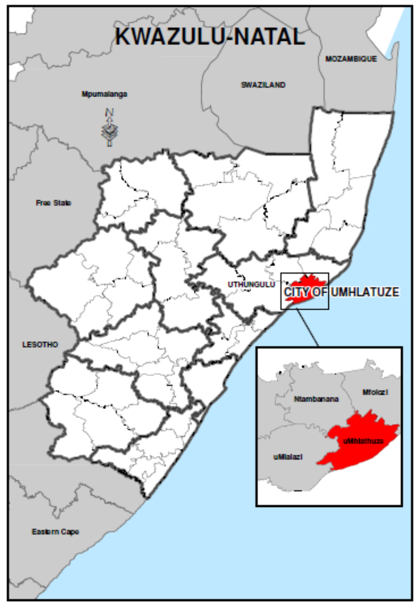
UNIVERSAL ACCESS PLAN (FOR WATER SERVICES) PHASE 2

PROGRESSIVE DEVELOPMENT OF A REGIONAL CONCEPT PLAN – CITY OF UMHLATHUZE LOCAL MUNICIPALITY

CONTRACT NO. 2015/178

RECONNAISSANCE STUDY
FINAL

JUNE 2016



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REPORT CONTROL PAGE

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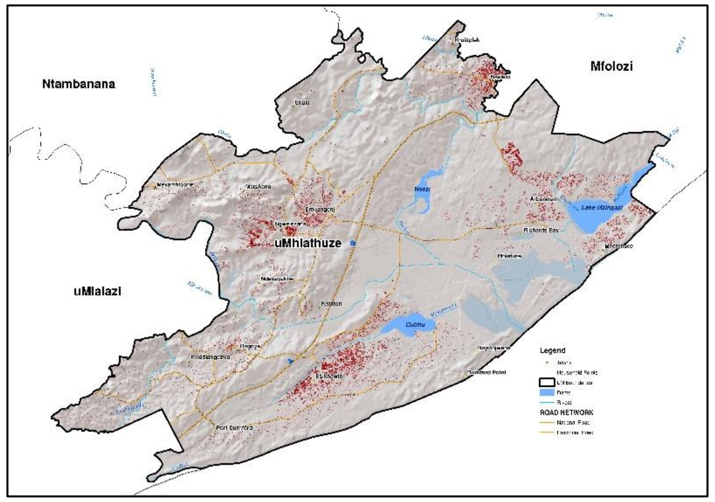
EXECUTIVE SUMMARY

This report is the Reconnaissance Study for the Universal Access Plan Phase 2 – Progressive Development of a Regional Concept Plan for The City of uMhlathuze (CoU).

The key objective of this study is to produce a concept plan for the Municipality that would address water backlogs in terms of Regional Bulk Water Supply.

Context

The project study area covers the CoU, a local municipality within uThungulu District Municipality, KZN. The area has large agricultural and Traditional Authority areas, as well as the two (2) main urban nodes of Richards Bay and Empangeni. Richards Bay is characterised by large industrial areas, as is the key physical and economic hub of the Municipality.

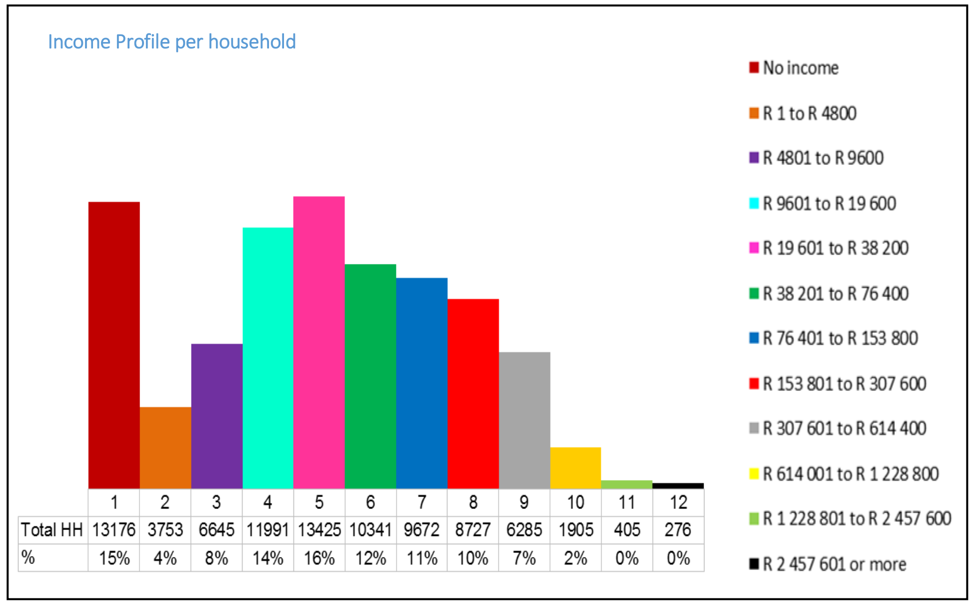


The CoU is the water service authority (WSA) and retail water services provider for local municipal areas. Bulk water services provision is shared between the CoU and Mhlathuze Water Board.

Demographics, and socio-economics

The municipality has an estimated 2015 population of 349 887 people, growing at an annual rate of 1.13%. Over 50% of the population live on a monthly income of R3000 or less.

Descripton	Value
Census 2011 Population	334 459
Estimated Population for 2015	349 887
% Average Annual Growth Rate	1.13%



Water Availability and Use

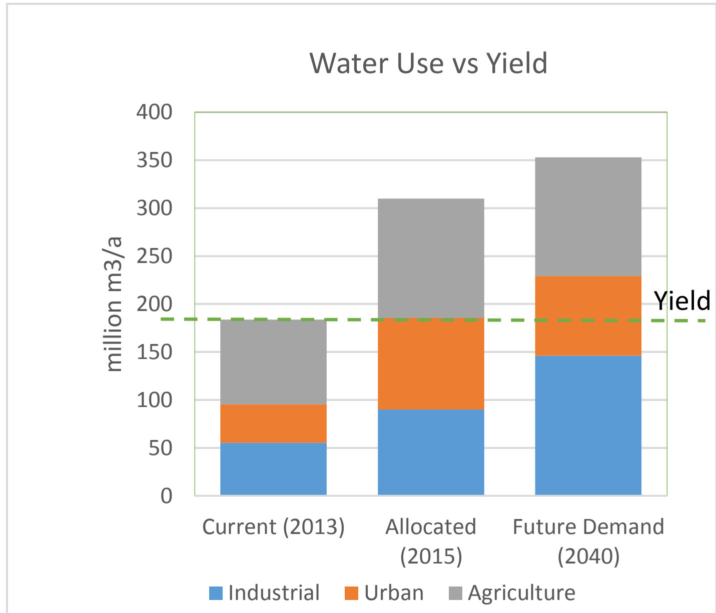
Water for the CoU is sourced from surface water within the Mhlathuze Catchment, and is abstracted from the Mhlathuze River, the Lake Nsezi, the Lake Mzingazi, and the Lake Cubhu. The Lake Nhlabane is also significant, as it is a water source for Richards Bay Minerals, who is also a contracted client for supply from Lake Nsezi, and must therefore be included in calculations. Water is transferred from other basins to supplement supply – from the uThukela River via the Middledrift Transfer Scheme; and the uMfolozi to Richards Bay Minerals.

The Goedertrouw Dam is an important regulator of water in the Mhlathuze River and improves the yield and assurance of supply to the downstream users.

A compulsory licensing process is almost completed in the catchment, providing legal rights to the use of water by the different sectors. This process appears to have allocated more than the historical firm yield of the Mhlathuze System, resulting in uncertainty of supply for downstream users. Of an estimated 195 million m³/a historical firm yield from the Mhlathuze System, a total of approximately 276 million m³/a has been allocated, nearly 80 million m³/a more than is possibly available at a sustainable level, and to meet assurance of supply.

From a water resource perspective there is insufficient available water to supply for the 2035 demands of the CoU. The situation is exacerbated by drought conditions, making demand management a top, and urgent, priority in this area. Intervention is required.

Current water use in the Mhlathuze System consists mainly of irrigated agriculture, bulk industrial, urban (domestic, commercial and light industrial).



The total estimated 2013 water use for the broader CoU water supply system was 95.94 million m³/a (262 Mℓ/day) (Note: More recent figures are not utilised due to drought restrictions, and are not viewed as representative of normal conditions). Agricultural usage has been licensed at 125 million m³/a.

The reduction of water losses in the system is still a challenge, most especially in the rural areas where it is estimated at 45%. The municipality aims to reduce this to 25% in the future.

	Urban	Rural
Current Non-Revenue Water	31%	45%
Target	25%	25%
Achieve By	2020	2025

Bulk Water Supply Infrastructure

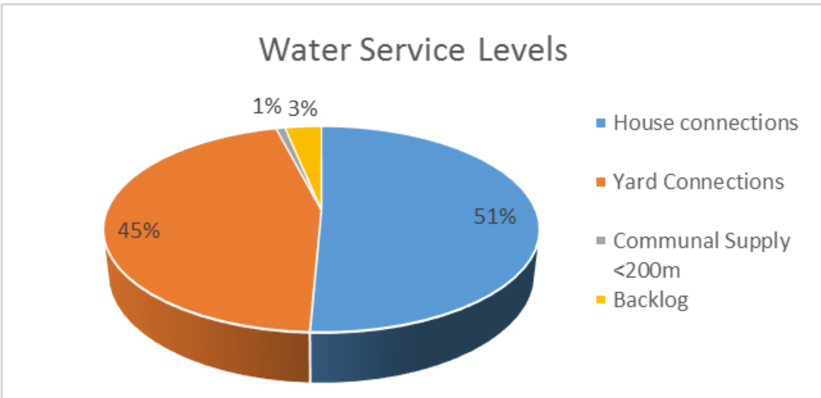
The four (4) existing Bulk Water Supply Schemes are:

1. Northern (Richards Bay/Nseleni)
2. Southern (Esikhaleni)
3. Western (Ngwelezane)
4. Empangeni

The four (4) Water Treatment Works are Nsezi (204Mℓ/day), Mzingazi (65Mℓ/day), Esikhaleni (36Mℓ/day), and Ngwelezane (8Mℓ/day). The **Nsezi** works is the most significant, supplying Empangeni at all times, and supplementing Richards Bay, and Ngwelezane, depending on drought levels. At present Nsezi provides the full supply to all these areas. The **Esikaleni** WTW is the second key WTW, providing water from Lake Cubhu (except in drought) and supplemented from the Mhlathuze Weir, to Esikaleni, Vulindlela and South into the neighbouring LM. The yield of the lake needs to be confirmed, as a recent study shows it to only be 1.1Mℓ/day. If this is true, then abstraction from the lake may need to cease, and all water come from the Weir. A study to confirm this is necessary. The **Mzingazi** WTW abstracts from Lake Mzingazi, but the yield of the lake is half of the treatment capacity, and the lake has failed more than once in the last decade. Water re-use interventions are recommended to supplement the water available from Mzingazi Lake, and take advantage of the available treatment capacity at this works. This will assist with both the increase of system yield, and also help justify the operational costs of this large works currently sitting in disuse. **Ngwelezane** WTW is a small works that has a run of river abstraction from the Mhlathuze River. Water levels result in operational issues, and it is recommended that this WTW is decommissioned, which will reduce overall operational costs.

Backlog

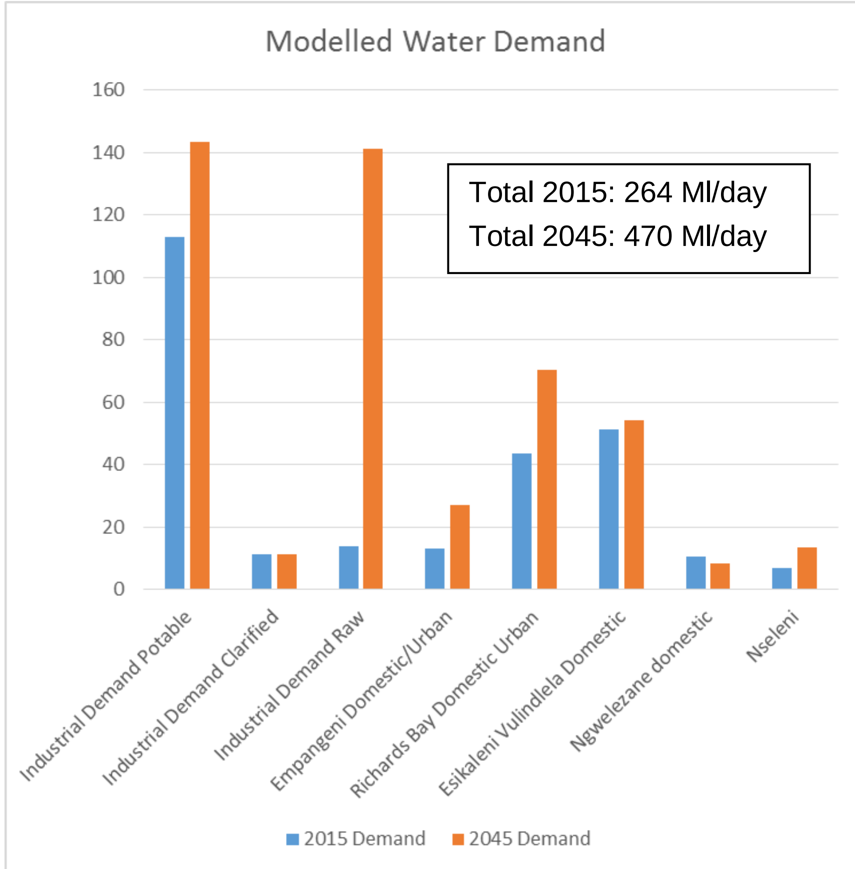
The City of Mhlathuze has reduced the water supply backlog significantly over the years, and as at March 2015, there is a backlog of only 3%.



Water Demands

Bigen Africa developed a zero-based demand modelling tool that has been used to determine the projected demands over a 30 year period (2015 – 2045) for City of uMhlathuze. The demand model is a Microsoft Excel application in which modelling is performed at Census "Small Area" Level. The predicted "zero based" water demands as derived through the model are calculated against time as:

- AADD (Average Annual Daily Demand): Average water demands excluding water losses
- GAADD (Gross Average Annual Daily Demand): AADD plus water losses
- SDD (Summer Daily Demand): GAADD x Summer Peak Factor



Three different scenarios were modelled. The scenario chosen for the gap analysis and intervention planning was the KZN Provincial Growth and Development Plan (PGDP) target to provide a minimum of 75ℓ/cap/day to all consumers in KZN by 2030. This has been interpreted as a level of service equivalent to a yard connection.

The total demand is inclusive of commercial, institutional, industrial (CII) and domestic demands. Due to the high industrial nature of CoU, it is critical to differentiate between the domestic and industrial demands. It can be observed that 63% of CoU's water demand is for industrial use.

Gap Analysis

Based on the findings, the recommendations being put forward are as follows:

- A detailed hydrological modelling exercise looking at the impact of NOT utilising the Mzingazi and Cubhu Lakes, and the impact this will have on the overall system yield. As a part of this study, the yields of the lakes should be confirmed. This eventuality should be planned for from a water resource provision perspective, considering the history of these lakes failing.
- The further investigation and implementation of the water resources yield improvement interventions
- The possible decommissioning of the Ngwelezane WTW

- The planned upgrade to the raw water line from Mhlathuze Weir to Nsezi WTW is recommended to meet future water demands.
- The upgrade of some of the bulk pipelines and reservoirs is required to meet future demand.

Interventions Proposed in this Study

Proposed Future Scheme	Proposed Infrastructure Component	Proposed Infrastructure Description	Estimated Cost		Year to be Commissioned				
			Prob	High	2015	2020	2025	2030	2035
Southern Scheme	Abstraction	Abstraction point: Mhlathuze Weir. Water to be augmented from Goedertrow Dam (raising dam wall). The Southern Scheme will be served exclusively by Mhlathuze Weir. Nsezi Scheme will also be supplemented with water from the Mhlathuze Weir.	R 284 926 271	R 436 517 987					
	Treatment	Upgrade existing Esikhaleni WTW with add. 13 - 21 Ml/d							
	Bulk Distribution	Upgrade Esikhaleni WTW to Forrest Reservoirs line with additional 400Ø - 500Ø mm line (9.0km)							
	Storage	Additional 7 -20 Ml storage at Forest Reservoir							
Nsezi Scheme	Abstraction	Mhlathuze Weir (augmentation costs included in Southern Scheme as this is a shared abstraction point); upgrade raw water line from Mhlathuze Weir to Nsezi WTW. Upgrade includes additional line from Mhlathuze Weir to Nsezi Offtake (1500Ø mm line (4km)) and Nsezi offtake to Nsezi WTW (1200Ø mm line (4km)) and raw water pumpstation.	R 2 789 090 190	R 3 071 140 674					
	Treatment	Upgrade Nsezi WTW with add. 67 - 112 Ml/d							
	Bulk Distribution	Upgrade raw water line from							
		New line (950Ø - 1000Ø mm) from Nsezi WTW to Madlazini Reservoir (7.7km)							
		Upgrade Nsezi WTW to Junction 50003 with additional 300Ø mm line (5.7km)							
		Upgrade Junction 50003 to Pearce Reservoir with additional 200Ø - 350Ø mm line (1.8km)							
	Storage	Additional 40 -60 Ml storage at Mandlazini Reservoir							
		Additional 20Ml storage at Hillview Reservoir							
		Additional 40 - 65 Ml storage at Hilltop Reservoir							
		Total	**R 3 074 016 462**	**R 3 507 658 660**					

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LIST OF ABBREVIATIONS

Ave.	Average
CoGTA	Department of Cooperative Governance and Traditional Affairs
CoU	City of uMhlathuze
DM	District Municipality
DWS	Department of Water and Sanitation
GIS	Geographical Information System
GRIP	Groundwater Research Information Project
GVA	Gross Value Added
HFY	Historical Firm Yield
IDP	Integrated Development Plan
ito	In terms of
KZN	KwaZulu-Natal
l/c/d	Litres per capita per day
LM	Local Municipality
LoS	Level of Service
m^3	Cubic meters
Ml/d	Mega-litres per day
m^3/a	Cubic meters per annum
MORFP	Mhlathuze Operating Rules and Future Phasing
MWAAS	Mhlathuze Water Availability Assessment Study
PSP	Professional Service Provider
RDP	Reconstruction and Development Plan
RF	Reference Framework
TBD	To be determined
UAP	Universal Access Plan
UW	Umgeni Water
WARMS	Water Authorisation and Registration Management System
WSA	Water Service Authority
WSDP	Water Services Development Plan
WSP	Water Service Provider
WSS	Water Supply Scheme
WTW	Water Treatment Works

1. OBJECTIVES AND METHODOLOGY

This report is the Reconnaissance Study for the Universal Access Plan Phase 2 – Progressive Development of a Regional Concept Plan for The City of uMhlathuze (CoU).

1.1. Background to Study

The Department of Cooperative Governance and Traditional Affairs (CoGTA) in association with Umgeni Water initiated the development of a Universal Access Plan (UAP) for bulk water supply in the KwaZulu-Natal province in 2013. The study focused on ten (10) WSA's in the KwaZulu-Natal Province and constituted Phase 1 of the project. The outcome of this Phase 1 plan provided good base information in some of the WSA's with regards to water supply in KwaZulu-Natal. There were however areas for improvement in the plan as per the following observations:

- The project focused on small localised schemes for universal access in the near future, however these proposed schemes are not necessarily sustainable.
- The proposed schemes were largely designed in isolation and took little cognisance of other water planning studies and recommendations.
- Many of the WSDP's and /or Water Master Plans were being updated during the course of the project, and need to be incorporated into UAP planning.
- The project did not go as far as Umgeni Water's extended area into the Eastern Cape.
- The footprints did not take cognisance of town planning type information that would give an indication of future demands.

These gaps have resulted in Umgeni Water (UW) initiating a second stage of this UAP project with the main objective being the progressive development of a Regional Bulk Water Supply concept plan for the Municipality that would address bulk water supply backlog.

Umgeni Water has appointed Bigen Africa Services (Pty) Ltd, in association with Ziyanda Consulting CC, to review the Phase 1 of the UAP project in the form of developing UAP – Phase 2, for Ugu District Municipality (UDM), uMgungundlovu District Municipality (UMDM), Umkhanyakude District Municipality (UKDM), Zululand District Municipality (ZDM) and City of uMhlathuze (CoU) all located in the KwaZulu-Natal province.

The development of the plan resulted in the following two (2) deliverables:

Deliverable 1:	Status Quo Report
Deliverable 2:	Reconnaissance Study Report and GIS data, namely an updated DWS Reference Framework Geodatabase for the study area; and maps to be published as part of an interactive mapping series.

This report serves as part of deliverable 2.

1.2. Purpose of Report

A reconnaissance study refers to a desktop study designed to ascertain whether further planning studies are warranted.

This report provides a concept plan for regional bulk water supply infrastructure that will address water backlogs in terms of Regional Bulk Water Supply.

In the context of this report, regional bulk is defined as per the *Regional Bulk Infrastructure Grant (RBIG) Framework for Implementation (DWS, 2010)* definition:

> *The infrastructure required to connect the water resource, on a macro or sub-regional scale (over vast distances), with internal bulk and reticulation systems or any bulk supply infrastructure that may have a significant impact on water resources in terms of quantity and quality.*

- ***"Macro"** is defined as infrastructure serving extensive areas across multi-municipal boundaries.*
- *"**Sub-regional**" is defined as large regional bulk infrastructure serving numerous communities over a large area normally within a specific district or local municipal area;*
- *Over "**vast distances**" is considered as any distances greater than 5 km.*
- *Bulk infrastructure that has a "**significant impact on water resources**" includes:*
  - *Any bulk scheme or component that is designed for maximum demand of 2 Mℓ/day or more.*
  - *Any waste water treatment plant that discharges into a fresh water resource system.*
  - *Any water treatment plant that is designed for a maximum demand of more than 2 Mℓ/day.*

1.3. Specific Targets of the Study

The main outcomes as per agreement between the Client, Umgeni Water and all professional service providers engaged in this study are as follows:

1. Supply areas are defined and prioritised based on agreed criteria including footprints (from UAP Ph1), needs, proximity to existing bulk schemes, financial viability, footprint density, DHS and land claim areas, proximity to development nodes, sustainable demands, etc.
2. Existing supply schemes (NB regional) are verified, quantified, documented and mapped.
3. Options of already proposed regional schemes are assessed and documented.
4. Perform high level assessment of demand/supply capability.
5. Required new or existing water resource sources are determined and mapped.
6. Extensions to existing schemes and/or new regional schemes are documented in GIS and Visio.
7. Key stakeholders are informed (UW, DWS, COGTA, SALGA).
8. DWS Geodatabase is updated, data sent to COGTA.

