental and Mhlathuze Water	**Document content** This strategy represents Mhlathuze Water's first step to improving the readiness of their organisation to cope with the future challenges of climate change. **Relevance to the Study** Climate change was into consideration during the intervention scenario evaluation. This evaluation by Mhlathuze Water can provide a guide on how to integrate climate change into the scenario analysis.
102.	**Client**: City of uMhlathuze **Date:** March 2014 **Document Title:** Lake Management Plan for Lake Mzingazi, Richards Bay: Final Situation Assessment Report **Author:** CSIR EMS, PAS and SDP	**Document content** Situation Assessment Report for Lake Mzingazi in support of the Lake Management Plan process, based mainly on existing technical information available at the time. This serves as a baseline against which outcomes of future monitoring can be assessed. **Relevance to the Study** This is relevant as background information for the evaluation required to estimate the sustainable contribution of groundwater to the lake, update the sustainable lake yield and establish sustainable operational abstraction and use of the lake in line with findings.
103.	**Client:** City of uMhlathuze **Date:** September 2014 **Document Title:** Lake Management Plan for Lake Mzingazi, Richards Bay: Draft Lake Zonation and Management Plan (Approved) **Author:** CSIR EMS, PAS Environmental and SDP	**Document content** Approved Lake Zonation and Management Plan for Lake Mzingazi, inclusive of a visioning and stakeholder engagement process. **Relevance to the Study** This is relevant as background information for the evaluation required to estimate the sustainable contribution of groundwater to the lake, update the sustainable lake yield and establish sustainable operational abstraction and use of the lake in line with findings.
104.	***Book Held in Aurecon Library*** **Client**: Water Research Commission **Date:** 2006 **Document Title:** Consideration for design of river abstraction works in South Africa, Vol 2 **Author:** GR Basson	**Document content** To be read in conjunction with Vol 1 report of this study titled "Sediment control at river abstraction works in South Africa" by Brink et al, 2005. It provides a guideline for the planning and design of river abstraction works in South Africa. **Relevance to the Study** River abstraction works has been included in the Thukela and Mfolozi transfer scheme options, which are rivers with very high sediment loads

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