1.4. Study Process

Figure 1 summarises the process followed for this Reconnaissance Study.

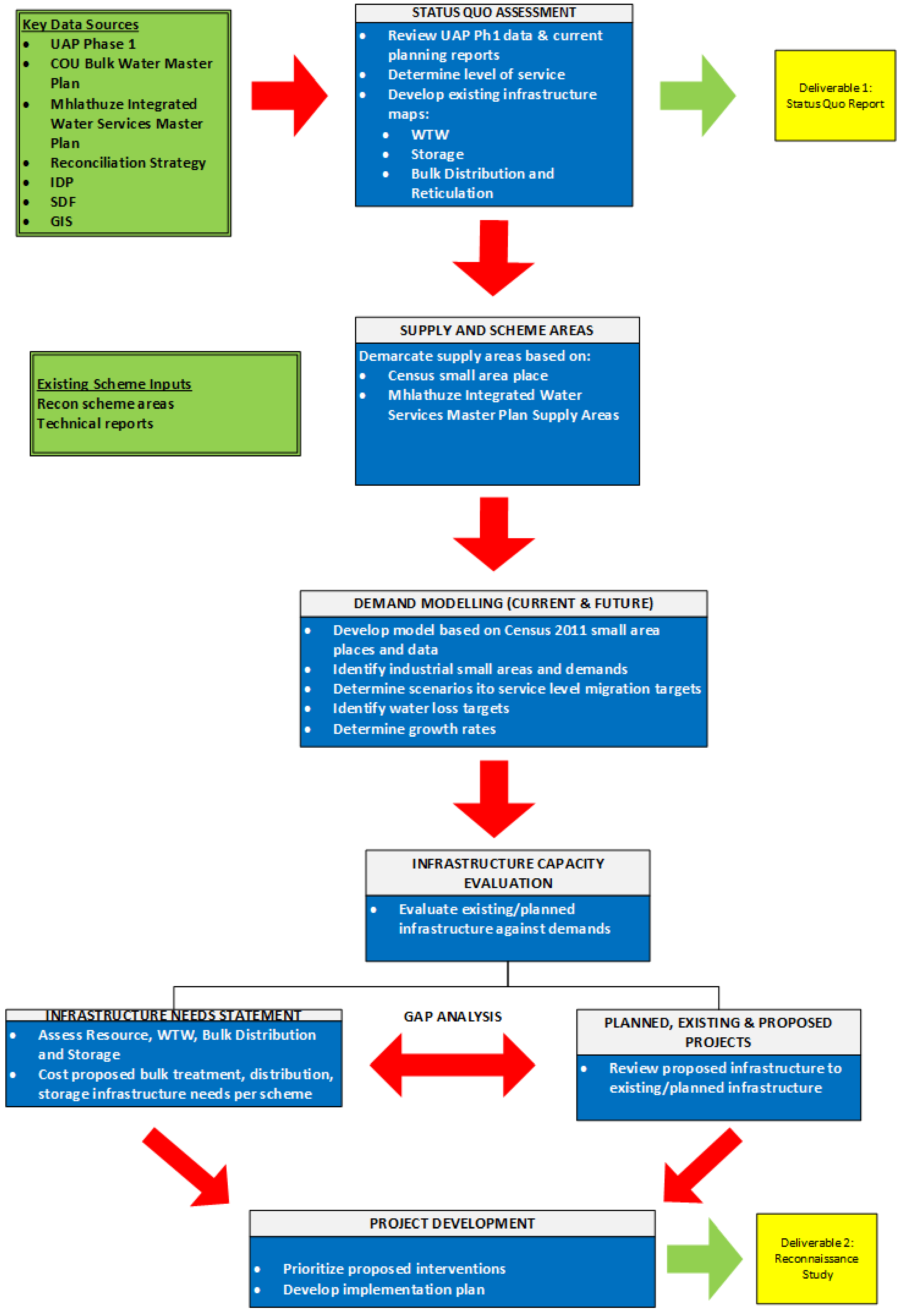

Figure 1: Study Process

This report is outlined in relation to the process shown in **Figure 1**:

- **Section 2** and **3** provides general background information on the study area.
- **Section 4** describes the demand modelling process, inputs and a WSA summary of the demand projections.
- **Section 5** summarises water resource availability in CoU.
- **Section 6** details the existing bulk schemes within the study area. Existing infrastructure is defined as either infrastructure already in the ground or currently in construction.
- **Section 7** highlights planned bulk infrastructure interventions/projects either by the WSA or related institutions. The interventions summarised in this section are from the CoU Bulk Water Master Plan and Mhlathuze Water, the current Water Board in this study area. Only interventions/projects related to regional bulk infrastructure were evaluated during this study.
- **Section 8** details the interventions proposed by Bigen Africa as a result of this study. This section is broken down per water supply scheme. Each scheme details the respective demands, water resource considerations, proposed infrastructure and financial implications.
- **Section 9** provides recommendations for actions going forward.

2. STUDY AREA

2.1. Context

The City of uMhlathuze (CoU) is on the North-East coast of KwaZulu-Natal, approximately 180km North of Durban. The local municipality is part of the uThungulu District Municipality and is the third (3rd) largest municipality in KZN (City of Umhlathuze, 2016). CoU is a port city, with a vision to be a renowned centre for travel and tourism, nature lovers, coastal recreation, commerce, industry, forestry and agriculture. The Municipality's mission is to be an industrial, commercial and administrative centre with an aspiration to achieve **Metropolitan Status**. CoU has Water Services Authority (WSA) status. Bulk water services (WSP function) within CoU are currently shared between the WSA and Mhlathuze Water Board, the existing Water Board in this region. **Figure 2** provides a provincial perspective of CoU's location within KZN.

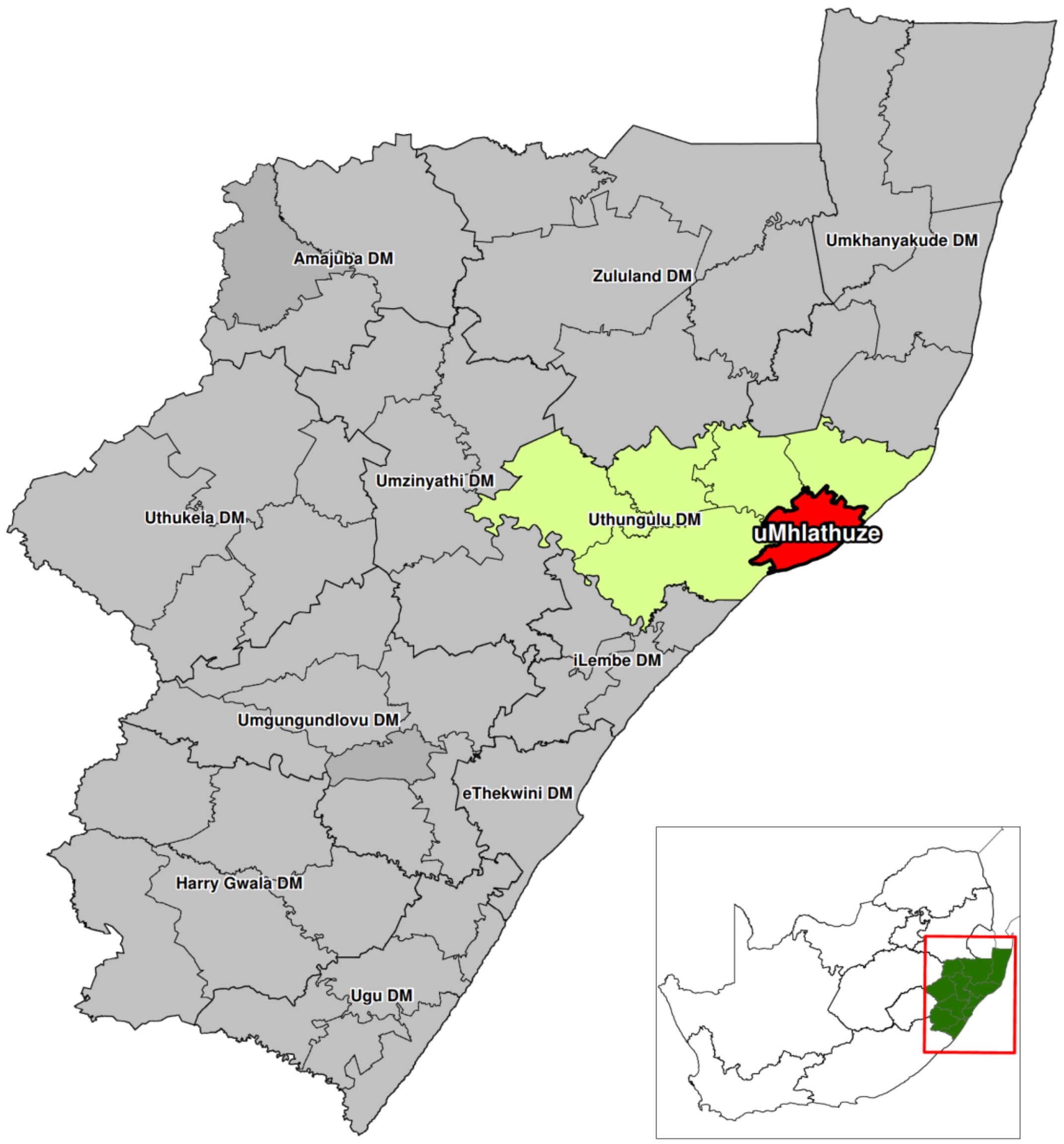

Figure 2: Provincial Perspective

2.2. Boundaries of Study Area

CoU (KZN282) is bounded by three (3) other local municipalities that are part of uThungulu District Municipality (DM28), namely; Mfolozi Municipality (KZN281) in the North, Ntambanana Municipality (KZN283) in the North-West, and uMlalazi Municipality (KZN284) in the South-West. The Eastern boundary is the Indian Ocean coastline (City of uMhlathuze, 2015). **Figure 3** provides a district municipality perspective of CoU's location.

Figure 3: District Municipality Context of WSA (Refer to **Annexure A** for an enlargement of this map)

The area is divided into 30 municipal wards, as reflected in **Figure 4**.

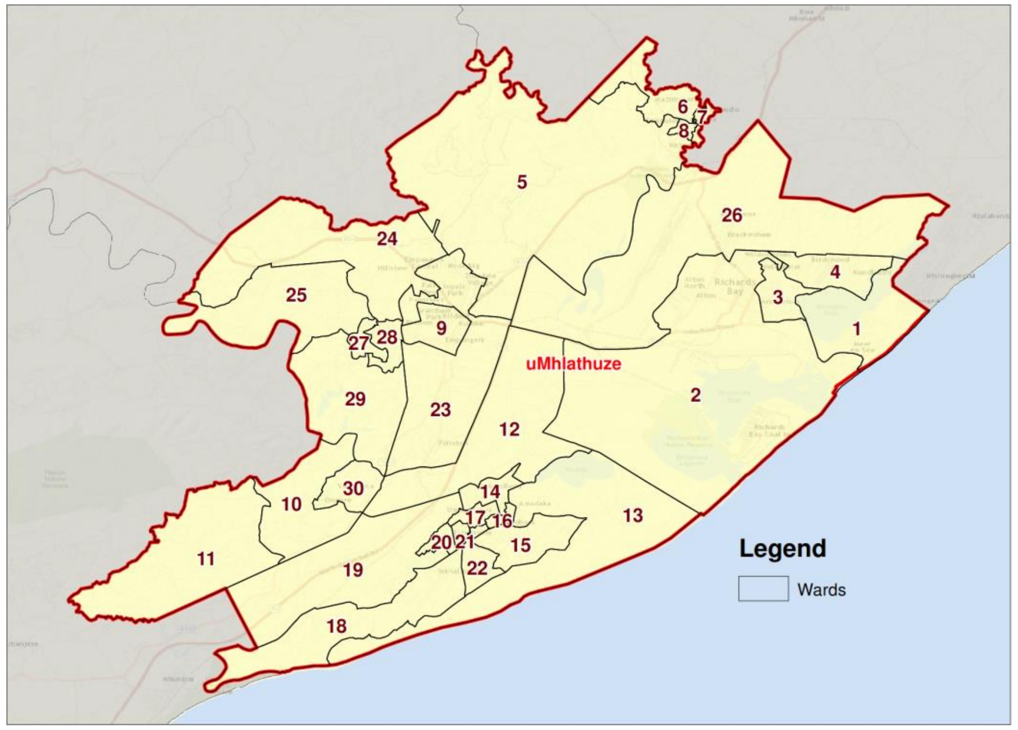

Figure 4: Local Municipality Context of WSA (Refer to **Annexure A** for an enlargement of this map)

The two (2) main economic towns are Richards Bay and Empangeni (**Figure 5**). Supporting areas include eSikhaleni, Ngwelezane, Nseleni, Felixton and Vulindlela. Traditional Authority areas of Dube, Mkwhanazi, Khoza, and Zungu are in the South of CoU and are considered rural.

According to CoU's IDP (2015), the boundaries of CoU are being re-determined and are expected to take effect following the municipal elections in 2016. Wards 5, 7 and 8 of Ntambanana Municipality, to the North West, will be incorporated into CoU, adding the Traditional Authority areas of Obuka, Somopho, Mthuyane and Cebekhulu to CoU. Due to the timing of the study, the new areas have not been taken into account and are still considered as part of Ntambanana LM as it was not official at the time of completion of this report.

2.3. Physical Characteristics of Study Area

Figure 5 illustrates land use, major roads and development nodes.

The area covers approximately 795km^2. Large areas within CoU are under commercial agriculture (IDP 2015/16).

There are fairly large Traditional Authority areas, in the South on both sides of the N2, with the private, commercial and other land uses stretching from West to East between Empangeni and Richards Bay.

The N2 highway transects the Municipality in a North-East to South-West direction, dividing the towns of Empangeni and Richards Bay. The R34 is another major East-West road in the area, and passes through Empangeni towards Melmoth. Other roads include the MR431 into Richards Bay and the Old Main Road. Railways are prevalent in the area but are for commercial and industrial use only.

The port of Richards Bay is a key physical and economic characteristic in the area. There is an airport located within the residential developed area towards the North East of the City and its relocation is currently being considered. There are large industrial areas in and around Richards Bay.

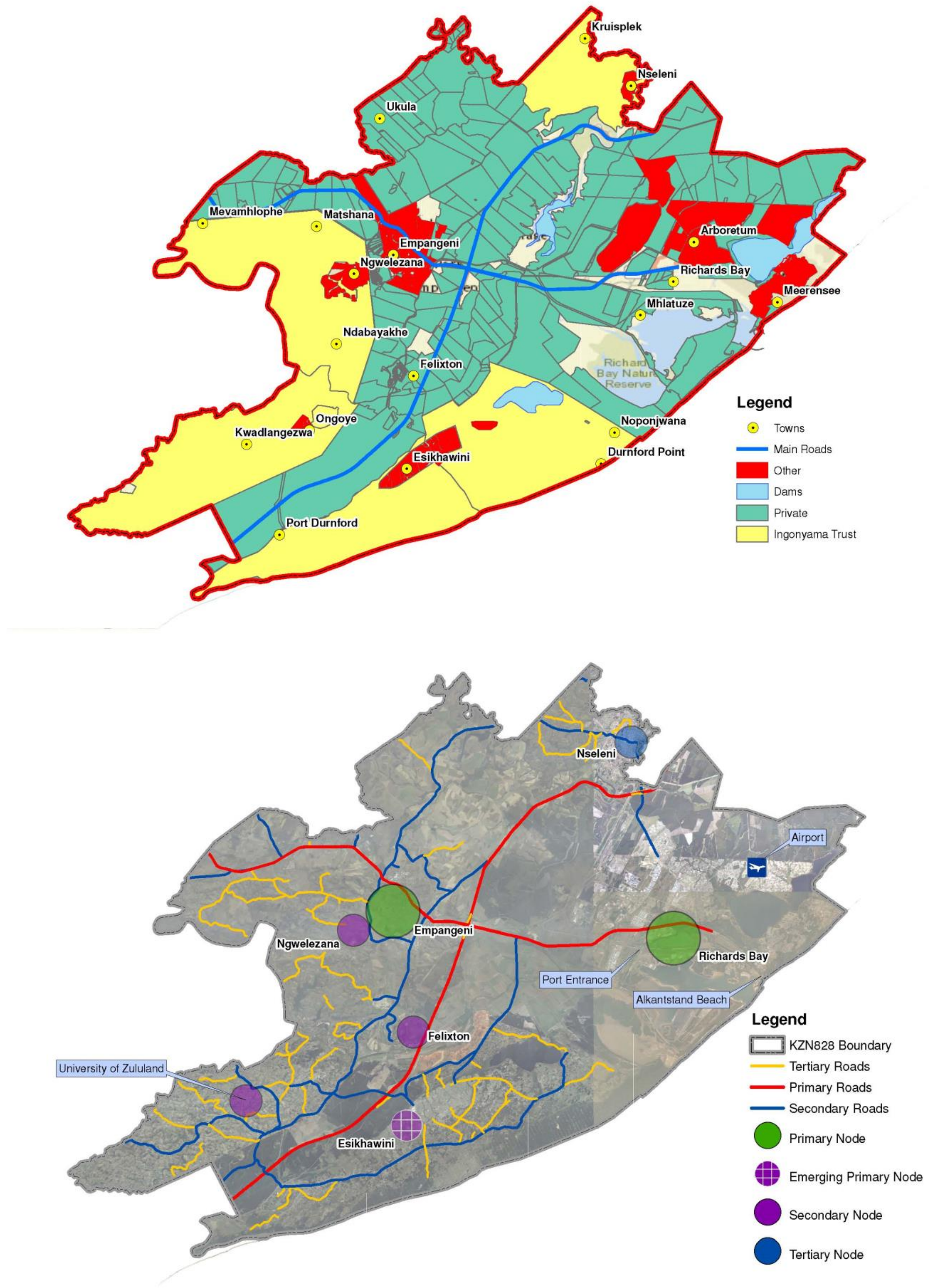

Figure 5: Land Use (Above) and Physical Characteristics (Below)

2.4. Climate

The CoU falls within the sub-tropical coastal region. The climate is warm to hot and humid sub-tropical. Average daily maximum temperatures range from 29 degrees Celsius in January (summer), to 23 degrees Celsius in July (winter); however summer does reach the extremes of greater than 40 degrees Celsius in summer. The average annual rainfall is 1228mm, with 80% of this occurring in summer from October to March. Extreme rainfall and extensive flooding due to cyclonic activity is on the increase (City of uMhlathuze, 2015).

CoU is currently affected to a major degree by the drought being experienced in KZN.

2.5. Topography, Geology and Soils

The coastal plains around Richards Bay are generally very flat, with the terrain rising and becoming undulating towards Empangeni. The area has large wetland systems and natural water features such as Lakes Cubhu, Nsezi, Nhlabane, and Mzingazi.

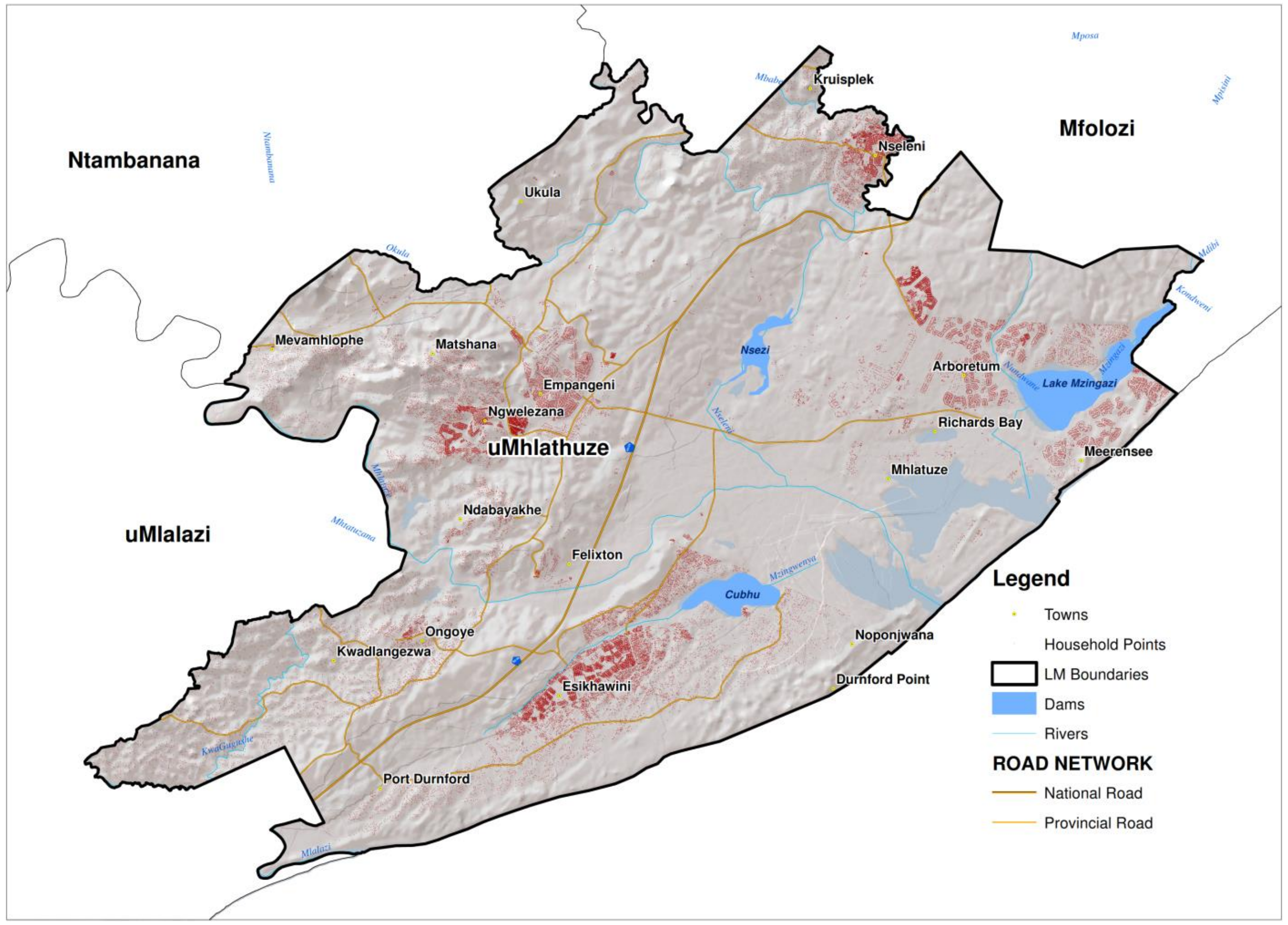

Figure 6 illustrates the topography of CoU.

The area is part of the Zululand Coastal Plain and the landscape is generally described as low-relief bounded by coastline in the East; and high-relief in the West. The area is underlain by marine, littoral, and dune deposits of the Maputaland Group. The area supports unique hydrological systems due to the unusual landscape, and this has resulted in a high level of species diversity. The soils are very permeable and almost all rainfall infiltrates into the groundwater before ultimately being discharged into streams, lakes and wetlands (City of uMhlathuze, 2015).

The lithologies in the study area comprise a wide variety of sedimentary, igneous and metamorphic geological types. The Zululand coastal plain comprises a near surface succession of loosely consolidated sands, silts and clay overlying Cretaceous Age sedimentary siltstone bedrock. Organic silts and clays associated with fluvio – estuarine deposits of the Mhlathuze River and the marine estuary are prevalent in certain areas. The presence of alluvium – infilled incised formed river channels extending to depth below the general bedrock level have been established (WSDP, 2005).

Thin discontinuous layers of late Tertiary Miocene sediments comprising an upper calcarenite and lower coquina are found to overlie the Cretaceous Age siltstone in certain areas (WSDP, 2005).

The sub-regional groundwater level generally occurs at shallow depths below ground level. Surface water bodies which occur as small vleis, marshes and drainage courses, are an expression of the regional ground water level on the sites investigated (WSDP, 2005).

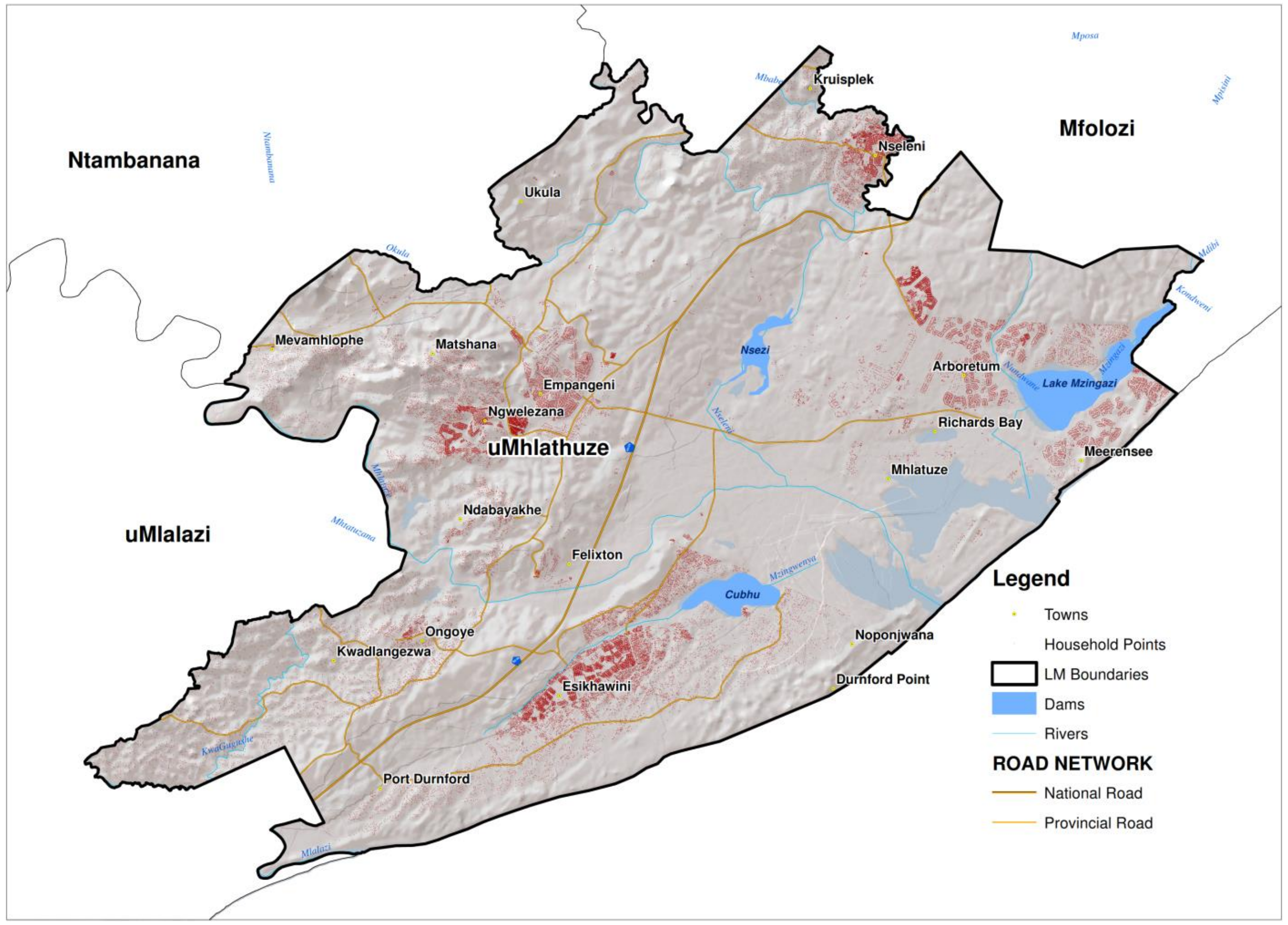

Figure 6: CoU Topography (Refer to Annexure A for an enlargement of this map)

The South-Western area which includes Mhkwanazi and Vulindlela mainly composes biotite quartzo-veldspathic schists. A few dolerite dykes have intruded through the schists, especially in the South-Eastern part. Amphibolites covering a few hectares have been found in the schist between Ngoye Mission and the Ngoye range (WSDP, 2005).

A thin veneer of red sand (Berea member) of middle Pleistocene age overlies the schist in the East along the Empangeni-Mthunzini Road. This red sand has been deposited on an old erosion platform which has been found to be 115 meters above sea level. A boulder bed which is less prominent in this area has been found to form a border line between the deeply weathered schists and red sands. The red sands extend towards Port Durnford forest and Esikhawini to terminate in an island shape at Hillendale on the edge of the Mhlathuze River floodplain (WSDP, 2005).

The Empangeni metamorphic suite is found immediately to the West and North-East of Empangeni. It comprises granoblastic, gneissic and amphibolitic rocks (WSDP, 2005).

2.6. Environmental

According to the IDP (City of uMhlathuze, 2015), CoU is a part of the Maputaland-Pondoland-Albany biodiversity hotspot, which is the second richest floristic region in Africa. The area supports 174 Red Data species, which is exceptionally high for an area of this size. For this reason, the remaining areas of indigenous floral cover are considered irreplaceable. A large portion of the hotspot continues to be transformed and degraded by human activities and the species complexity is being threatened.

Many wetland areas have been drained to accommodate development, but some of these, for example the Thulazihleka Pan, have resulted in the formation of valuable natural assets that support endemism and biodiversity.

The area has a persistent problem with poor air quality due to the emissions in the industrial areas. This poses a risk to human and environmental health, and exacerbates climate change.

The coastal dunes are sensitive to erosion and change, but are also sought after for their mineral content, and large areas are under mineral mining.

An Environmental Management Framework (EMF) was completed in 2007 focusing on the port expansion areas. It was concluded that the port and harbour falls within environmental management zones with high levels of sensitivity in terms of biodiversity and geotechnical constraints.

In addition, the CoU adopted an Environmental Services Management Plan in 2011 that looked at the entire municipal area and areas of environmental sensitivity were defined, and land that could be developed was identified.

Figure 7 illustrates zonal areas of environmental significance.

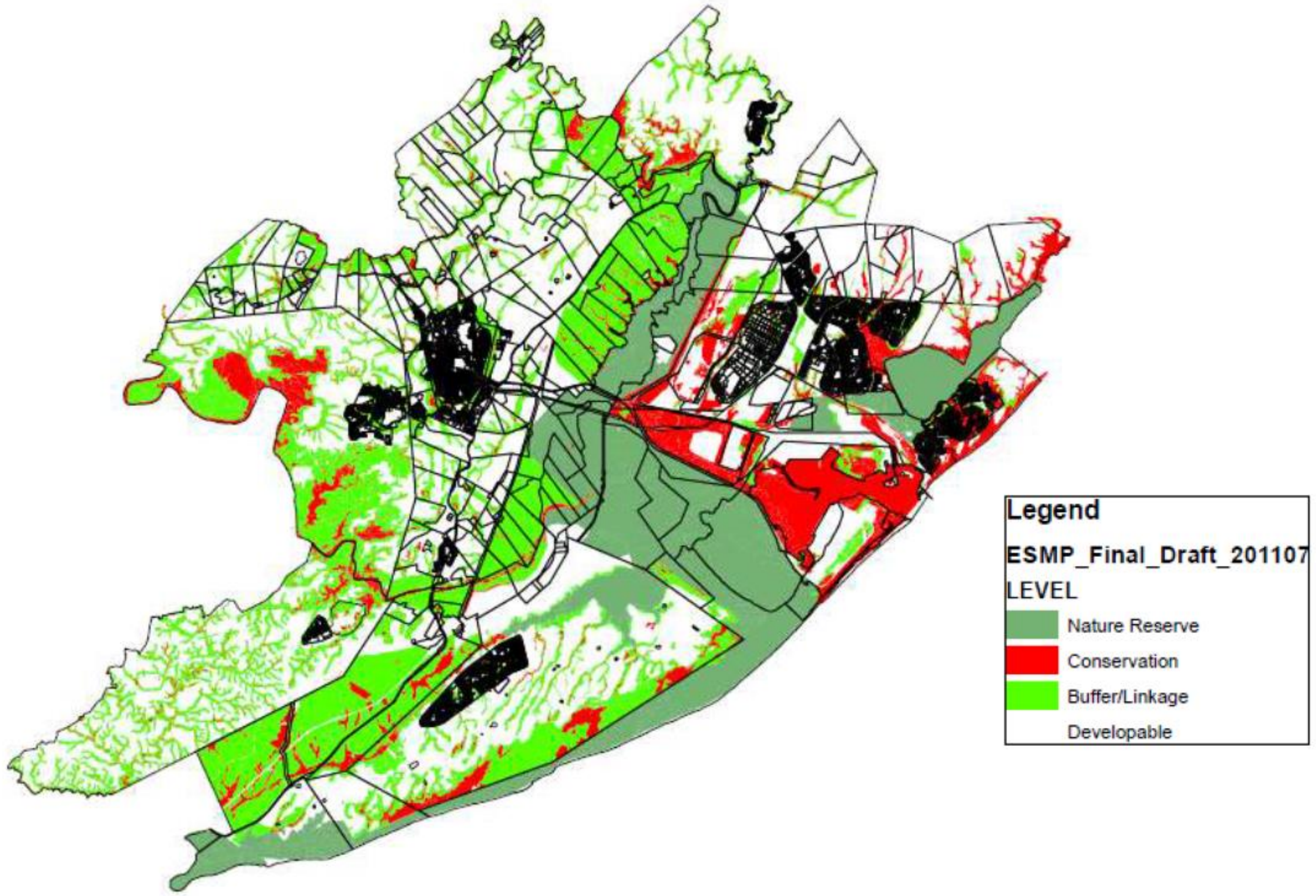

Figure 7: Zones defined in the Environmental Services Management Plan

3. DEMOGRAPHICS

3.1. Existing Population and Distribution

The population of CoU as per Census 2011 (StatsSA, 2011) was 334 459. This constitutes 37% of the total population of the uThungulu District Municipality. There are slightly more females (51.3%) than males (48.7%) in the Municipality.

A total of 58% of the population resides within Tribal Authority areas, 39% in urban areas, and 3% on farmland. So, although the Municipality markets itself as a “City”, there are 1.5 persons living on tribal or farmland for every person residing in an urban area. **Figure 8** illustrates the distribution and type of settlements in CoU as per the Infrastructure Reference Framework Geodatabase (Department of Water and Sanitation, 2016).

The age profile of the Municipality shows a dominance in the 15-29 year age brackets, which could be as a result of the perception of the job opportunities in the area, causing in-migration of job seekers from surrounding local municipalities. Overall, 67.5% of the population is in the economically active age group of 15-64 years.

Based on growth rates provided by Umgeni Water (detailed in Section 3.5), it is estimated that the 2015 population for CoU has increased to 349 887. This is based on an average annual growth rate of 1.13%. These figures are summarised in **Table 1**.

Table 1: CoU Existing Population Summary

Descripton	Value
Census 2011 Population	334 459
Estimated Population for 2015	349 887
% Average Annual Growth Rate	1.13%

3.2. Social and Economic Indicators

As per Census (StatsSA, 2011), the unemployment rate in CoU is 31%, with youth unemployment higher, at 40.8%. There is fairly significant range across the wards with the urban areas of Richards Bay and Empangeni having the highest level of employment and the lowest employment on the urban periphery of Esikhaleni and Nseleni (City of uMhlathuze, 2015). The unemployment growth rate in unemployment in the Traditional Authority areas from 1996 to 2011 was 57.64% and in the urban areas almost three times higher, namely 158.9% (SA Cities Network, 2014).

The average household annual income in CoU in 2011 was R 121 177, just over double that declared in 2001. However, 15% of households have no income, while over 50% of households have an annual income of R 38 200 per annum (R 3000 or less per month) or less. There is a large proportion of the economically active population that earns <R 1600 per month (R 19 200 per annum).

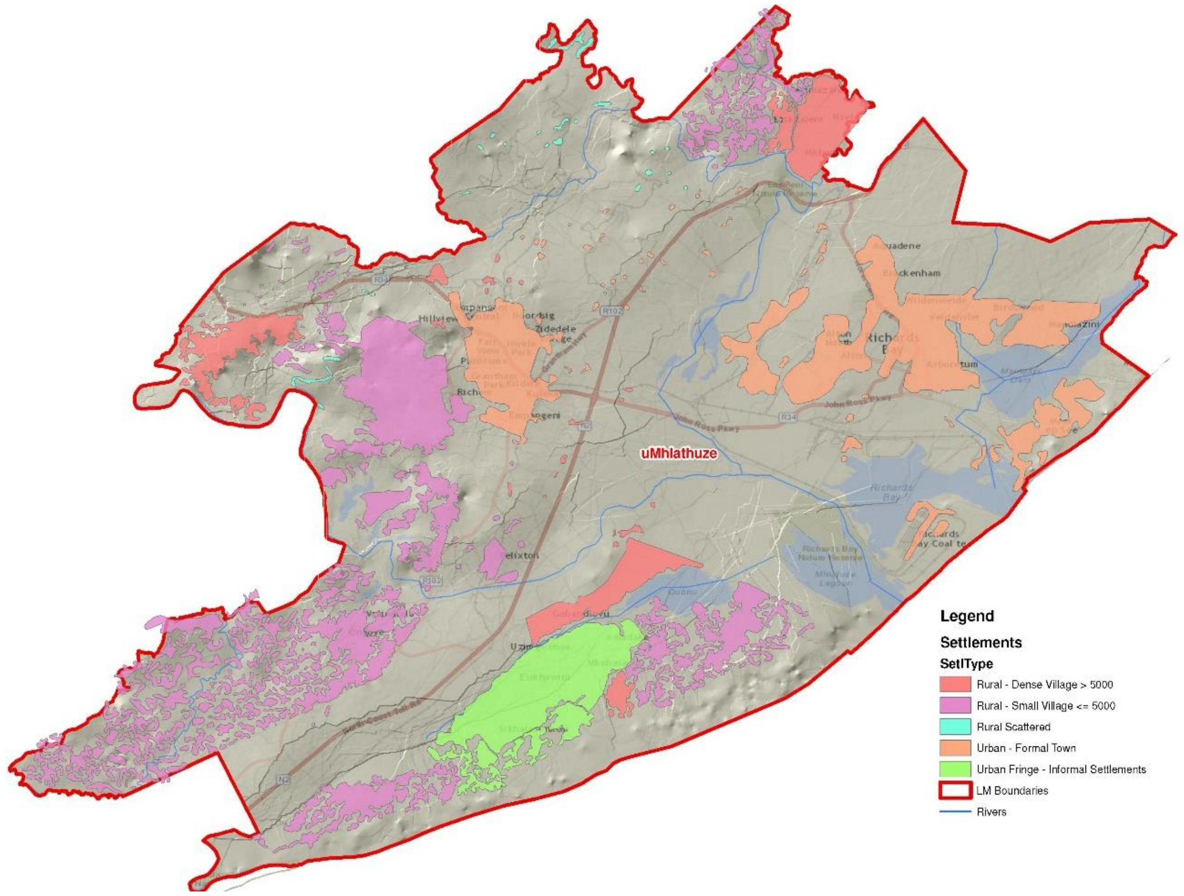

Figure 8: CoU Settlement Distribution (Refer to **Annexure A** for an enlargement of this map)

The sectors that experienced a decline in employment from 1996-2011 are:

- Agriculture
- Metal products, machinery and household equipment
- Electricity and water
- Land and water transport

Given the economic importance of forestry and logging, wood and wood products and metal products, machinery and household equipment, the relative decline in these sectors is a cause for concern.

The sectors showing a growth in jobs are:

- Education
- Health and social work
- Retail trade
- Wholesale
- Construction
- Other business services

(SA Cities Network, 2014)

3.3. Commercial, Industrial and Institutional Development

CoU plays an important role in the National, Provincial and District Economies due to the bulk-handling harbour at Richards Bay. The harbour is the largest deep water port in Africa, and handles a large proportion of South Africa's exports. The port originally provided the impetus for large scale industrial development in the area. The CoU is the uThungulu DM's largest contributor to its GDP. The most important industries are BHP Billiton Aluminium, Mondi, SAPPI, RBCT, Tata Steel and Bell Equipment (IDP 2015/16).

The economy of CoU is dominated by the Richards Bay – Empangeni complex. The sectors that contribute the most are (SA Cities Network, 2014):

- Metal products, machinery and household appliances (11.02%)
- Land and water transport (10.83%)
- Food, beverages & tobacco (7.37%)
- Wood and wood products (7.21%)
- Mining of metal ores (6.42%)
- Education (5.66%)
- Real estate (5.57%)
- Finance and insurance (4.4%)

These eight (8) sectors contributed 58.5% of the GVA in 2011. Metal products and machinery; wood and wood products; and mining of metal ores are the primary drivers, with education, real estate, finance and insurance as secondary. The strong GVA component in manufacturing and processing is dependent on the success of a handful of large industries (SA Cities Network, 2014).

The economy of the CoU grew significantly in the period 1996-2001, outpacing the growth rates of KZN and the country. However, from 2001-2011, the growth slowed significantly due to the strong link of the local economy to the international economy, which saw a slump in 2007/08. If the local economy continues to decline, this will have a significant impact on the residents in this area. The City will need to look beyond the mining phase and ensure other strong economic drivers if the City is to regain and sustain a strong local economy (SA Cities Network, 2014).

The CoU, more specifically Richards Bay, is a highly industrialised area. The municipal valuation roll gives an indication of the value the industrial and commercial sector add to the Municipality:

- The number of industrial properties is 3.56% of the total properties, but constitutes 22.8% of the value of all properties.
- The commercial properties form 3.43% of the total properties and 14.4% of the total value.
- Residential properties form 90% of the total number of properties and 54% of the value of all properties.

In contradiction to the Provincial Economic Growth, significant growth and development plans in the residential, commercial and industrial sectors are planned by the CoU. The overall approach is outlined in **Table 2**.

Table 2: CoU Planned Development Outline (City of uMhlathuze, 2015)

Overarching Development Plans	
Port and related infrastructure	As the main economic attraction of the area, the port is the overarching priority for stimulating the local economy. It is also a provincial priority in that it is the growth engine for one of the primary provincial growth nodes. Port and related infrastructure is classified as Strategic Important Developments and such is important for the National Economy. Port expansion options are addressed in the Port Development Framework (2007) which has been integrated with the City's IDP and SDF and form parts of the City's Local Economic Development Strategy.
Transport	The City's Arterial Road Framework and Airport Framework Plan are under review (2009). **The John Ross Parkway is currently being upgraded.** Over the long-term it may need to be rebuilt to accommodate the proposed port layout plan, encroaching into land earmarked for development for the IDZ.
Rail infrastructure	Rail infrastructure links the port with the hinterland to ensure the flow of resources. The National Infrastructure Plan makes provision for expansion and upgrades of transport networks.
Industrial development	The Richards Bay Industrial Development Zone has been designated as a National priority for stimulating growth in the manufacturing sector. The manufacturing sector is important in the province (largest contributor to PGDP). The City promotes "competitiveness in the manufacturing sector whilst advancing downstream value-adding opportunities that are labour intensive". IDZ are advocating high growth scenarios which are not supported.
Commercial activities	National Government: Promote Local Economic Development Initiatives. The City's IDP promotes a diversity of economic activities and the Local Economic Development Plan makes provision for growth in the commercial sector by encouraging new initiatives for emerging businesses, the informal sector and SMME's.
Agriculture	Agriculture is a provincial development priority (food security). The focus of the City's Agricultural Development Strategy and Plan is on traditional authority areas and addressed emerging farmers. **There are no local priorities for agriculture expansion within the study area.**

Overarching Development Plans	
Tourism	The region within which the study area is located has been identified as a provincial tourism priority. The City's IDP acknowledges the tourism potential of the area and promotes the enhancement of this potential.
Mining	Mining of mineral resources is an important economic activity in the region. There is only one mine in the study area while mining rights have been assigned to the south of the area. **The mining activities are being catered for.**
Energy	The City has an Energy Strategy (2009) to "minimise the local and global environmental impacts of energy use by adopting and promoting efficient demand-side practices and by encouraging the uptake of renewable energy options within all sectors". The strategy defines objectives for the environmental, social, economic and institutional sectors. It also sets demand side and supply side targets for the municipality. Existing electric overhead power lines serves the City and the aluminium smelters. These power lines may need to be relocated further north to accommodate the proposed port layout plan, encroaching into land earmarked for development for the IDZ.
Housing	Sustainable human settlements are a national policy goal. Private land ownership, lack of suitable infrastructure, environmentally sensitive wetlands, geotechnical and environmental considerations limits suitability. A number of potential land parcels have been identified with housing potential and urban densification is receiving attention. An increasing need for housing within or close to the CBD is projected. The greatest need for housing occurs in rural/tribal areas and the removal of slums and informal settlements is a priority. Land tenure is a major challenge.

As part of the Strategic Development Framework (SDF), eight (8) expansion areas (A-H) as shown in **Figure 9** with specified land uses have been determined based on anticipated population increase. In addition, an urban edge has been delineated, which will be utilised when considering the provision of urban services.

Areas A-H are significant expansion areas and the plan is that they would contain mixed land uses.

The division of land uses is as follows (CSIR, 2014):

- The Human Settlements Plan has the potential residential units as 100 000, allowing for 250 000-400 000 people. Based on population growth of 2% per annum, this would be adequate beyond 2040.
- A total of 1640 ha of the expansion areas have been deemed suitable for commercial and industrial development. Already, plans have been approved in areas C, E and F for 550 ha of industrial and commercial development.
- A total 820 ha has been approved for social/administrative purposes, with 240 of these already approved within areas A, D, E, F, and H, with the remainder still being available for future use in B and G.

These expansion areas have only been taken into account in the demand model, in terms of industrial demands as identified in the CoU Bulk Water Master Plan.

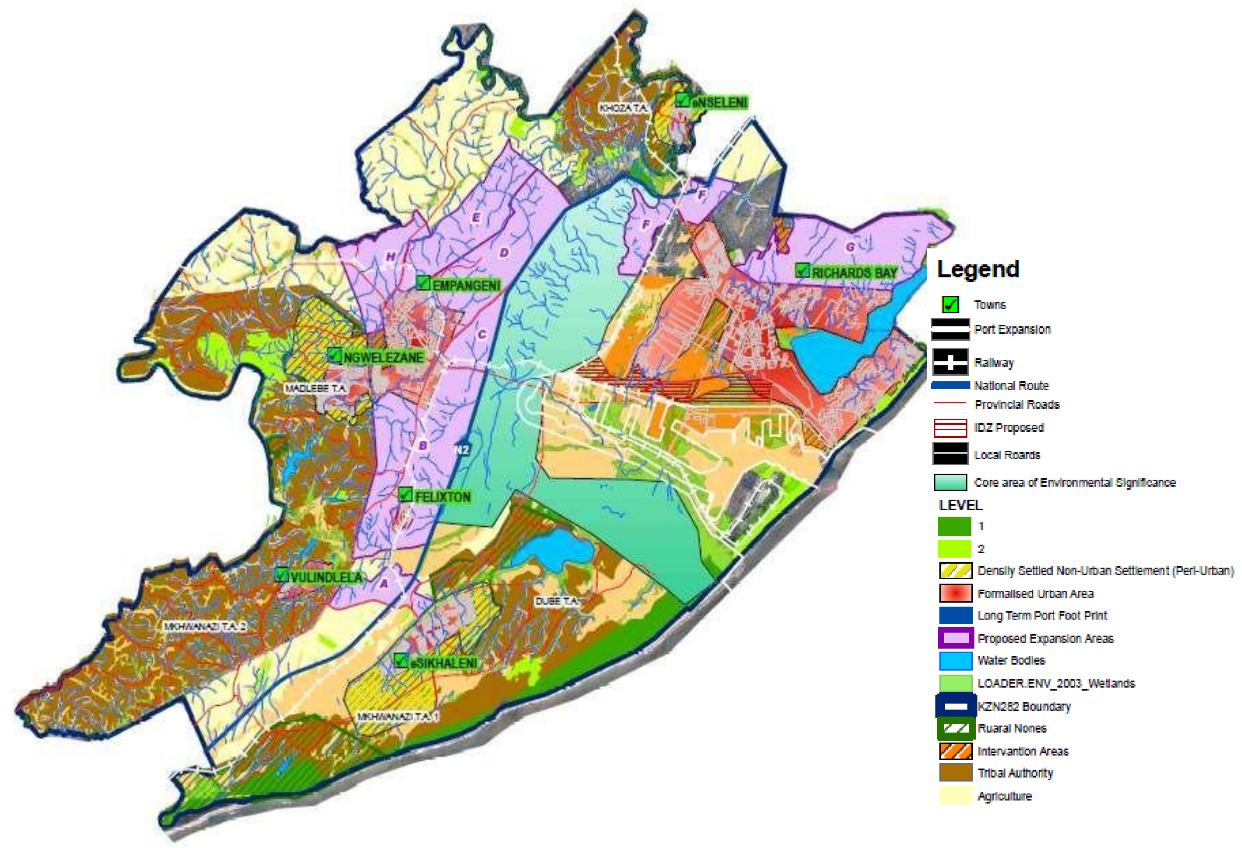

Figure 9: Current and planned development areas (IDP) 205/16)

3.4. Population Growth

This sections highlights the historic growth rates of CoU.

The CoU population grew from 289 190 in 2001 to 334 459 in 2011 (Census figures). This is an annual growth rate of 1.45% per annum, which is nearly double the provincial growth rate. This is, however, a significant slowdown in growth from the previous period of 1996-2001 where the rate was over 7% per annum. The CoU and Mfolozi LM are the only municipalities in the uThungulu District that had a positive growth rate for this period. CoU has remained the municipality with the largest population (**Table 3**).

Table 3: Population growth rates from 1996-2011 (CoU, 2015))

	1996 - 2001	2001 -2011
KZN282: Mhlathuze	7.69%	1.45%
KZN286: Nkandla	0.62%	-1.55%
KZN281: Mfolozi	2.06%	1.39%
KZN283: Ntambanana	3.07%	-1.31%
KZN284: uMlalazi	-0.81%	-0.34%
KZN285: Mthonjaneni	6.27%	-0.52%
DC28: uThungulu	**3.00%**	**0.24%**

The following is noted:

The population changes from 2001 to 2011 can be understood in more detail:

- The population of uThungulu DM, excluding CoU, decreased overall by 23 764 – 18 003 less in the Traditional Areas, 10 041 less on commercial farms; and 4 756 more people in the urban areas.
- The population of CoU increased by 45 617 – 14999 more people in the Traditional Areas; 3 442 more on commercial farms; and 27 276 more in the urban areas.

The SA Cities Network (2014) report suggests that much of the decline in population in the greater uThungulu areas is due to people moving into the CoU. **Figure 10** illustrates this possible migration trend.

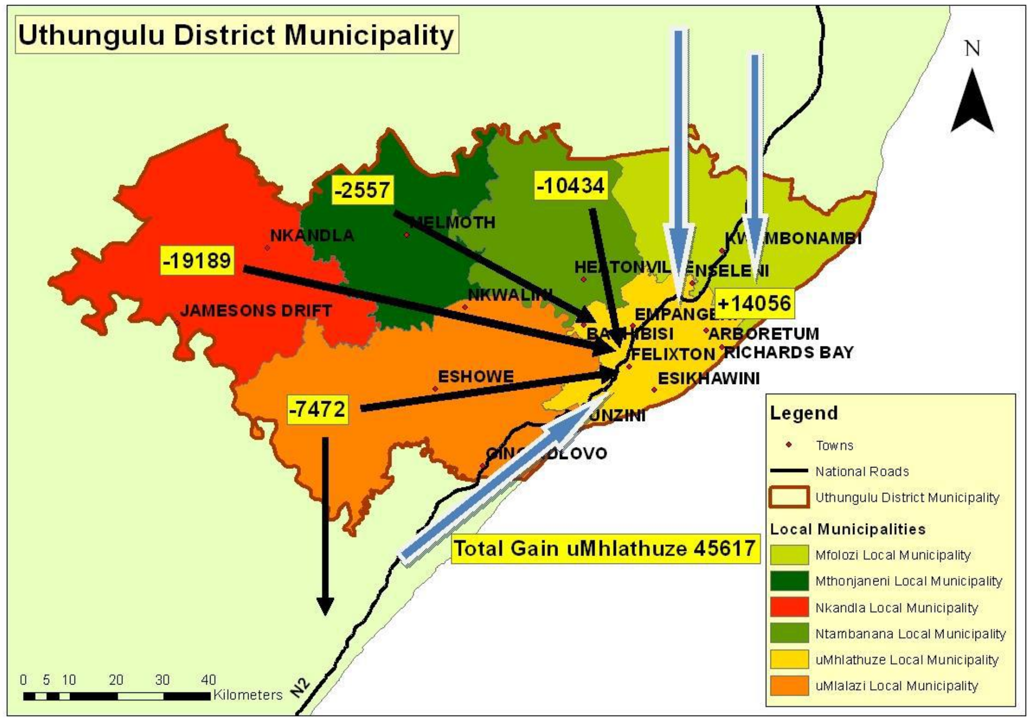

Figure 10: Possible explanation of population movements between 2001 and 2011 (SA Cities Network, 2014)

3.5. Population Growth Scenarios

This section highlights the expected growth rates from 2015 until 2045.

Umgeni Water obtained information from Stats SA and under their guidance, estimated growth rates for each sub-place in KZN for each five (5) year period from 2011 to 2035. These growth rates have been adopted in the modelling process as the probable population growth rates per sub-place and take into account births, deaths and population migration. These predictions remain an estimate and have an associated level of accuracy, which deteriorates the longer into the future the prediction is made. For this reason, the model adopts an inaccuracy of 5% initially, growing to 15% by 2035 for the growth rates provided. These extremes are used for the determination of the low and high modelled estimates.

The estimated population for the next 30 years is summarised in **Table 4** followed by the Average Annual growth percentages in **Table 5**.

Table 4: Estimated Future Population for CoU

Population	2011	2015	2020	2025	2030	2035	2040	2045
Low	334 457	349 103	371 875	391 623	413 505	428 772	441 954	451 394
Probable	334 457	349 887	374 613	396 770	422 190	440 582	457 053	469 301
High	334 457	350 673	377 368	401 980	431 049	452 705	472 657	487 910

Table 5: Estimated Annual Average Growth Rate

Average Annual Growth Rate	2011 - 2015	2015 - 2020	2020 - 2025	2025 - 2030	2030 - 2035	2035 - 2040	2040 - 2045
Low	1.08%	1.27%	1.04%	1.09%	0.73%	0.61%	0.42%
Probable	1.13%	1.38%	1.16%	1.25%	0.86%	0.74%	0.53%
High	1.19%	1.48%	1.27%	1.41%	0.99%	0.87%	0.64%

Note for comparative purposes:

The Strategic Development Framework proposes a range of population growth prediction scenarios (1.45%, 2%, 3%, 5% and 10%), but does not show preference for one. The IDP 2015/16 utilises these growth scenarios as well. The CSIR 2014 Water Master Plan adopts the 2% growth scenario as per the instruction of the City of uMhlathuze. **At a 2% growth rate, the municipal population will double by 2050 which is considered as over conservative and unrealistic, as shown in Figure 12.**

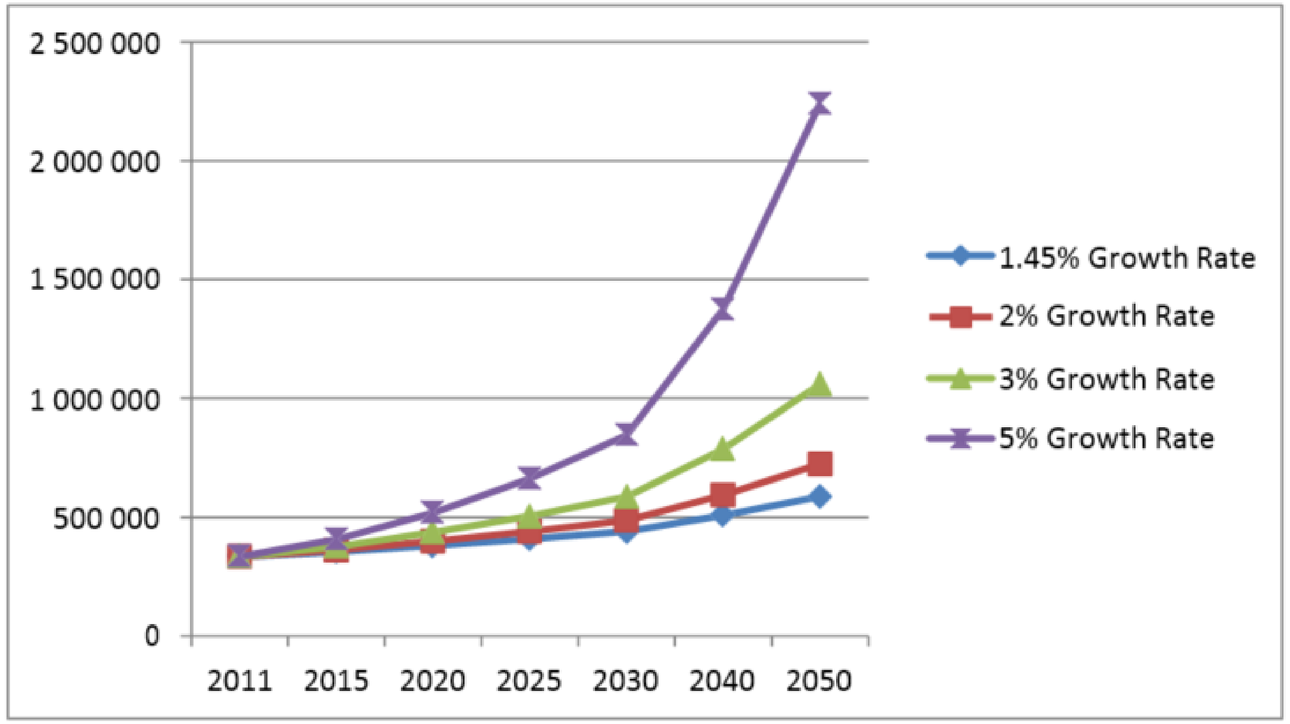

Figure 12: Population growth prediction scenarios (IDP 2015/16)

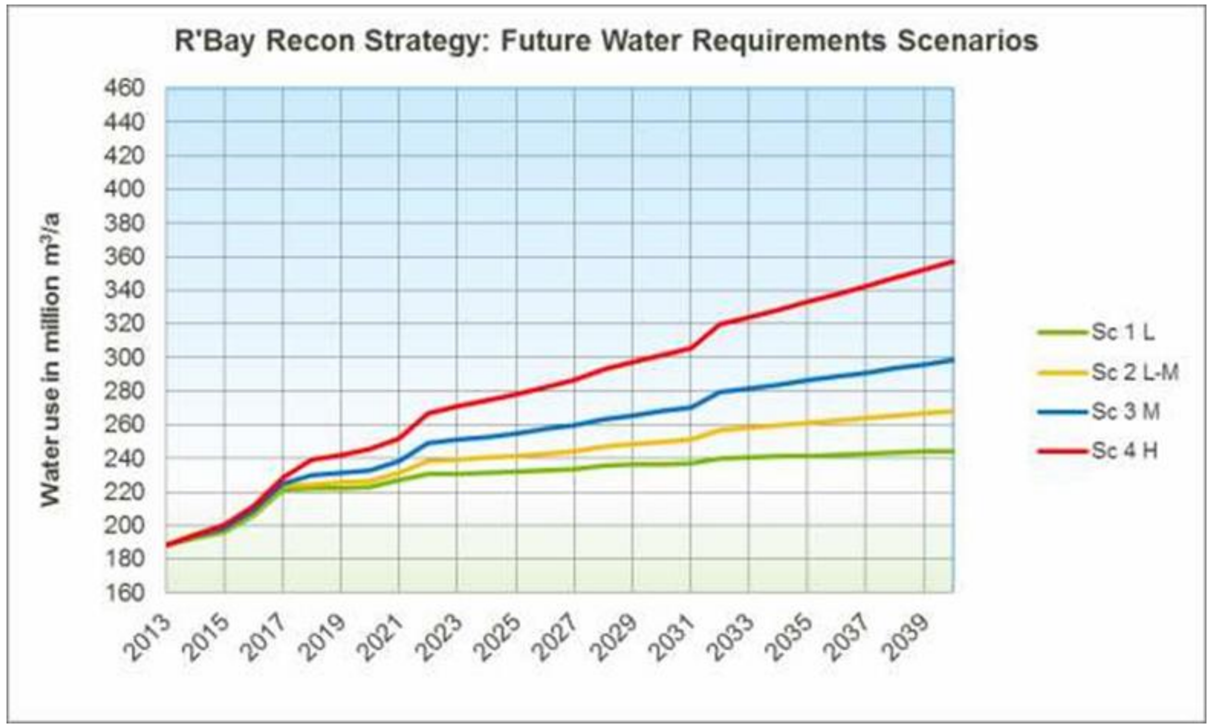

Figure 11: Results of the various DWS Reconciliation Strategy growth scenarios (DWS, 2014)

In terms of the Reconciliation Study (DWS, 2014), which is influenced strongly by the IDZ, the future water requirements for the "*Best-estimate Water Use*" scenarios are as shown in **Figure 11**. The expected sharp increases in future water requirements from 2016 to 2018 for the various scenarios are as a result of the Fairbreeze mine and potential Jindal mine going into production. The sharp increases in 2022 and 2032 are the result of potential IDZ expansion.

Table 6: DWS Reconciliation Strategy Growth Scenario description (DWS, 2014)

Scenario	Water requirement component							
	Current bulk industries (including growth or identified changes in use)	**New identified IDZ bulk industries** (% of full identified potential realised)	**New mine develop-ment** (potentially Jindal)	**Further bulk new industries** (cumulative growth on previous year's total)	**Municipal: urban, domestic & rural domestic** (% growth)	**Increased rural domestic supply in rest of Mhlatuze catchment** (% growth)	**Significant increased domestic supply to areas outside WSS** (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	✓

These figures relate to a 657 Mℓ/d low and 986Mℓ/d high scenario demand against a current contracted or allocated volume of 397Mℓ/d. This is discussed further in **Section 4.6**.

4. WATER SERVICE LEVELS AND REQUIREMENT

The purpose of this section is to provide an overview of the water service levels and demands over the next 30 years (2015 - 2045). The water demands were calculated in a demand model developed for the purpose of this study. The methodology and reliability of the model is detailed further within this section. A summary of the demand projections is presented firstly at local municipality (WSA) level and then for each water supply scheme. Three (3) sets of demand results were generated based on varying demand scenarios. All three results are presented in this section thereafter a preferred scenario results is taken forward for further analysis in following sections.

For the purpose of analysis, CoU was demarcated into four (4) water supply schemes and further broken down into supply areas based on infrastructure and topography. The four (4) schemes are illustrated in **Figure 13.**

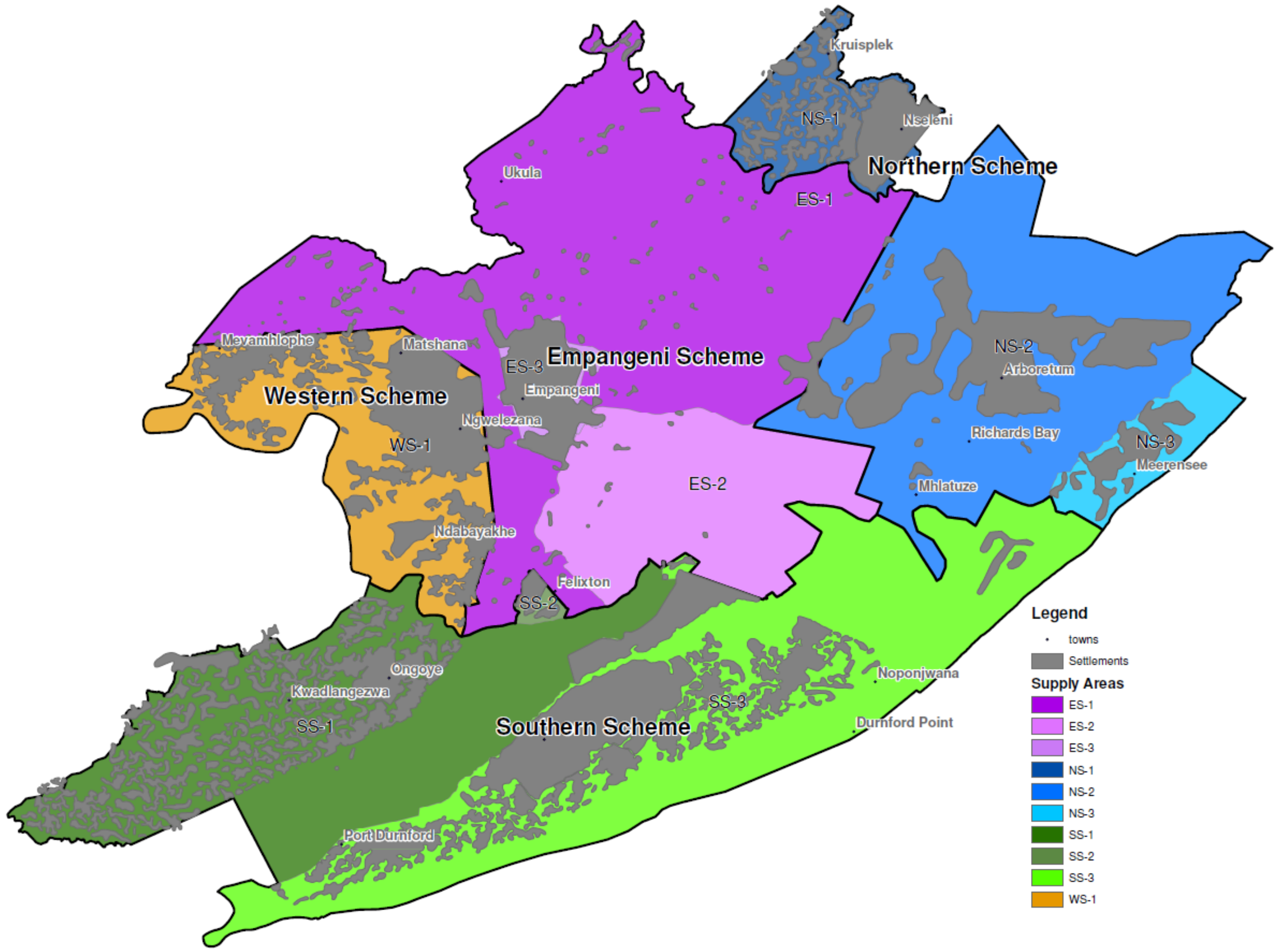

Figure 13: Water Supply Areas

The backlogs noted in this report refers to households that do not have a RDP level of service i.e. households that are more than 200m walking distance to the nearest standpipe or have no formal service at all.

Water resources within CoU is shared with neighbouring local municipalities. This includes:

- Supply of raw water to Fairbreeze Mine, situated in Umlalazi LM, south of CoU.
- Supply of potable water to Bhojane and surrounding areas on Ntambanana LM, north of Nseleni
- Assurance of raw water in Lake Nsezi to Richards Bay Minerals, located in Mfolozi LM, north of Richards Bay.

These demands have been included in the evaluation of the relevant schemes.

4.1. Levels of Service

CoU updates their level of service statistics regularly, and as at March 2015, 96.65% had access to potable water at communal tap stand <200m or higher i.e. a backlog of approximately 3% (IDP). **Table 7** details the types of service levels (IDP 2015/16).

Table 7: Latest water supply levels of service as at 31 March 2015 (CoU, 2015)

Service Level	Households	%
Access to Water	**83 795**	**97%**
House connections	44 308	51%
Yard Connections	39 572	46%
Communal Supply < 200 m	698	1%
Communal Supply > 200m (Backlog)	**2 814**	**3%**
Total households	**86 609**	**100%**

Approximately 89% of households in CoU obtain water from the municipality; 3% from water tankers and a few are reliant on boreholes and springs. Settlements with a backlog of more than 75% of households, lie on the fringes on CoU, in Tribal Authority areas. The area with the biggest backlog is in Vulindlela, a Tribal Authority area in the south of CoU. Backlogs per scheme and supply area are detailed in **Section 4.6**. **Annexure A** highlights the water service levels of settlements as per DWS water service level categories.

CoU notes that the challenge that needs to be dealt with is constant supply with fewer interruptions. Upgrades to existing infrastructure is noted as a priority.

4.2. Water Losses and Demand Management

Water Conservation and Water Demand Management forms a critical component to ensuring sustainable services by reducing losses and controlling demands.

CoU has a 5-year strategic management plan for the reduction of non-revenue water in place (Joat, 2015). This plan is for the period 2015 – 2020.

According to the plan, CoU currently has water losses equating to approximately 31% of the WSA's total system input volume. Water losses refers to apparent and real losses. In the next 5 years, CoU aims to reduce these water losses to 25% of the total system input volume.

4.3. Water Service Level Migration

Three (3) development scenarios are analysed in the modelling process. Each of these scenarios are defined by the change / improvement of the levels of service expected over differing time scales and differentiate between urban and rural areas, defined as per the DWS Infrastructure Reference Database.

The three (3) scenarios can be defined as follows:

Scenario 1: This scenario refers to the targets being aimed for by the Local Water Service Authority (WSA) for each area.

Scenario 2: This is the target scenario as per the KZN Provincial Growth and Development Plan (PGDP). The target as per the KZN PGDP is to provide a minimum of 75ℓ/cap/day to all consumers in KZN by 2030. This has been interpreted as a level of service equivalent to a yard connection.

Scenario 3: This is the expected, practical, implementable development scenario as set by Bigen Africa, based on engineering experience and knowledge.

Table 8 provides the respective targets set per scenario.

Table 8: Demand Model Scenarios

	Urban			Rural			
Scenario 1	Portion to Convert	Start Year	End Year	Portion to Convert	Start Year	End Year	WSA Targets
Convert from No Service to RDP LOS	100%	2015	2020	100%	2015	2020	All pop. without supply converted to RDP level of service by 2020
Convert from <RDP LOS to RDP LOS	100%	2015	2020	100%	2015	2020	All pop with <RDP LOS converted to RDP level of service by 2020
Convert from RDP LOS to Yard Conn.	100%	2015	2020	100%	2015	2020	All pop with RDP LOS converted to Yard Connection level of service (YC LOS) by 2020
Convert from Yard Conn. to House Conn.	0%	2020	2035	0%	2025	2035	0% of pop with YC LOS converted to HC LOS

	Urban			Rural			
Scenario 2	Portion to Convert	Start Year	End Year	Portion to Convert	Start Year	End Year	KZN Prov Growth and Dev Plan (PGDP)
Convert from No Service to RDP LOS	100%	2015	2020	100%	2015	2020	All pop. without supply converted to RDP level of service by 2020
Convert from <RDP LOS to RDP LOS	100%	2015	2020	100%	2015	2020	All pop with <RDP LOS converted to RDP level of service by 2020
Convert from RDP LOS to Yard Conn.	100%	2015	2030	100%	2015	2030	All pop with RDP LOS converted to Yard Connection level of service (YC LOS) by 2030
Convert from Yard Conn. to House Conn.	30%	2020	2035	10%	2025	2035	30% of pop with YC LOS in Urban areas and 10% in Rural Areas converted to HC LOS between 2020 and 2035 for Urban and between 2025 and 2035 for Rural

	Urban			Rural			
Scenario 3	Portion to Convert	Start Year	End Year	Portion to Convert	Start Year	End Year	Realistic Achievable Estimate
Convert from No Service to RDP LOS	95%	2015	2035	90%	2015	2035	95% of Urban pop and 90% of Rural pop with no service converted to RDP level of service by 2035
Convert from <RDP LOS to RDP LOS	95%	2015	2035	90%	2015	2035	95% of Urban pop and 90% of Rural pop with <RDP LOS converted to RDP level of service by 2020
Convert from RDP LOS to Yard Conn.	90%	2015	2035	90%	2015	2035	90% of Urban pop and 90% of Rural pop with RDP LOS converted to YC LOS by 2035
Convert from Yard Conn. to House Conn.	30%	2020	2035	10%	2025	2035	30% of Urban pop and 10% of Rural pop with YC LOS converted to HC LOS between 2020 and 2035 for Urban and between 2025 and 2035 for Rural

4.4. Water Demand Modelling Methodology

Bigen Africa developed a zero-based demand modelling tool that has been used to determine the projected demands over a 30 year period (2015 – 2045) for City of uMhlathuze. The demand model is a Microsoft Excel application in which modelling is performed at Census "Small Area" Level. The sub-sections that follow provide an overview of the source data, inputs and structure of the outputs from the model.

4.4.1. Source Data

The Census 2011 data was used as the base data for the following:

- Population
- Households
- Heads per household
- Income level categories
- Existing levels of water supply services

The data provided has some level of accuracy and for purposes of this model it has been assumed that the true figures within a 10% wide band around the data provided in the census. The definition of urban and rural areas used in the model is derived from the classification applied to sub-place areas by DWS National in the DWS Reference Framework Geodatabase.

Growth Rates

Population growth rates were derived by Umgeni Water, utilising algorithms provided by Statistics SA. The data utilised in the model was provided at sub-place level. These growth rates allow for migration into and out of sub-places as well as for births and deaths for the period 2011 to 2045.

The growth rates provided are estimates and a band width of 10% is allowed for the period 2011 – 2015, increasing linearly up to 30% for the period 2040-2045. See **Section 3.5** for the Average Annual Growth rate percentages.

4.4.2. Inputs

The key inputs for the CoU demand model included the following:

1) Unit Water Demands
2) Industrial Demands
3) Supply Areas
4) Quaternary Catchments
5) Water Loss Targets
6) WTW Losses

4.4.2.1. Unit Water Demands

Various categories of unit water demands are used in the model. The basis of these unit demands is as indicated by DWS, Umgeni Water and as set out in UAP Phase 1. **Table 9** indicates the unit domestic demands used in the model.

Table 9: Average Annual Daily Demands

Average Annual Daily Demands									
Category	Description of consumer category	Household Annual Income range		Per capita cons (l/c/d)			Non Seasonal	Seasonal
		From	to	Low	Prob	High	SPF	SPF
1	Very High Income; villas, large detached house, large luxury flats HC	R1 228 001	R9 999 999	360	410	460	1.5	2.5
2	Upper middle income: detached houses, large flats HC	R153 601	R1 228 000	260	295	330	1.5	2.4
3	Average Middle Income: 2 - 3 bedroom houses or flats with 1 or 2 WC, kitchen, and one bathroom, shower HC	R38 401	R153 600	200	228	255	1.4	2.3
4	Low middle Income: Small houses or flats with WC, one kitchen, one bathroom HC	R9 601	R38 400	140	170	200	1.4	2.2
5	Low income: flatlets, bedsits with kitchen & bathroom, informal household HC	R1	R9 600	80	100	120	1.3	2.0
6	No income & informal supplies with Yard connections	R0	R0	70	80	90	1.2	1.5
7	Informal with no formal connection RDP LOS	R0	R0	40	50	60	1.1	1.1
8	Informal below 25 l/c/d <RDP .	R0	R0	5	12	20	1.0	1.0

Further to the description of consumer categories presented in the table above:

- Informal below 25ℓ/c/d = "<RDP" or no formal supply
- Informal with no formal connections = "RDP LoS" or walking distance to water <200m and minimum supply of 25ℓ/c/d
- No income and informal supplies with yard connection = "YC" or water at yard boundary
- House connections = "HC" with sub-categories:
  - Low Income (R 1 to R 9,600): flat lets, bedsits with kitchen and bathroom, informal household
  - Low Middle Income (R 9,601 to R 38,400): small houses or flats with WC, one kitchen, one bathroom
  - Average Middle Income (R 38,401 to R 153,600): 2-3 bedroom houses or flats within 1 or 2 WC, kitchen and one bathroom, shower
  - Upper Middle Income (R 153,601 to R 1,228,000): detached houses, large flats
  - Very High Income (>R 1,228,000): villas, large detached house, large luxury flats

Table 10 indicates the Commercial / Institutional / Industrial (CII) norms.

Table 10: Commercial / Institutional / Industrial Norms

Commercial/Institutional/Industrial Norms					
Ref	Description	Units	Low	Probable	High
A	Comm/Inst/Indust Floor area per HH (Urban)	m2/HH	12.0	20.0	28.0
B	Comm/Inst/Indust Floor area per HH (Rural)	m2/HH	3.0	5.0	7.0
C	Comm/Inst/Indust Water Demand	kl/mnth /100m2	14.0	20.0	25.0
D	Equivalent Comm/Inst/Industrial Water Demand (Urban)	l/HH/d	55.2	131.5	230.1
E	Equivalent Comm/Inst/Industrial Water Demand (Rural)	l/HH/d	13.8	32.9	57.5
F	Comm/Inst/Indust Summer Peak Factor .	f		1.1	

The following is to be noted with regard to the CII inputs above:

- Ratios of Commercial, Institutional and Industrial roof areas to number of households exist for all small areas / settlements
- These ratios will vary according to the formality of the small area / settlement. For the purpose of this model, two (2) categories of formality have been adopted as "Urban" and "Rural"
- Typical ratios have been combined into a single weighted range of ratios for CII water demands expressed as kℓ/households per day for urban and rural settlements
- There exists a large spread for these demands
- Where a small area is mainly industrial of nature, these small areas are specifically defined and the water demands uniquely identified. The water demands for such small areas are populated in the model directly, using actual records where available. For CoU, individual lists of the top 15

Commercial, Institutional and Industrial water users were made available to Bigen Africa. The location of the specific users were identified and their AADD (base date: 2013/14) was input as the probable with variations to the probable calculated for the high and low demands of the respective small areas

The norms utilised list low, probable and high as the range of unit demands. For purposes of this model, the low and high have been adopted as the extreme low and extreme high respectively. These have been equated to the 0.1% and 99.9% probability. Using a normal distribution, the 5% and 95% probabilities have been interpolated and these figures have been used in the model for the low and high unit demands.

4.4.2.2. Industrial Demands

CoU is considered a high industrial zone. High industrial demands were identified using data of the top 15 industrial consumers billed and top users reported in the reconciliation strategy water balance report. The major industrial users identified include, among other smaller but significant users:

- Mondi
- Foskor
- Richards Bay Minerals
- Hillendale (Tronox)/Fairbreeze Mine

Census Small Area places with high industrial demands were identified and treated as exceptions in the demand model. Demands for these small areas were manually input into the model. The industrial users' current usage was used as the 2015 demand and grown incrementally to 2045. The 2045 demand noted for most of the industries identified either took into account, if available, the future demand reported or the current allocation.

Industrial demands for growth development zones surrounding Empangeni were also taken into consideration. Demands in these areas were initially based on demands noted in the CoU Bulk Water Master Plan (CSIR, 2015). These demands were considered highly overstated due to the high growth rate and unit demands accounted for in the demand model adopted by CSIR. These demands were adjusted accordingly based on the growth rates adopted by Bigen Africa in this study.

The current total industrial demand is approximately 133 Ml/day. By 2045, the total industrial demand is expected to grow to 296 Mℓ/day. The demand model input sheets in **Annexure B** detail the small areas identified and the relevant industrial demands reported for these areas. Current and future industrial demands are discussed further under **Section 4.6**.

4.4.2.3. Supply Areas

For the purpose of analysis, WSA's were demarcated into supply areas based on infrastructure and topography. This provided wall-to-wall coverage of the WSA. All supply areas align with Census Small Area Places. In CoU, supply areas were demarcated as sub-areas of the four (4) major schemes in the area (**See Figure 13**). These supply areas are detailed in **Table 11**.

Table 11: CoU Supply Areas

Scheme Name	Supply Area Code	Description
Empangeni Scheme	ES-1	High agricultural land use. Sparse settlements.
	ES-2	High agricultural land use. Sparse settlements.
	ES-3	Main town - Empangeni. High industrial area. Area served with bulk water from Nsezi WTW.
Northern Scheme	NS-1	Main town - Nseleni. Served with bulk water from Richards Bay.
	NS-2	Main Town - Richards Bay. High industrial area. Served with water from Mzingazi WTW and supplemented by Nsezi WTW.
	NS-3	Main town - Meerensee. Water from Mzingazi/Nsezi WTW supplies a command reservoir to serve area.
Southern Scheme	SS-1	Main town - Vulindlela. Served with bulk wate from Esikhaleni WTW.
	SS-2	Main town - Felixton. High industrial area. Served with bulk wate from Esikhaleni WTW.
	SS-3	Main town - Esikhawnin. Served with bulk wate from Esikhaleni WTW.
Western Scheme	WS-1	Main town - Ngelezane. Served by Ngwelazane WTW and supplemented by Empangeni scheme

4.4.2.4. Quaternary Catchments

The GIS database was utilised to determine which quaternary catchments each small area falls within. W12E, W12F, W12H, W12J and W13B are mapped in **Figure 14**.

Figure 14: Quaternary Catchments related to CoU's boundaries

4.4.2.5. Water Loss Targets

For purposes of this model, because it is required to quantify water demands that need to be satisfied over time, the term "Water Losses" is used to include physical losses and excessive water use.

For all service level migration scenarios to be detailed in the section to follow, the estimated existing water loss is reduced over a defined period down to an expected reasonable water loss target. Such water losses differentiate between urban and rural areas due to the differing capacity and circumstances of local authorities to manage such losses.

As per the Water Reconciliation Strategy for Richards Bay and Surrounding Areas (Aurecon, 2014), the estimated current total system losses is approximately 31% of the treated water production with a target to reduce losses to 19%. **Table 12** summarises the water loss input into the water demand model based on the aforementioned statement. The rural inputs were estimated based on targets noted for the urban.

Table 12: Water Loss Inputs

Water Loss Inputs	Urban	Rural
Non-Revenue Water	31%	45%
Target	25%	25%
Achieve By	2020	2025

4.4.2.6. WTW Losses

For purposes of this model, a fixed allowance of 10% is made for the water lost during water treatment.

4.4.3. Outputs

The predicted "zero based" water demands as derived through the model are calculated against time as:

- AADD (Average Annual Daily Demand): Average water demands excluding water losses
- GAADD (Gross Average Annual Daily Demand): AADD plus water losses
- SDD (Summer Daily Demand): GAADD x Summer Peak Factor

The predicted populations, AADD, GAADD and SDD are aggregated per:

- Small Area
- Sub-place
- Supply Area
- Local Municipality
- Quaternary Catchment
- Study Area

Annexure B, provides the demand model input sheet and respective outputs in the structure noted above for all three (3) scenarios.

4.5. Reliability of Demand Modelling

The following limitations, constraints and definitions are to be noted with regard to the Census 2011 data used and the range of results produced.

- Although the Census 2011 data is considered the most reliable source of statistical data regarding demographics, this data should be seen in context when utilised in determining water demands. One should remember that Census data is obtained over a single week in a particular year and this data is not necessarily fully representative of the location where services are utilised throughout the year (e.g. holiday homes, people working in other places and returning home over holidays etc.).
- It can also be noted that some data obtained by the Census is subjected to deceitful responses by the people being questioned with regard to issues like illegal immigrants, incomes, etc.

- The existing levels of service as reported by the Census are also not as reliable as one would hope as the reporting is based on the experiences of the consumer according to his/her recent recollection/experience.
- The results reported as the probable are the results of adding/multiplying/dividing each of the average/probable input and Census 2011 data values. The results are only as accurate as the combined accuracy of the input values.

- Low and high estimates are the result of adding/multiplying/dividing each of the low/high input data values in the modelling process. The methodology used for the modelling can therefore not provide any statistically meaningful measure of the accuracy of the model estimates, except to say that the truth lies somewhere between the low and high estimates as predicated by the model. The only way to determine statistically meaningful and quantifiable predictions would be to utilise statistically defined probability distributions for each of the data inputs. Such modelling can be carried out and it is highly recommended that such techniques be utilised before committing any funding to any project required to be financed.

4.6. Summary of Demand Projections for Study Area

4.6.1. Water Requirements for CoU

As detailed in **Section 4.3**, three (3) demand scenarios were evaluated for CoU. The total probable Gross Annual Average Daily Demand (GAADD) for each of the scenarios are summarised in **Table 13** and **Table** 14**.**

Table 13: 30 Year GAADD for CoU per Scenario in Mℓ/d

Scenario	Probable GAADD (Ml/d)						
	2015	2020	2025	2030	2035	2040	2045
1	263.87	299.01	317.18	359.11	392.97	431.51	466.63
2	263.87	298.02	316.85	360.72	396.11	434.75	469.93
3	263.87	296.63	315.51	359.23	395.02	433.62	468.78

Table 14: 30 Year GAADD for CoU per Scenario in mill m³/a

Scenario	Probable GAADD (mill m³/a)						
	2015	2020	2025	2030	2035	2040	2045
1	96.31	109.14	115.77	131.08	143.43	157.50	170.32
2	96.31	108.78	115.65	131.66	144.58	158.68	171.52
3	96.31	108.27	115.16	131.12	144.18	158.27	171.11

It can be deduced that demands from the three (3) scenarios fall within a small range. For purposes of simplification, one set of results will be used from hereon. Scenario 2 results are selected to be utilised as the service level migration target for this scenario is considered achievable for CoU. **Table 15** (Mℓ/d) and **Table 16** (m³/a) below details the backlog and probable total GAADD per existing water supply scheme area in CoU**.**

Table 15: 30 Year GAADD for CoU per supply scheme in Mℓ/d

Scheme	Total Households (Census 2011)	Backlog (Census 2011)	Probable GAADD (Ml/d)						
			2015	2020	2025	2030	2035	2040	2045
Empangeni Scheme	10 028	190	16.93	15.93	19.08	26.01	34.03	40.22	43.72
Northern Scheme	26 306	767	156.77	161.93	174.83	191.79	208.50	231.49	256.54
Southern Scheme	36 591	3 088	78.79	108.53	111.07	130.05	139.93	148.96	155.25
Western Scheme	13 464	493	11.38	11.63	11.87	12.87	13.66	14.08	14.41
Total	**86 389**	**4 537**	**263.87**	**298.02**	**316.85**	**360.72**	**396.11**	**434.75**	**469.93**

Table 16: 30 Year GAADD for CoU per supply scheme in mill m³/a

Scheme	Total Households (Census 2011)	Backlog (Census 2011)	Total GAADD (mill m³/a)						
			2015	2020	2025	2030	2035	2040	2045
Empangeni Scheme	10 028	190	6.18	5.81	6.96	9.49	12.42	14.68	15.96
Northern Scheme	26 306	767	57.22	59.10	63.81	70.00	76.10	84.49	93.64
Southern Scheme	36 591	3 088	28.76	39.61	40.54	47.47	51.07	54.37	56.67
Western Scheme	13 464	493	4.15	4.24	4.33	4.70	4.98	5.14	5.26
Total	**86 389**	**4 537**	**96.31405**	**108.78**	**115.65**	**131.66**	**144.58**	**158.68**	**171.52**

The total demands reflected in **Table 14** and **Table 15** is inclusive of commercial, institutional, industrial (CII) and domestic demands. Due to the high industrial nature of CoU, it is critical to differentiate between the domestic and CII demands. **Table 17** details CoU's total GAADD in terms of industrial and domestic demand. It can be observed that CoU's water demand is for industrial use. Domestic demands for the main towns in CoU is also provided. The respective supply areas are noted in brackets.

Table 17: Current and Future Water Demands per Industrial and Domestic User

Sector	User	Contr./Alloc. (Ml/d)	2015 Demand (Ml/d)	2045 Demand (Ml/d)
Industry	Mondi	100.00	67.00	100.00
	Foskor	13.60	21.40	21.40
	Other (incl. commercial, institutional and planned expansion area industrial demands)	14.00	81.56	106.78
	Foskor (Clarified)	17.00	11.28	11.28
	Tronox	40.50	6.50	55.40
	RMB (Lake Nsezi)	45.00	6.50	45.00
	RMB (Zulti)	40.00	0.00	40.00
	Other	0.94	0.94	0.94
Total Industry		**271.04**	**195.18**	**380.80**
Potable Total		**127.60**	**169.96**	**228.18**
Clarified Total		**17.00**	**11.28**	**11.28**
Raw water Total		**126.44**	**13.94**	**141.34**
Domestic	Empangeni (ES)	37.00	11.00	14.15
	Richards Bay (NS-2 & NS-3)	48.00	17.48	23.35
	Esikhaleni & Vulindlela (SS)	15.00	25.07	32.62
	Nseleni (NS-1)		5.89	7.29
	Ngwelazane (WS)	8.00	9.25	11.72
Total Domestic		**108.00**	**68.69**	**89.13**
Total Demand		**379.04**	**263.87**	**469.93**
% Domestic		**28%**	**26%**	**19%**
% Industry		**72%**	**74%**	**81%**

*** Current and Future demand based on Scenario 2, probable results.*

The following subsections provide further detail on the total water demand per water supply scheme. Each supply scheme is broken down further into supply areas. The backlog reported on refers to the Census 2011 data. This differentiates to the backlog noted in Section 4.1, which is a more update backlog figure. The backlog figure provided by CoU is not broken down to supply area level thus the use of the Census 2011 figures. The backlog figures noted in the tables below are indicative of the backlogs in the areas and may not be the most updated figures.

4.6.2. Northern Scheme

Table 18 and **Table 19** provide the total backlog and water demand for the Richards Bay and Nseleni area.

Table 18: Backlog and water demands (2015- 2045) for Northern Scheme in Mℓ/d

Scheme	Census 2011		Total GAADD (Ml/d)						
	Total Households	Backlog	2015	2020	2025	2030	2035	2040	2045
COU-NS-1	10 571	187	6.78	6.86	6.91	7.48	7.95	8.20	8.37
COU-NS-2	11 113	324	144.97	149.81	162.26	178.16	194.05	216.52	241.17
COU-NS-3	4 622	274	5.02	5.26	5.66	6.14	6.49	6.76	7.01
Total	**26 306**	**785**	**156.77**	**161.93**	**174.83**	**191.79**	**208.50**	**231.49**	**256.54**

Table 19: Backlog and water demands (2015- 2045) for Northern Scheme in mill m³/a

Scheme	Census 2011		Total GAADD (mill m³/a)						
	Total	Backlog	2015	2020	2025	2030	2035	2040	2045
COU-NS-1	10 571	187	2.48	2.51	2.52	2.73	2.90	2.99	3.06
COU-NS-2	11 113	324	52.91	54.68	59.23	65.03	70.83	79.03	88.03
COU-NS-3	4 622	274	1.83	1.92	2.07	2.24	2.37	2.47	2.56
Total	**26 306**	**785**	**57.22**	**59.10**	**63.81**	**70.00**	**76.10**	**84.49**	**93.64**

- **NS-1:** The main town in this supply area is Nseleni. The demand for this supply area is primarily for domestic use.
- **NS-2:** The main town in this supply area is Richards Bay. High demands are recorded in this supply area due to high industrial demands. High industrial consumers included in this demand includes Mondi, Foskor and RBM (Lake Nsezi).
- **NS-3:** The main town is Meerensee.
- The backlogs in this area are minimal and could possibly be attributed to informal settlements within the main towns.

4.6.3. Empangeni Scheme

Table 20 and **Table 21** provide the total backlog and water demand for the Empangeni area.

Table 20: Backlog and Water Demands (2015- 2045) for Empangeni Scheme in Mℓ/d

Scheme	Census 2011		Total GAADD (Ml/d)						
	Total Households	Backlog	2015	2020	2025	2030	2035	2040	2045
COU-ES-1	3 693	59	6.18	4.64	6.65	12.26	19.22	24.36	26.83
COU-ES-2	32	-	0.23	0.12	0.14	0.21	0.33	0.45	0.56
COU-ES-3	6 303	144	10.52	11.17	12.28	13.53	14.48	15.41	16.33
Total	**10 028**	**204**	**16.93**	**15.93**	**19.08**	**26.01**	**34.03**	**40.22**	**43.72**

Table 21: Backlog and water demands (2015- 2045) for Empangeni Scheme in m³/a

Scheme	Census 2011		Total GAADD (mill m³/a)						
	Total	Backlog	2015	2020	2025	2030	2035	2040	2045
COU-ES-1	3 693	59	2.26	1.69	2.43	4.47	7.02	8.89	9.79
COU-ES-2	32	-	0.08	0.04	0.05	0.08	0.12	0.17	0.20
COU-ES-3	6 303	144	3.84	4.08	4.48	4.94	5.28	5.62	5.96
Total	**10 028**	**204**	**6.18**	**5.81**	**6.96**	**9.49**	**12.42**	**14.68**	**15.96**

- **ES-1 & ES-2:** These areas are predominantly agricultural land. As per the SDF, areas within ES-1 have been marked as potential growth areas thus the modelled growth in demand.
- **ES-3:** The main town in this supply area is Empangeni.
- The backlogs in this area are minimal.

4.6.4. Western Scheme

Table 22 and **Table 23** provide the total backlog and water demand for the Richards Bay and Nseleni area.

Table 22: Backlog and Water Demands (2015- 2045) for Western Scheme in Mℓ/d

Scheme	Census 2011		Total GAADD (Ml/d)						
	Total Households	Backlog	2015	2020	2025	2030	2035	2040	2045
COU-WS-1	13 464	493	11.38	11.63	11.87	12.87	13.66	14.08	14.41
Total	**13 464**	**493**	**11.38**	**11.63**	**11.87**	**12.87**	**13.66**	**14.08**	**14.41**

Table 23: Backlog and Water Demands (2015- 2045) for Western Scheme in mill m³/a

Scheme	Census 2011		Total GAADD (mill m³/a)						
	Total	Backlog	2015	2020	2025	2030	2035	2040	2045
COU-WS-1	13 464	493	4.15	4.24	4.33	4.70	4.98	5.14	5.26
Total	**13 464**	**493**	**4.15**	**4.24**	**4.33**	**4.70**	**4.98**	**5.14**	**5.26**

- **WS-1:** This area is considered as a Tribal Authority area within CoU. The main town in this supply area is Ngwelazane.
- Backlogs in this area can be considered minimal.

4.6.5. Southern Scheme

Table 24 and **Table 25** provide the total backlog and water demand for the Richards Bay and Nseleni area.

Table 24: Backlog and Water Demands (2015- 2045) for Southern Scheme in Mℓ/d

Scheme	Census 2011		Total GAADD (Ml/d)						
	Total Households	Backlog	2015	2020	2025	2030	2035	2040	2045
COU-SS-1	8 013	1 223	51.99	72.73	67.81	76.80	77.28	77.55	77.75
COU-SS-2	405	52	0.38	0.57	0.80	1.04	1.27	1.56	1.94
COU-SS-3	28 173	1 656	26.42	35.23	42.46	52.21	61.38	69.85	75.55
Total	**36 591**	**2 931**	**78.79**	**108.53**	**111.07**	**130.05**	**139.93**	**148.96**	**155.25**

Table 25: Backlog and Water Demands (2015- 2045) for Southern Scheme in mill m³/a

Scheme	Census 2011		Total GAADD (mill m³/a)						
	Total	Backlog	2015	2020	2025	2030	2035	2040	2045
COU-SS-1	8 013	1 223	18.98	26.55	24.75	28.03	28.21	28.30	28.38
COU-SS-2	405	52	0.14	0.21	0.29	0.38	0.46	0.57	0.71
COU-SS-3	28 173	1 656	9.64	12.86	15.50	19.06	22.41	25.49	27.58
Total	**36 591**	**2 931**	**28.76**	**39.61**	**40.54**	**47.47**	**51.07**	**54.37**	**56.67**

- **SS-1**: The main town is Vulindlela and is a tribal authority area.
- **SS-2**: The main town is Felixton.
- **SS-3**: The main town is Esikhawini.
- The Southern Scheme has the biggest water supply backlog in CoU.
- The high demands in SS-1 and SS-2 correlate with high industrial demands due to mining i.e. Tronox and RBM (Zulti South).

5. WATER RESOURCES

The Mhlathuze River Catchment (W12) covers 4209km² starting in the Drakensburg Mountains in the West near Babanango, and flowing South East through grassland and agricultural land until it reaches the Goedertrouw Dam in the upper catchment. The river then flows East across the wide alluvial plains of the Zululand coastal plains to Richards Bay (DWS, 2015). The Mfule, Nseleni and Mhlathuzana are significant tributaries.

There is extensive commercial afforestation in the catchment. According to the Mhlathuze Water Availability Assessment Study (MWAAS) there is 677km² afforested area in the Mhlathuze catchment, although only 560km² have been gazetted in the compulsory licensing process. Forestry is always located in the high precipitation regions and as such results in reduced stream-flow, which leads to decreased yields downstream. For this reason the growth in forestry activities in this area is strictly regulated by the DWS, and it is not intended that significant expansion in this sector be allowed (DWS, 2014). In addition there is extensive dryland sugarcane (262km²) in the catchment.

There are large areas of alien vegetation in the Mhlathuze catchment, which cause a substantial reduction in runoff. MWAAS gives a value of 44.29km² in the catchment. This is a water use that should be reduced, and the DWS is addressing this issue with collaboration with stakeholders through projects such as the Working for Water. If strategies for eradicating alien vegetation are successful, and such additional low flows are not intercepted by users before the Mhlathuze weir, more water will become available downstream (DWS, 2014).

A significant land area (131km²) is under irrigation, primarily sugarcane and citrus, which is along the Mhlathuze River downstream of the Goedertrouw Dam (DWAF, 2004)

Half the catchment is Ingonyama Trust land, which is used for cattle and subsistence farming, with little other development (DWAF, 2004).

5.1. Main Water Sources

The main sources of water supplied to CoU is summarised in **Table 26** below.

The Goedertrouw Dam on the Mhlathuze River regulates the water to downstream irrigators as well as urban and industrial users in CoU. The dam had a storage capacity of 321 million m³ when it was commissioned in 1982; a decreased capacity of approximately 301 million m³ in 2000; and is decreasing at an estimated rate of 1.1 million m³/annum due to siltation. The water from the dam is abstracted from an irrigation canal, from run-of-river abstractions for agriculture, and at the Mhlathuze weir. Nkwaleni, Mfule and Heatonville irrigators draw water from the river for the irrigation of sugar and citrus, between the Dam and the Mhlathuze Weir. Irrigation is supplied under the Goedertrouw Government Water Scheme, with some irrigators fed directly from the dam, the Heatonville irrigators from a system of concrete channels that are fed from a pump station on the Mhlathuze River (DWS, 2014).

Goedertrouw Dam is supplemented with water transfers from the Thukela River when the dam drops below 90%. This transfer scheme was built as an emergency intervention during the drought of 1994, and aimed to supply 37 millionm³/a (1.2m³/s) to the Mvuzane stream, which flows into the Mhlathuze River upstream of the Dam. The scheme includes an abstraction works near Middledrift, two pump stations, and a 13.7km long 1.5m diameter pipeline to a third pump station that pumps water over 3.5km in an 800mm diameter rising main, up over the watershed, then a 1km long, 600mm diameter gravity main down to the Mvuzane stream.

There are four (4) lakes that are significant in the area. Lakes Nhlabane, Mzingazi, and Cubhu are coastal lakes that are thought to be extensions of the local groundwater. The fourth lake is Lake Nsezi, which is a coastal lake fed by rivers originating inland.

Lake Nhlabane has a historical firm yield of approximately 7.9 million m³/a (DWS, 2014). The lake has been significantly transformed by Richards Bay Minerals (RBM) through the building of a concrete barrage that blocks the lake's connection with the sea. This barrage resulted in the North and South sections of the lake merging, and the lake changing from an estuarine to fresh water lake, with the consequent change in fauna and flora. This barrage was built in order to increase the water available for the RBM ponds and smelters (DWS, 2015). In addition to the supply from Nhlabane, RBM transfers about 18 million m³/annum from the Mfolozi catchment near the estuary into their mining ponds in order to supplement the water they abstract from Lake Nhlabane. RBM also has a supplementary supply source in Lake Nsezi, and they have an agreement with Mhlathuze Water for 16.4 million m³/a.

Lake Mzingazi is a freshwater coastal lake fed by a number of streams, the main ones being Mdibi and Mzingazi Rivers. The coastal dune barrier separates the lake from the sea. The Mhlathuze flood plain separates the lake from the Richards Bay Harbour. The Southern part of the lake is approximately 14m below mean sea level and therefore susceptible to saline water intrusion, especially during drought conditions. A weir was constructed across the lake's outlet in order to increase its capacity and meet the local demands for water. A second weir is downstream of the lake to limit saltwater intrusion into the lake from the Mzingazi River (Moloi P, 2012). The historical firm yield of Lake Mzingazi is documented as 10.5 million m³/a (28.8Mℓ/day) The registered water use allocated to the City of uMhlathuze Local Municipality for Richards Bay is much higher than the historical firm yield, at 24.18 million m³/a. The actual abstractions in 2008 through to 2013 fluctuated from a low of 11.92 to a high of 22.4 million m³/a (DWS, 2014.)

Lake Nsezi is an inland lake, located in W12F quaternary catchment on the Southern end of the Nseleni River. The section from Lake Nsezi out flow to the Mhlathuze River has been canalised to accommodate sugar cane farming by uMhlathuze Valley Sugar. The Nseleni River includes for a substantial catchment area to the North of Empangeni including mostly tribal areas. Tribal areas of note are Khoza / Bhojane, Cebekhulu, Ndlazini (Mambuka) and Ntambanana (WSDP, 2005). . The volume of the lake is 25 million m³, and the historical firm yield is 6.6 million m³/a (18Mℓ/day) (DWS, 2014).

Lake Cubhu is a natural, shallow, freshwater system in the Mzingwenya River catchment. An earth wall was constructed in 1979 in order to raise the lake level. The outflow passes over a weir in the North East corner of the lake, and flows through a wetland to the Mhlathuze Estuary (Martin and Cyprus, 1994). The quoted yield of Lake Cubhu, was determined in the 1970's 30Mℓ/day (WSDP, 2005), but the recent DWS Reconciliation Strategy determined the yield at only 0.4 million m³/a (1.1Mℓ/day). If lake levels drop too low, then the area can be supplied from the Mhlathuze Water transfer scheme. The lake level dropped to 18% in the 2014/15 financial year due to drought.

When levels at Lake Nsezi and Lake Cubhu drop, the water is supplemented from the Mhlathuze River via the Mhlathuze Weir. The Mhlathuze Weir water supply is regulated by releases from the upstream Goedertrouw Dam.

5.2. Water Balance

The Water Balance study undertaken in 2014 as part of the DWS Rec88.5onciliation Strategy project, undertook a water balance assessment. Previous assessments were taken into consideration, updated information was added, and an attempt to resolve a few yield discrepancies was made. The model was based on 2013 requirements for urban usage, and allocations as at 2013 for industry.

The historical firm yield of the individual sources was carried out for the reconciliation strategy, and compared with previous studies. The results are shown in **Table 26**.

Table 26: Historical Firm Yield of individual water sources in the area: Comparison of recent studies (DWS, 2014)

Lake/Reservoir	MORFP HFY (million m^3/a)	MWAAS HFY (million m^3/a)	Reconcilaition Strategy 2014 HFY (million m^3/a)
Goedertrouw Dam excl. Thukela transfer	70.8	58	51.5
Goedertrouw Dam incl. Thukela transfer	Not modelled	Not	84.5
Lake Nsezi	13.9	5.7	6.6
Lake Mzingazi	10.8	8.2	10.5
Lake Cubhu	5.3	0.3	0.4
Lake Nhlabane: with support from Mfolozi	30.7	32.7	34.5
Lake Nhlabane: with no support	Not modelled	Not modelled	7.9
Total yield from natural lakes (with support from Mfolozi)	*60.7*	*46.9*	*52.0*
Total yield from natural lakes (with no support from Mfolozi)	*Not modelled*	*Not modelled*	*25.4*

The current yield of the system was then modelled. "*An initial estimate of the available water in the Mhlathuze system was done by switching off all the irrigation, urban and industrial demands. A yield channel with a fixed seasonal demand was placed at the Mhlathuze Weir and the historical firm yield was determined. The resultant yield is 122.1 million m³/a, which represents the yield available from Goedertrouw Dam and at the Mhlathuze Weir. The individual yields of the lakes were added to this yield as well as an estimate of catchment return flows and groundwater contribution. The transfers from the Thukela and the Mfolozi rivers were incorporated in two ways. This was firstly done by calculating the yield excluding the transfers and adding the estimated volume of each transfer outside of the model. Second, this was done by calculating the yield by switching on the transfers and thereby integrating them into the system. The available water using the second approach is slightly higher which highlights the benefit of storage to the yield of the system*" (DWS, 2014 section 1.1.4). The historical firm yield of the Mhlathuze Supply System in shown in **Table 27**.

Table 27: Historical Firm Yield of the Mhlathuze Supply System (DWS, 2014)

Source	HFY 1[(a)]: Estimated contribution to system yield (million m^3/a)	HFY 2[(b)]: Estimated contribution to system yield (million m^3/a)
Thukela transfer	34	*(34)*
Mfolozi transfer	18	*(18)*
Yield from natural lakes	25.4	52
Return flow[(c)]	10	10
Goedertrouw Dam plus run-of-river yield at Mhlathuze Weir	86.6	122.1
Total (Surface water)	**174.0**	**184.1**
Estimated groundwater contribution[(d)]	11	11
Total (All sources)	**185.0**	**195.1**

Notes:

[(a)] The yield calculation assumes that the transfer from Thukela and Mfolozi are not in operation and the estimated transfer volume is simply added to the total yield for the system after the yield is determined in the WRYM.

[(b)] The yield calculation assumes that the transfer from Thukela and Mfolozi are in operation and is integrated to the system, resulting in a higher net yield from the respective sources i.e. Goedertrouw for Thukela and Lake Nhlabane for Mfolozi

[(c)] Estimated return flows from the MORFP Study (DWAF, 2001)

[(d)] Estimated groundwater contribution from MORFP Study (DWAF, 2001)

This latest yield of 195 million m³/a for the Mhlathuze System is adopted in this study.

In March 2015, the Final Allocation Schedule for the Mhlathuze River Catchment (**Table 28**) was gazetted (Government Notice 242 of Gazette No. 38599, 25 March 2015) per sector. The total allocations (excluding streamflow reduction and storage) are 297.56 million m³/annum. This does include a small portion of allocations that are in the upper catchment above Goedertrouw Dam, but based on the information in the final licensing schedules, this is minimal. The total licenses granted are potentially 100 million m³/a more than what is available from the resource – based on the most recent models.

Table 28: Gazetted water use allocations for Mhlathuze Catchment (SA Govt, 2015)

Sector	Total Volume (million m^3/a)	Estimated portion upstream of Goedertrouw Dam
Industry	5.74	0.13
Commercial/Domestic	0.18	0.06
Municipal	58.73	20.8
Mhlathuze Water Board	94.48	0
Mines	14.02	0
Irrigation	124.41	Negligible

The safe yield from the coastal lakes is a concern. RBM reports a decreasing yield from Lake Nhlabane, ostensibly due to afforestation upstream, and in 2010/2011 and again now in 2015/16 Lake Mzingazi and Lake Cubhu have failed due to drought. Considering the drought in 2010 was not extreme, and yet the lakes still failed, this points towards a serious issue around the sustainability of the resource. There has been a recommendation that the lakes are not utilised until they reach 85-90% of their total volume to allow sufficient recovery, and that future abstractions need to be curbed. From a water balance perspective, the removal of these lakes from the system will reduce the available yield, and is perhaps advised to take this reduced yield into account for planning purposes due to the uncertainty over future use of these sources. This change in system should be modelled to see the impact, for CoU.

In a simplistic manner, the removal of the two lakes from the yield calculations above would result in a system yield of 184.2 million m^3/annum, but this could be inflated. In essence, based on actual usage patterns for 2013, there is very little additional water available for use in normal conditions.

It should also be noted, that RBM have not been operating the Mfolozi transfer scheme, and are thus more reliant on the supply from Nsezi Lake. This has reduced the available water, putting additional pressure on the Mhlathuze system. This needs to be highlighted and resolved.

For this study, the findings of the Reconciliation Strategy, the licensing process, and the current drought conditions are represented in **Table 29**, which will be utilised for modelling and planning purposes.

Table 29: Summary of Water Resources (Recon Study 2015)

Summary of Water Resources (Recon Study 2015)

Source	Registered User	Adopted Firm Yield		Registered/Licenced Volume		Currently Available		Future Availability	
		mill m^3/a	Mℓ/d	mill m^3/a	Mℓ/d	mill m^3/a	Mℓ/d	mill m^3/a	Ml/d
Mhlathuze Weir	Mhlathuze Water	84.3	231.0	94.5	258.9	74.8	205.0	122.0	333.0
Thukela Middledrift	Mhlathuze Water	37.8	103.6	37.8	103.7	28.7	78.7		
Thukela Mandini	Mhlathuze Water	n/a	n/a	47.3	129.6	-	0.0	-	-
Lake Mzingazi	City of Mhlathuze	10.5	28.8	21.7	59.5	-	0.0	10.5	28.7
Lake Nsezi	Mhlathuze Water	6.6	18.1	6.6	18.1	6.6	18.1	6.6	18.0
Lake Chubu	City of Mhlathuze	0.4	1.1	6	16.4	0	0.0	0.4	1.1
Lake Nhlabane	Richards Bay Minerals	34.5	94.5	14	38.4	7.9	21.6	34.5	94.5
Mfolozi Transfer (modelled with Nhlabane for yield)	Richards Bay Minerals			18	49.3	0	0.0		
Sub-total		**174.1**	**477.0**	**245.9**	**624.4**	**118.0**	**301.7**	**173.9**	**475.3**
Possible Groundwater		11.0	30.1	11.0	30.1	11.0	30.1	11.0	30.1
Return Flows		10.0	27.4	10.0	27.4	10.0	27.4	10.0	27.4
Sub-Total		**195.1**	**534.5**	**266.9**	**682.0**	**139.0**	**359.3**	**194.9**	**532.8**
Less irrigation requirement		88.5	242.5	124.4	340.8	69.0	189.0	88.5	242.5
Balance for Urban & Industrial		**106.6**	**292.1**	**142.5**	**341.2**	**70.0**	**170.2**	**106.4**	**290.4**

Note: Irrigation allocation 121 mil m^3/day (84 mil m^3/day from WSS and 88,49 mil m^3/day modelled)

Note Mhlathuze Water has contracted to supply various industries and City of Mhlathuze. Total contracted amount at present is 107.1million m^3/a

Note: Due to severe drought conditions, current availability is curtailed. Agric has an 80% restriction of use in place as at March 2016, hence the low allocation under "currently available"

The DWS Reconciliation Strategy recommends seven (7) interventions to help resolve this water resources deficit for the CoU as shown in **Table 30**.

Table 30: Interventions to help resolve water resources deficit for CoU

Interventions	mill m³/a	Mℓ/d	Cap Cost (R million)	URV Value (R/m³)	Impl Prog: Years
Water Demand Management	6.8	18.6			5
Dam on Nseleni River	10.6	29.0	R 173	R 1.37	8.5
Raising Goedertrouw Dam wall	3.9	10.7	R 78	R 1.61	4.5
Arboretum Effluent Re-use	11	30.1	R 569	R 6.97	6.5
Thukela Transfer	47.3	129.6	R 842	R 6.43	8.75
uMfolozi on-channel storage	66.6	182.5	R 1 764	R 3.52	10.25
uMfolozi off-channel storage	36.9	101.1	R 1 601	R 5.87	9.5
Desalination Ph1	21.9	60.0	R 2 243	R 8.47	7.75

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

- Increased capacity of the Thukela-Mhlathuze Transfer Scheme.
- 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.
- Off-channel transfer scheme from the Mfolozi River.
- Coastal pipeline from the lower Thukela River.
- Desalination of seawater.

Medium-sized schemes to be considered, are:

- Arboretum Effluent Re-use Scheme.
- 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.

Annexure C provides for a map of these interventions.

6. EXISTING WATER SUPPLY INFRASTRUCTURE

This section provides an overview of the existing water supply schemes in CoU.

Annexure D, provides a key map (**Figure 15**), a schematic and detailed scheme map of the existing Bulk Water Supply Infrastructure in CoU.

6.1. Description of Supply to Study Area

There are four (4) major water supply schemes that serve CoU:

1. **Northern Scheme** supplied from the Mzingazi WTW supplemented with water from Nsezi WTW.
2. **Empangeni Scheme** supplied from the Nsezi WTW.
3. **Western Scheme** supplied from the Ngwelezane WTW and supplemented with water from the Empangeni Scheme.
4. **Southern Scheme** supplied by the Esikhaleni WTW.

Mhlathuze Water owns, operates and maintains the following infrastructure that primarily serves industry and supplements the above mentioned schemes when required (Mhlathuze Water, 2016):

- Nsezi Water Treatment Works.
- Nsezi Bulk Transfer Infrastructure: This infrastructure consists of pump stations to Empangeni, Richards Bay, Mondi and Foskor.
- Mhlathuze Weir
- Mhlathuze Weir raw water transfer infrastructure consisting of weir to Nsezi transfer scheme and Hillendale (Tronox) transfer scheme.

Some of the bulk industries own and manage their own water treatment works and supply pipelines, including:

- Mondi Richards Bay
- Richards Bay Minerals (RBM)
- Tongaat Hulett
- Bayside Aluminium

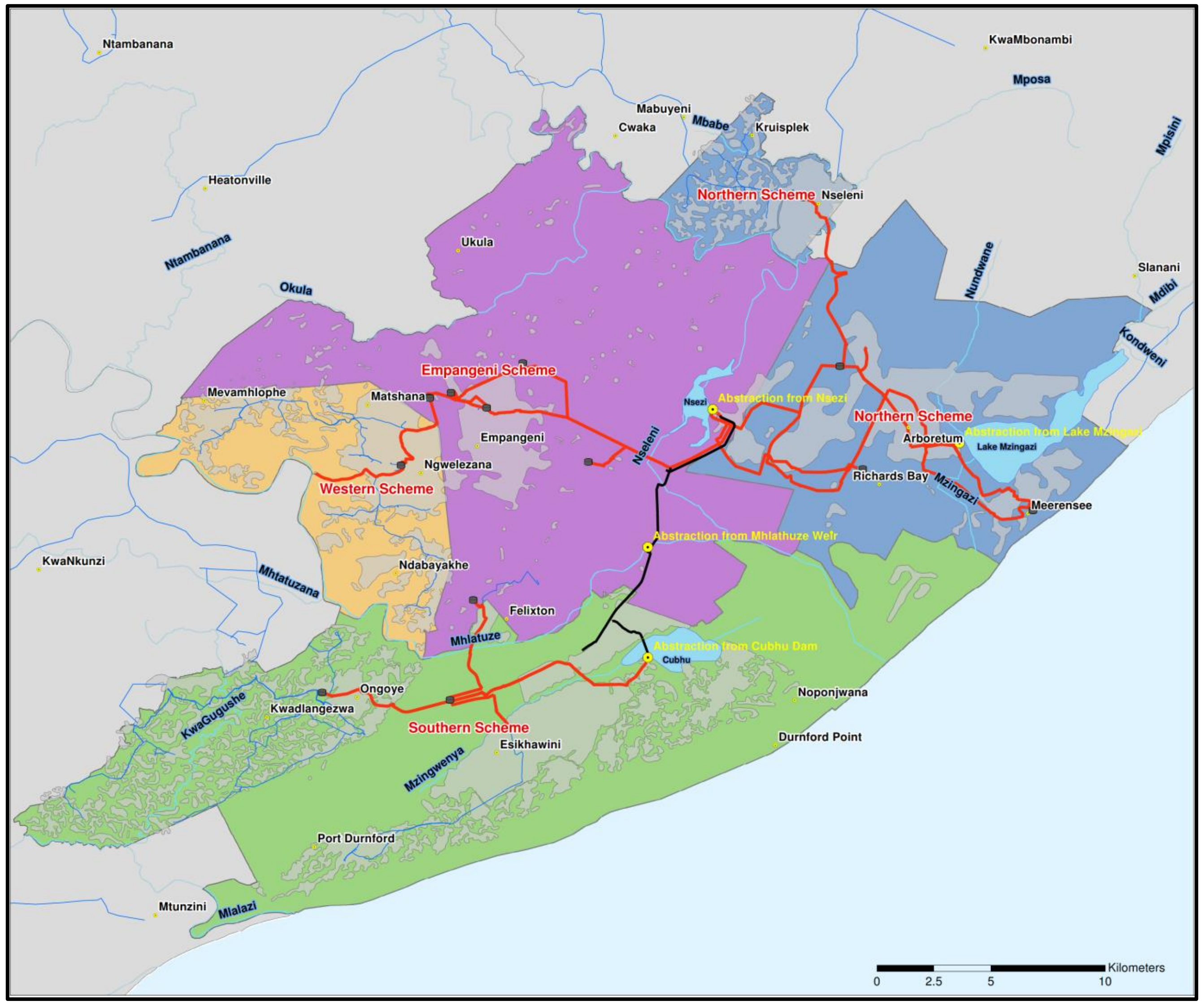

Figure 15: Key Existing Water Supply Scheme Map (Annexure D)

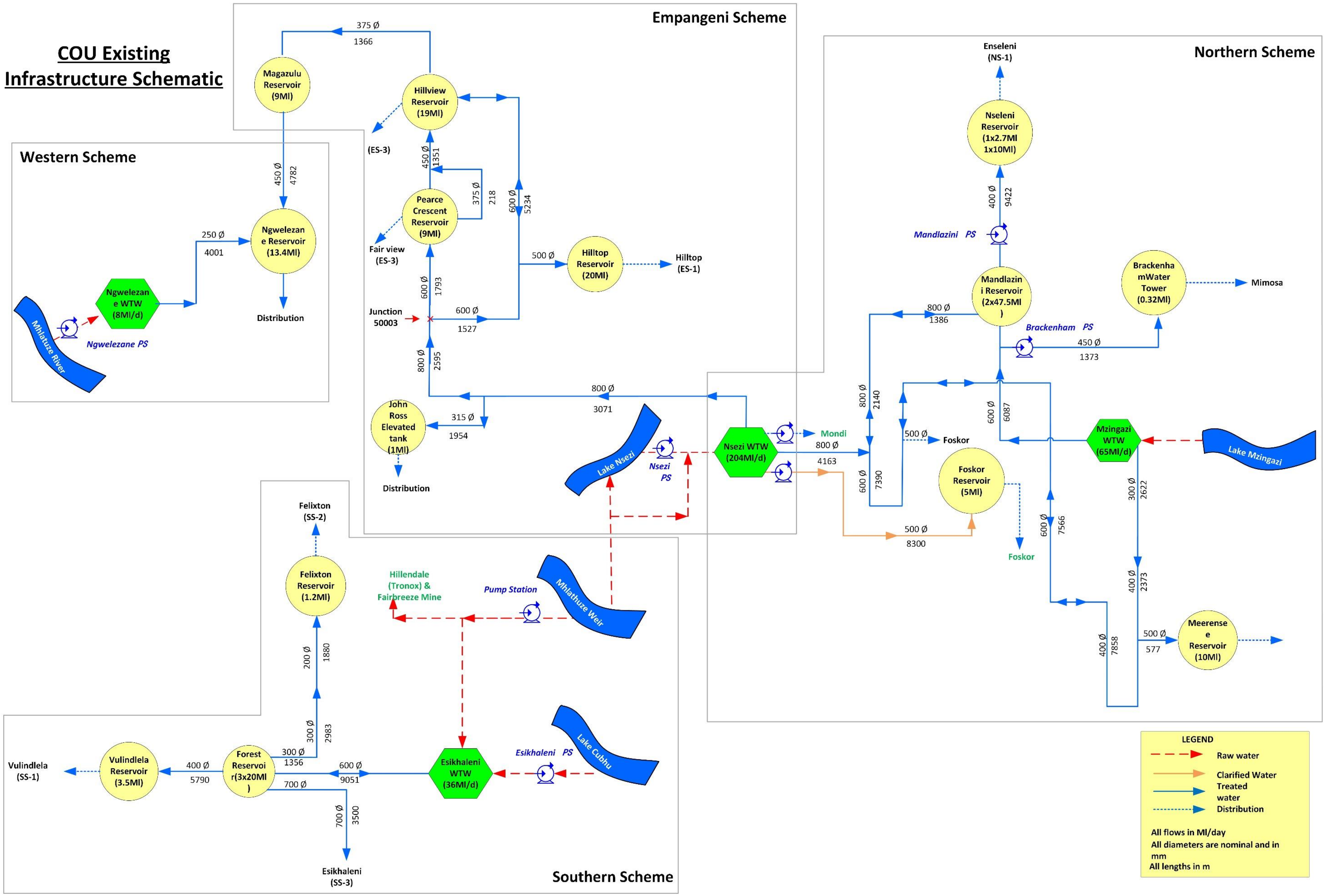

Figure 16: Schematic of CoU schemes, showing linkages with Nsezi WTW

6.2. Northern Scheme

The Northern Scheme, owned by City of uMhlathuze and operated by Mhlathuze Water, abstracts raw water from the Lake Mzingazi, which is then treated and distributed into Richards Bay and the industrial areas (DWS, 2011). The industrial area within the city of Richards Bay includes the Alton area, where Mondi, Hillside and Bayside Aluminium and Foskor are located. The residential suburbs include Meerensee, Arboretum and Veld en Vlei and the commercial/ light-industrial centre. Both residential and commercial/ light-industrial, are primarily supplied from the Mzingazi treatment works, and supplemented when necessary from the Nsezi treatment works. The rural town of Nseleni is also supplied via this scheme as the old Nseleni WTW is no longer functioning, but operates as a potable water pump station to supply the area (DWS, 2014). This area currently falls under Ntambanana LM, but will fall within CoU following the 2016 elections.

6.2.1. Abstraction and Treatment

The historical firm yield of Lake Mzingazi is documented as 10.50 million m^3/a[1] (28.77 Mℓ/d) (DWS, 2014.) The registered water use allocated to the City of uMhlathuze Local Municipality for Richards Bay is much higher than the historical firm yield, at 24.18 million m^3/a (66.25 Mℓ/d). The actual abstractions in 2008 through to 2013 fluctuated from a low of 11.92 to a high of 22.4 million m^3/a.

The raw water pumping capacity can deliver up to 97.5 Mℓ/d from the lake, however the flow rate of the treatment plant when lake levels are sufficient, is 50-60 Mℓ/d (2008-2013 data). This abstraction takes place until the lake drops to the level at which seawater intrusion becomes a possibility, at which point abstraction has to cease. Water supply is supplemented by water from the Empangeni Scheme, with a contracted volume of 25Mℓ/day (DWA, 2011).

The total annual and daily urban water use for Richards Bay can be seen in **Table 31**. Approximately 50-60% of the total water supplied within the area of the Northern Scheme is for urban Richards Bay, with the remainder for Nseleni, and Industrial companies.

Table 31: Richards Bay Urban Water Use (mill m^3/a) (DWS, 2014)

		2008	2009	2010	2011	2012	2013
Inflows	Nsezi WTW	0.03	0.12	3.32	8.12	2.04	1.06
	Mzingazi WTW	20.5	21.03	15.03	11.01	18	21.77
Outflows	Transfer to Nseleni supply area	2.77	3.88	4.06	4.13	4.29	4.28
	Hillside - approximate	0.72	0.72	0.78	0.78	0.78	0.72
	RBCT	0.84	0.79	0.67	0.21	0.3	0.43
	Foskor (potable)	5.24	5.24	5.24	3.43	2.01	2.97
	Bayside (potable) - approximate	0.18	0.18	0.18	0.18	0.18	0.18
Remainder	Urban Richards Bay	10.77	10.33	7.47	10.46	12.53	14.24

[1] The recent Reconciliation Strategy questions this yield, as it does not appear to take groundwater recharge into account. Study recommended. (DWS, 2014)

In September 2014, the minimum allowable abstraction level of Lake Mzingazi was reached, and abstraction was suspended. The Northern Scheme was then wholly supplied with water volumes from Nsezi WTW as requested by the CoU.

6.2.2. Distribution and Storage

Water is distributed to two (2) command reservoirs from Mzingazi WTW, namely Mandlazini and Meerensee Reservoirs from which potable water is distributed to urban Richards Bay and industrial areas (NS-2 & NS-3). A bulk line from Mandlazini Reservoir feeds water to Nseleni (NS-1).

The bulk water infrastructure description and capacity is summarised in **Table 32**.

Table 32: Existing Water Supply Infrastructure - Northern Scheme

Infrastructure Component	Existing Infrastructure Capacity		
Treatment	Capacity (Ml/d)		
Mzingazi WTW	65		269
Nsezi WTW	204		
Storage	Capacity (Ml)		
Meerensee Reservoir	10		123.26
Foskor Reservoir	5		
Mandlazini Reservoir	95		
Brakenham Water Tower	0.32		
Nseleni Reservoir	12.7		
KwaKhoza Reservoir	0.24		
Bulk Distribution	Dia (mm)	Length (m)	Flow (Ml/day)
Mzingazi WTW – Meerensee Reservoir	400	3 199	13.20
Meerensee Reservoir to Meerensee	400	1 023	13.20
T-off on Mzingazi/Meerensee line to Foskor Reservoir	400	10 231	13.20
Mzingazi WTW to Mandlazini Reservoir	600	6 087	34.00
Mandlazini Reservoir to Foskor Reservoir	800	unknown	69.22
Mandlazini Reservoir to Nseleni Reservoir	400	9 422	13.20
Nseleni Reservoir to KwaKhoza Reservoir	200	2 403	2.87
Brakenham Pump station to Brackenham water tower	450	1 373	17.25

6.2.3. Condition of Bulk Supply Infrastructure

Components of the bulk water supply system that warrants attention for refurbishment or replacement are as follows:

- Mzingazi WTW lime dosing equipment and alum mixer

- Nseleni low level reservoir, new low level reservoir and high level water tower
- Upper Hlaza pump station, pump station to Nseleni high level water tower, Kwambo and KwaMbonambi
- WTW's delivery valves on the raw water pumps, actuators at the inlet to the filters, laboratory equipment

6.3. Empangeni Scheme

The Empangeni Scheme supplied the Empangeni urban centre that contains large light industry, commercial, and residential users. Lake Nsezi WTW was built to supply Empangeni, Mondi Richards Bay, Foskor, and the Richards Bay Minerals (RBM) smelter (DWA, 2011). Approximately 25Mℓ/day is pumped to the town of Empangeni daily via a 12.1km pipeline (DWS, 2014). However, when the levels of Lake Mzingazi drop too low, Mhlathuze Water is contracted by CoU to supplement supply to Richards Bay with up to 25Mℓ/day from Lake Nsezi WTW.

6.3.1. Abstraction and Treatment

The scheme is supplied from the Nsezi WTW on the banks of Lake Nsezi. Because the yield of Lake Nsezi can no longer meet the water requirements, it is supplemented by transfers from Mhlathuze River, which is abstracted at Mhlathuze Weir. Mhlathuze Weir relies on releases from Goedertrouw Dam (Recon Study, 2011). Mhlathuze Water is the bulk water services provider from the Thukela-Mhlathuze Government Water Scheme. The water is supplied from the Goedetrouw Dam (owned and operated by the Department of Water and Sanitation) on the Mhlathuze River. The water is released from the dam and flows for about 90km to a weir owned and operated by Mhlathuze Water. From the weir, water is pumped into Lake Nsezi, which acts as balancing storage for Mhlathuze Water's Nsezi WTW. The WTW recently upgraded and now has a capacity of 204Mℓ/day.

In September 2014 when abstraction at Lake Mzingazi ceased completely due to low lake levels, additional water was required. The system capacity at Nsezi for the Richards Bay System was 40 Mℓ/day, but even this was not sufficient, and diesel pumps had to be hired and utilised to meet the 55Mℓ/day required (Mhlathuze Water, 2015). **Table 33** and **Table 34** shows the Empangeni Town Water Use and total production from Nsezi WTW respectively.

Table 33: Empangeni Town Water Use (DWS, 2014)

	2008	2009	2010	2011	2012	2013
Annual (Mm³)	7.24	7.53	8.24	7.77	9.15	9.34
Daily (Ml)	19.84	20.64	22.58	21.3	25.08	25.58

Table 34: Total production from Nsezi WTW (million m³/a) (DWS, 2014)

	2008	2009	2010	2011	2012	2013
Nsezi (potable)	32.19	33.06	33.78	41.03	36.59	34.01
Nsezi (clarified)	4.40	3.95	4.30	5.90	4.55	4.12
Nsezi Total	36.58	37.01	38.07	46.93	41.14	38.13

A total of 71 138 084m^3 of raw water was pumped from the Mhlathuze weir scheme in the 2014/15 financial year. Nsezi Lake received 9 430 042m^3 of this. This was done in order to augment Lake Nsezi during the drought (Mhlathuze Water, 2015).

In 2014/15 financial year a total of 56 689 409m^3 was abstracted by the Nsezi WTW, 54 510 504 m^3 from Mhlathuze River and 2 178 905m^3 from Lake Nsezi. This was a 37% increase in raw water abstracted due to the additional drought relief supply to Richards Bay (Mhlathuze Water, 2015). (**Figure** 17).

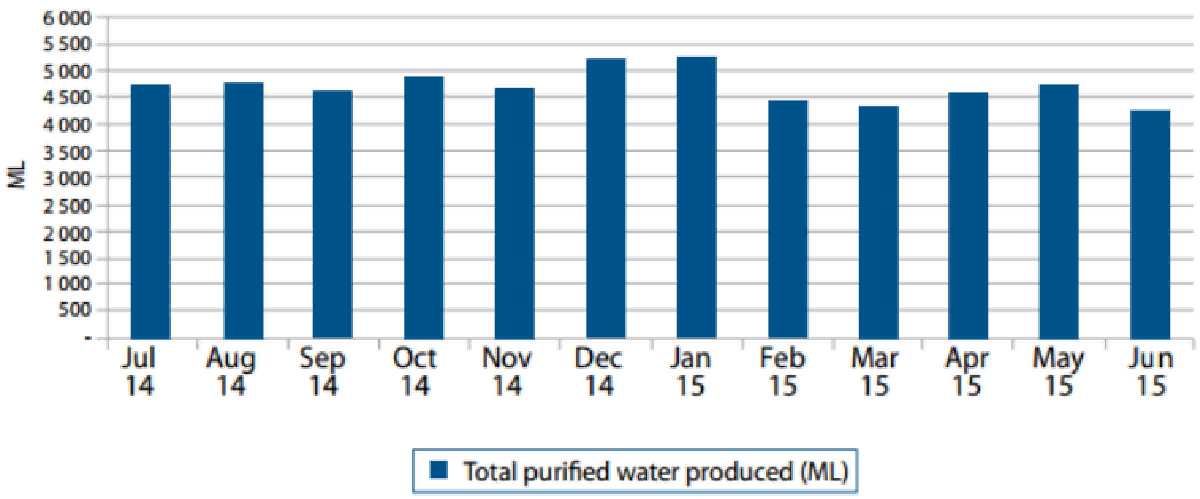

Figure 17: Nsezi WTW monthly potable water production for 2014/15 (Mhlathuze Water, 2015)

The operating rule of the Goedetrouw Dam is such that when the dam level is below 90%, water is pumped from the Thukela River through the Middledrift pipeline to supplement the water supplies of the Mhlathuze River system. The capacity of the transfer scheme adds an additional yield of 34 million m^3/a to the Mhlathuze River system. Upstream of the Goedetrouw Dam is the Mvuzane River inflow where the Thukela Transfer Scheme discharges into the Mvuzane River stream. The Thukela Emergency Transfer System is used to augment the dam level when it drops as a result of high water demand. Since the commissioning of the emergency scheme, it has not been in service because the dam level was high enough. During the second semester of the 2014 calendar year, as a result of minimum summer rainfall received and low raw water resources, it was necessary to officially declare that KZN is in a drought situation. This drought had an adverse effect on the Mhlathuze Water systems with the Goedetrouw Dam dropping to below 65% for the first time since it was commissioned in 1995.

6.3.2. Distribution and Storage

The bulk water infrastructure description and capacity is summarised in **Table 35**.

Table 35: Bulk Water Supply Infrastructure – Empangeni Scheme

Infrastructure Component	Existing Infrastructure Capacity	
Treatment	Capacity (Ml/d)	
Nsezi WTW	204	
Storage	Capacity (Ml/d)	
John Ross	1	58
Hilltop Reservoir	20	
Pearce Crescent	9	
Hillview Reservoir	19	
Magazulu	9	
Bulk Distribution	Dia (mm)	Length (m)
Nsezi WTW to Pearce Reservoir	800 till T-off 600 thereafter	7 459
T- off to Hilltop and Hillvew Reservoirs	600	6 761
Hilltop Reservoir to Hilltop	600	500
Pearce Crescent Reservoir to Hillview Reservoir	450	1 351
Pearce Crescent Reservoir to Hillview Reservoir – T-off back to reservoir	375	218
Hillview Reservoir to Magazulu Reservoir	375	1 366
Magazulu Reservoir to Ngwelezane	375	4 782
T-off to John Ross Tank	315	1 954

6.4. Western Scheme

Ngwelezane and Madlebe towns are supplied from the Ngwelezane WTW. Ngwelezane WTW abstracts water from the Mhlathuze River upstream of the Mhlathuze Weir on the border with uMlalazi LM. The communities are supplied via three (3) reservoirs located on the edge of town. The WTW has a capacity of 8 Mℓ/day and operates at full capacity.

6.4.1.1. Water Resource Consideration/Infrastructure

The Ngwelezane Scheme is supplied from the Mhlathuze River. WARMS shows a registration of 2.92 million m³/annum, and it is assumed that this allocation is included in the now finalised licenses for municipal use. (**Figure 18** and **Table 36**).

Figure 18: The Ngwelezane WTW and Abstraction Point (Google Earth)

Table 36: Ngwelezane WTW Production

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Annual (Mm3)	2.13	2.86	2.99	3.27	3.27	2.79	2.99	2.54		
Daily (Ml/d)	5.84	7.83	8.2	8.96	8.96	7.64	8.18	6.95		

6.4.1.2. Bulk Water Supply Infrastructure

Table 37: Bulk Water Supply Infrastructure of Western Scheme

Infrastructure Component	Existing Infrastructure Capacity		
Treatment	Capacity (Ml/d)		
Ngwelazane WTW	8		
Storage	Capacity (Ml/d)		
Ngwelazane Reservoir	6.5		
Bulk Distribution	Dia (mm)	Length (m)	Flow (Ml/day)
Ngwelazane WTW toNgwelazane Reservoir	250	4 001	4.66
Empangeni Scheme to Ngwelezane Reservoir	450	4 782	17.25

6.4.1.3. Condition of Bulk supply Infrastructure

Table 38: Refurbishment and replacement needs for the Western Scheme

Refurbishment and Replacement Needs for Western Scheme Bulk Infrastructure
Refurbish Ngwelezane WTW abstraction works, chlorine scales, settling tanks, filters, ply dosing equipment, clear water gallery, staff housing, fencing
Refurbish Ngwelezane reservoir pump station
Refurbishment Madlebe pump station (to primary reservoir and reservoir 2)
Replace WTW air blowers, inlet pipe to high lift pumps
Replace 225mm dia. and 250mm dia. fibre cement pumping mains from WTW high lift pumps to Jabulani Hospital and main reservoirs

6.5. Southern Scheme

The Southern Scheme is further divided into three (3) Sub-Schemes, namely Esikhaleni, Felixton and Vulindlela.

6.5.1. Water Resource Consideration

Esikhawini WTW relies on a dual system for the supply of raw water. The two (2) sources consist of Lake Cubhu and the Mhlathuze River. The system from the Mhlathuze River is only utilized when Lake Cubhu fails during a drought.

Historically Esikhawini relied completely on Lake Cubhu as a source. The lake has a quoted yield of 30Mℓ/day determined during the 1970's. Serious problems were however experienced during the 1992/94 drought, with low lake levels, after which it was decided to augment supply from the Mhlathuze River. The scheme from the Mhlathuze River was implemented as part of the Iscor Mining water supply scheme, and was completed during May/June 2001. This system has a rated capacity of 34 Mℓ/day. Lake Cubhu is utilized as a source for as long as possible. Water turbidity in the Lake varies between 5 and 30 NTU. Mhlathuze River turbidity is between 20 and 300 NTU. The cost of purification is therefore much reduced if abstraction is from Lake Cubhu. Abstraction from Lake Cubhu is furthermore under gravity conditions whereas supply from the Mhlathuze River is via a pumping scheme (WSDP, 2005).

Due to the decreasing lake levels, as from August 2014, Esikhaleni WTW was supplemented with 7,5Mℓ/day (raw water from Mhlathuze Water Weir P/S) and this volume was increased gradually over the months up to the maximum system capacity of 30Mℓ/day in January 2015, as per the request from CoU District Municipality. The CoU is currently contracted for 15Mℓ/day (Mhlathuze Water, 2015).

Table 39: Treatment Volumes from the Esikhaleni WTW (DWS, 2014)

Year	2006	2007	2008	2009	2010	2011	2012	2013
Annual (Mm^3)	9.32	9.45	11.97	9.98	9.98	11.37	11.36	11.16
Daily (Ml/d)	25.55	25.88	32.8	27.35	27.35	31.15	31.11	30.56

6.5.1.1. Bulk Water Supply Infrastructure

The bulk water infrastructure description and capacity is summarised in **Table 40** below.

Table 40: Bulk Water Supply Infrastructure – Southern Scheme

Infrastructure Component	Existing Infrastructure Capacity		
Treatment	Capacity (Ml/d)		
Eskikhaleni WTW	30		
Storage	Capacity (Ml/d)		
Forest (3x20Ml)	60.00		81.25
Felixton	1.25		
Vulindlela	20.00		
Bulk Distribution	Dia (mm)	Length (m)	Flow (Ml/day)
Esikhaleni WTW to Forest Reservoir	600	9 300	34.00
Forest Reservoir to Felixton	300	3 000	7.02
	200	1 900	2.87
Forest Reservoir to Port Durnford	700	1 700	49.88
	500	2 950	22.05
	400	5 420	13.20
Forest Reservoir to Vulindlela Reservoir	400	5 800	13.20

The Tronox Pumpstation that supplies raw water from the Mhlathuze River Weir to the Esikhaleni WTW, as well as the Tronox Mine is due for upgrade in 2016.

6.5.2. Condition of Bulk Supply Infrastructure

Components of the bulk water supply system that warrants attention for refurbishment or replacement is shown in **Table 41** below (CSIR Report 2014).

Table 41: Condition of Bulk Supply Infrastructure (Extract from CSIR Report 2014)

Esikhaleni Sub-System
Refurbish WTW's high lift pump station manifold, poly storage tanks, sludge pond
Upgrade of the WTW along the lines proposed in MSW's report of July 2013
Refurbish 'Old Section' of the pumping main from the WTW to Hillendale (5 200m)
Replace WTW's chlorine scale, filter gallery valves
Replace 600mm diameter fibre cement raw water pipe between Plants 1 and 2

7. BULK WATER SUPPLY INTERVENTIONS CURRENTLY IN PLANNING

This section provides an overview of currently planned and potential future water supply projects in CoU. Projects have been identified from three (3) main sources:

1. **Water and Wastewater Infrastructure Master Plan by Mhlathuze Water:** This plan is currently in draft. Interventions proposed in this report have been discussed in person with Mr Thinus Potgieter from Mhlathuze Water.
2. **CoU Bulk Water Master Plan by CSIR:** The status of the planned interventions noted in the CoU Bulk Water Master plan is to be confirmed by CoU. To Bigen Africa's knowledge, these interventions have yet to be committed to funding.
3. **Project lists from DWS:** Projects listed in this section are from the Municipal Infrastructure Grant (MIG) program (COGTA, 2016). CoU does not have any projects funded by the Regional Bulk Infrastructure Grant (RBIG).

7.1. Mhlathuze Water - Bulk Water Projects

Mhlathuze Water owns, operates and maintains Nsezi WTW, Mhlathuze Weir and Nsezi WTW Transfer Infrastructure. The two (2) main developments currently being planned by Mhlathuze Water includes:
1. Augmentation of Nsezi WTW
2. Augmentation of raw water supply from Mhlathuze Weir to Nsezi WTW

7.1.1. Augmentation of Nsezi WTW

The current WTW has a potable water treatment capacity of 204Mℓ/day. Mhlathuze Water intends increasing this capacity to 260Mℓ/day of potable water (272Mℓ/day filtered water and 303Mℓ/day clarified water). The augmentation is expected to meet the planned demands as shown in **Table 42**. This project is currently at design stage and is expected to be completed in 2017/18.

Table 42: Estimated future water allocations from Nsezi WTW by Mhlathuze Water

Consumer	Future Demand (±15 years)
Mondi	100
Richards Bay	65
Empangeni	37
Foskor	25 (clarified)
Uthungulu/Umkhayakhude	25
Ngwelazana	8
Reservce	25
Total Potable	**260**

7.1.2. Augmentation of Raw Water Supply from Mhlathuze Weir to Nsezi WTW

To meet the demand of the augmented WTW noted above, Mhlathuze Water is planning to upgrade the raw water bulk pipeline from Mhlathuze Weir to Nsezi WTW. The planned upgrade is expected to increase the pipeline capacity to 333Mlℓday. The planned capacity upgrade accounts for 260Mℓ/day potable water, 28Mℓ/day treatment losses and 45Mℓ/day RBM transfer to Lake Nsezi. The planned infrastructure includes the following:
- Additional pipeline in parallel to the existing
  - Weir to Nsezi Offtake – 1500mm ND pipe with length of 4068m
  - Nsezi offtake to Nsezi WTW – 1200mm ND pipe with length of 3895m
- Transfer pump station

The project is currently in tender stage.

7.1.3. Other Planned Projects

A summary of other bulk augmentation projects currently being planned by Mhlathuze Water is shown in **Table 43** below. Detailed information on the projects listed in the table are currently very limited as most of the projects are still at a conceptual stage.

Table 43: Mhlathuze Water Planned Projects (MW, 2015)

Project Name	Project Description
Madungela Pump Station	Investigate refurbishment/replacement/upgrade
Esikhaleni potable supply	Investigate feasibility of a direct supply of potable water to Esikhaleni from the Nsezi WTW
New weir	Investigate positioning and impact of a new weir to replace the existing Mhlathuze Weir
Foskor dedicated clarified water supply	Determine feasibility and cost implications for all parties
Mzingazi WTW – Nsezi link	Investigate ways of maximising the benefit of raw water available from the Mzingazi Lake – potentially into the Nsezi WTW
UThungulu direct supply	Investigate options available and feasibility of supplying water directly to the Upper Nseleni water supply area
Desalination and water reuse	Long-term study into ways and means to supplement current sources and reduce water lost to waste
City bulk supply pipeline augmentation	Determine cost implications of upgrading the portions of the City of uMhlathuze industrial ring main, which is a weak point in the supply of water from the Nsezi WTW to the city's Mandlazini reservoirs

7.2. WSA Bulk Water Master Plan Interventions

The CSIR completed a Bulk Water Master Plan for the City of uMhlathuze in 2014. Much time was spent in assimilating and cleaning water infrastructure data, and then open source software called EPANET was used for the hydraulic modelling of the system. The IDP, Spatial Development Framework, and the Human Settlements Plan were used as the main sources of information for the future development in the area. The focus of the study was on the supply of the new areas, as well as refurbishment of existing infrastructure. Interventions proposed by CSIR are summarised in this section. The map in **Figure 19** shows the planned infrastructure proposed by CSIR.

Annexure E provides a key map as shown in **Figure 19** and a schematic of the planned infrastructure.

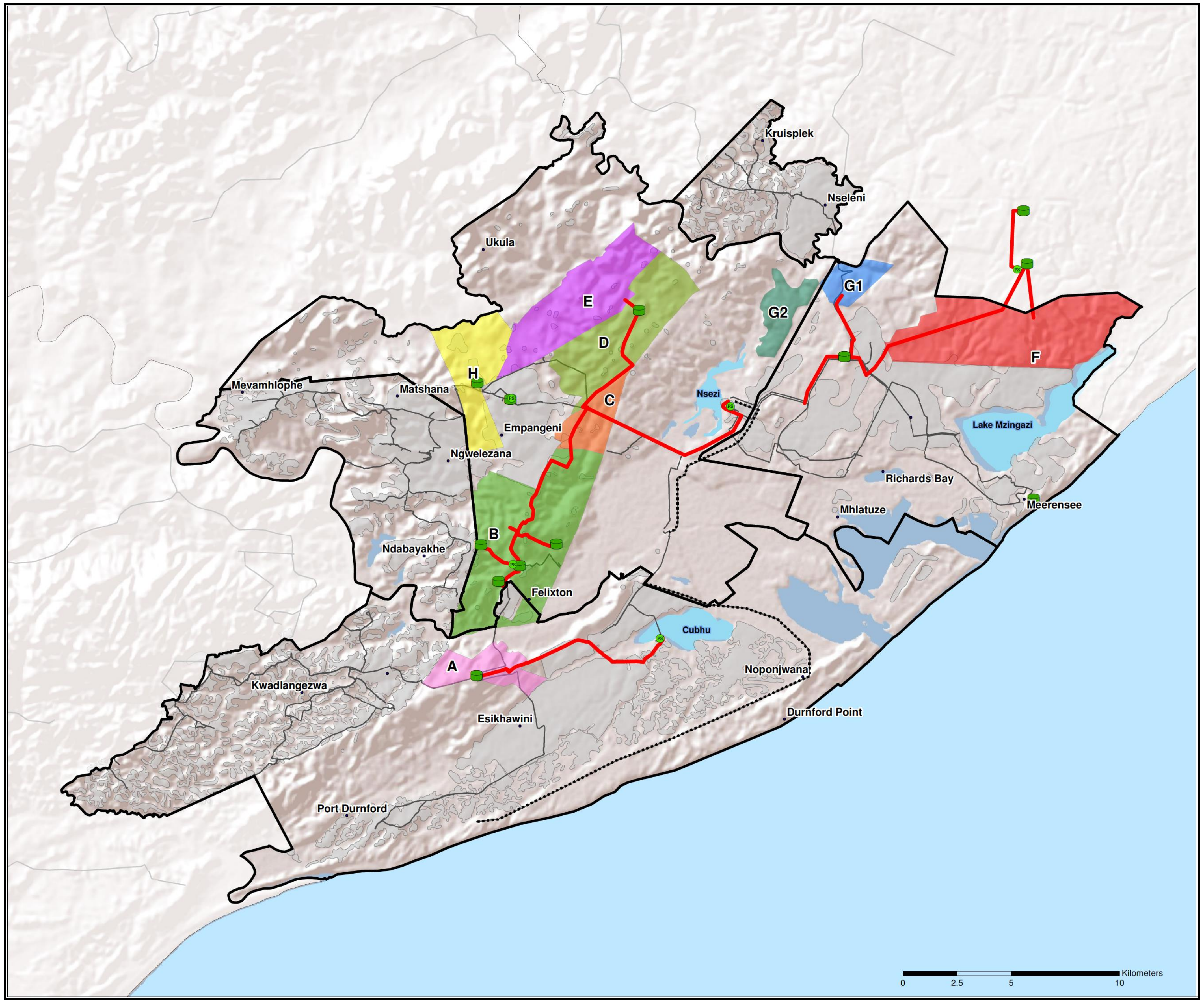

Figure 19: Key map of planned infrastructure from CoU Bulk Master Plan (Annexure E)

The planned interventions are summarized in **Table 44**. The key interventions proposed by CSIR relate to the future expansion areas. No new schemes have been identified. The planned interventions listed are either upgrades of existing infrastructure or an extension from an existing line to an expansion area. A significant intervention proposed by CSIR relates to supply of water to Felixton. Currently, water is supplied to Felixton from the Southern Scheme i.e. Esikhaleni WTW. Based on CSIR's demand model, it was concluded that the future demand for this area would not be sustainably supplied from the Southern Scheme, thus a recommendation was made to construct an off-take from the Nsezi WTW to Empangeni bulk pipeline to supply this area. The total cost of all interventions proposed by CSIR equates to approximately R1.8 billion.

Table 44: Planned Interventions from CoU Bulk Water Master Plan (CSIR, 2014)

Component ID	Component	Period to be Commissioned	Dia/No. of Units	Length/Capacity	Unit	Rate/Unit	Total
Northern Scheme							R 788 554 000
NP-1	Mandlazini Reservoirs to Proposed 12555 Reservoir	2015-2020	300	9 000	m	R 2 640	R 23 760 000
NP-1	Mandlazini Reservoirs to Proposed 12555 Reservoir	After 2025	500	9 000	m	R 5 390	R 48 510 000
NP-2	Mandlazini Reservoirs to expansion area G1 and G2	2021-2025	600	7 000	m	R 7 040	R 49 280 000
NP-3	Extension of Nsezi WTW/Mandlazini Reservoir Supply Main	After 2025	800	4 000	m	R 11 000	R 44 000 000
NR-1	Mandlazini Reservoirs	After 2025	1	47.5	Ml	R 1 126 400	R 53 504 000
NR-2	Meerensee Reservoir	2015-2020	1	10	Ml	R 2 750 000	R 27 500 000
NR-3	Proposed 12555 Reservoir and Elevated Tank	2015-2020	1	10	Ml	R 2 500 000	R 25 000 000
NR-3	Proposed 12555 Reservoir and Elevated Tank	After 2025	2	10	Ml	R 2 500 000	R 50 000 000
NW-1	Wastewater Reclamation from the Alton/Arboretum Marine Outfall	After 2025	1	20	Ml/d	R 15 466 667	R 464 000 000
NW-2	Mzingazi WTW - Attention to Equipment in a Poor and Fair Condition	2015-2020	1			R 3 000 000	R 3 000 000
Empangeni Scheme							R 882 620 000
EP-1	Nsezi WTW to Junction 50003	2021-2025	1 200	9 000	m	R 21 800	R 196 200 000
EP-2	Junction 50003 to Pearce Reservoirs	2021-2025	900	3 000	m	R 13 420	R 40 260 000
EP-3	Pearce Reservoirs to the Hillview Reservoirs	After 2025	450	3 000	m	R 5 460	R 16 380 000
EP-4	Pearce Reservoirs to the proposed Hilltop Reservoir	2015-2020	500	3 500	m	R 4 620	R 16 170 000
EP-4	Pearce Reservoirs to the proposed Hilltop Reservoir	After 2025	750	3 500	m	R 9 000	R 31 500 000
EP-5	Junction 50003 to the off-take to the proposed Beacon 157 Reservoirs	2015-2020	500	7 000	m	R 4 900	R 34 300 000
EP-5	Junction 50003 to the off-take to the proposed Beacon 157 Reservoirs	After 2025	500	7 000	m	R 5 390	R 37 730 000
EP-6	Off-take to the Beacon 157 Reservoir to the Beacon 157 Reservoir	2015-2020	350	1 000	m	R 3 000	R 3 000 000
EP-7	Off-take to the Beacon 157 Reservoir to the Perkins Estate Reservoirs	2021-2025	350	2 000	m	R 3 000	R 6 000 000
EP-7	Off-take to the Beacon 157 Reservoir to the Perkins Estate Reservoirs	After 2025	500	2 000	m	R 5 390	R 10 780 000
EP-8	Proposed Perkins Estate Reservoirs to the Proposed Pentlands Reservoir	After 2025	200	2 000	m	R 1 400	R 2 800 000
EP-9	Proposed Perkins Estate Reservoirs to the Proposed Felixton Reservoir	2021-2025	200	1 000	m	R 1 400	R 1 400 000
EP-10	Junction 50003 (876) to the proposed Korhaan Hill Reservoirs	After 2025	450	6 000	m	R 4 200	R 25 200 000
EPS-1	Proposed Perkins Estate to the Proposed Pentlands Reservoir	After 2025		75	kW	R 60 000	R 4 500 000
EPS-2	Pearce Reservoirs to the Hillview Reservoirs	2015-2020		90	kW	R 78 000	R 7 020 000
ER-2	Pearce Reservoir	2021-2025		30	Ml	R 1 820 000	R 54 600 000
ER-3	Hillview Reservoir	2021-2025		10	Ml	R 2 750 000	R 27 500 000
ER-3	Hillview Reservoir	After 2025		10	Ml	R 3 250 000	R 32 500 000
ER-4	Proposed Hill Top Reservoir	2015-2020		20	Ml	R 1 800 000	R 36 000 000
ER-4	Proposed Hill Top Reservoir	After 2025	3	20	Ml	R 1 980 000	R 118 800 000
ER-5	Proposed Perkins Estate Reservoir and possible elevated tank	2021-2025		20	Ml	R 2 079 000	R 41 580 000
ER-5	Proposed Perkins Estate Reservoir and possible elevated tank	After 2025	3	20	Ml	R 1 980 000	R 118 800 000
ER-6	Felixton Reservoir and Possible Elevated Tank	2021-2025		5	Ml	R 3 920 000	R 19 600 000
ER-6	Felixton Reservoir and Possible Elevated Tank	After 2025	1	5	Ml	R 3 080 000	R 15 400 000
ER-7	Proposed Pentlands Reservoir and Possible Elevated Tank	After 2025		5	Ml	R 3 920 000	R 19 600 000
ER-8	Proposed Beacon 157 Reservoir and Possible Elevated Tank	2015-2020		25	Ml	R 1 848 000	R 46 200 000
ER-9	Proposed Korhaan Hill Reservoir	After 2025	2	10	Ml	R 2 500 000	R 50 000 000
Western Scheme							R 2 000 000
WT-1		2015-2020	1			R 2 000 000	R 2 000 000
Southern Scheme							R 160 410 000
SP-1	eSikhaleni (Lake Cubhu) WTW to the Forest Reservoirs	2015-2020	600	9300	m	R 7 040	R 65 472 000
SPS-1	eSikhaleni WTW to Forest Reservoirs	2015-2020		620	kW	R 60 000	R 37 200 000
SR-1	Forest Reservoir and possible elevated tank	After 2025	1	20	Ml	R 2 286 900	R 45 738 000
SW-1	eSikhaleni (Lake Cubhu) WTW Augmentation to 40 Ml/d and Attention to Equipment in a Poor and Fair Condition	2015-2020		1	Ml/d	R 12 000 000	R 12 000 000
						Total	R 1 833 584 000

7.3. DWS Project List

In reviewing approved DWS funded programme lists, it has been established that CoU, currently only has one (1) project being funded by the Municipal Infrastructure Grant (MIG) and no projects funded by the Regional Bulk Infrastructure Grant. The details relating to the current MIG project are as follows:

Provincial Reference No: 2012MIGFK282206974
Project Name: eSikhaleni Water Improvements Project
Registration Year: 2013/14
Project Status: Construction
Total Project Cost: R 106,502,857
Total Approved MIG Funding: R 105,502,857
Project Description: The Mkhwanazi North Water Supply Phase 5C- E project consists of the balance minor bulk and major the reticulation network of the area and has an estimated population of 29 008. The highest population densities, ranging between 600 and 700 per km, are found on the North, near Empangeni, Vulindlela around the University of Zululand and next to the Old Main Road to Mthunzini. The balance of the area is less densely populated at approximately 200 to 300 persons per km. There are approximately 3 011 households at an average of eight (8) individuals per household. The present average demand for Mkhwanazi North is 5Mℓ/day. The adopted standard for the supply of water includes provision of at least 60 litres per day per person with a connection to the boundary of each yard. The uMhlathuze Municipality will provide counter funding for the provision of yard connection. The requested MIG funding will also include individual yard taps just after the meter (the tap will be located inside the yard).

8. BULK WATER SUPPLY INTERVENTIONS CONSIDERED IN THIS STUDY

This section provides an evaluation of the future demands (detailed in **Section 4**) in relation to the existing infrastructure (detailed in **Section 6**) to provide proposed interventions for bulk water supply in CoU. The planned projects (detailed in **Section 7**) have been taken into consideration however does not form part of the costing in this section. Water resource interventions to meet existing and future demands has been discussed in **Section 5**.

Infrastructure is costed based on 2035 demands. **Annexure F** provides a key map and schematic of the proposed interventions discussed in this section.

8.1. Abstraction and Treatment Options

In light of developing an integrated and sustainable approach to bulk water supply in CoU, the existing Water Treatment Works were used as the basis to establishing future water supply arrangements.

CoU currently has four (4) existing Water Treatment Works that are considered to be in operating condition. **Table 45** summarises the raw water sources, owners and supply areas related to the various WTW's.

Table 45: Current WTW's supplying CoU

Raw Water Source	WTW	Owner	Supply Area
Lake Mzingazi	Mzingazi	CoU	Northern Scheme (Richards Bay and Nseleni)
Lake Nsezi and Mhlathuze Weir	Nsezi	Mhlathuze Water	Empangeni and supplements Northern and Western Scheme
Mhlathuze River	Ngwelazane	CoU	Western Scheme (Ngwelezane)
Mhlathuze Weir and Lake Chubu	Esikhaleni	CoU	Southern Scheme (Esikhawini)

Nsezi WTW serves as a redundancy to Mzingazi WTW and Ngwelezane WTW by supplementing the Northern and Western Scheme, respectively when required. Due to the current drought, the low water levels in Lake Mzingazi, Lake Nsezi and Lake Chubu have resulted in the Nsezi WTW serving the aforementioned resources' supply areas, thus in reality being operated as one scheme.

The draft Water and Waste Water Master Plan by Mhlathuze Water (2016), lists various WTW scenarios for future potable water supply to CoU based on the aforementioned relationships between the existing WTWs. These scenarios are listed in **Table 46**.

Table 46: Alternative Resource and WTW Scenarios

Scenario	Treatment Facility
Scenario A	• Nsezi WTW (Lake Nsezi supplemented by Mhlathuze Weir)
Scenario B	• Nsezi WTW (Lake Nsezi supplemented by Mhlathuze Weir) • Esikhaleni WTW (Lake Chubu supplemented by Mhlathuze Weir)
Scenario C	• Nsezi WTW (Lake Nsezi supplemented by Mhlathuze Weir) • Mzingazi WTW (Lake Mzingazi) • Esikhaleni WTW (Lake Chubu supplemented by Mhlathuze Weir)
Scenario D (status quo)	• Nsezi WTW (Lake Nsezi supplemented by Mhlathuze Weir) • Mzingazi WTW (Lake Mzingazi) • Esikhaleni WTW (Lake Chubu supplemented by Mhlathuze Weir) • Ngwelazane WTW (Mhlathuze River)

In Mhlathuze Water's analysis of the scenarios noted in **Table 46** above, the following was established:

- **Scenario D** is the least viable option in terms of source sustainability, economy of scale and maintenance costs. Ngwelazane WTW and Mzingazi WTW are aging infrastructure requiring more OPEX. It is suggested that Ngwelazane WTW be decommissioned within the foreseeable future.
- **Scenarios B and C** are highlighted as short – medium term viable options. Due to the current state of Lake Mzingazi which is extremely depleted and may take years to recover if ever, Scenario B is considered the more reliable option in the longer term.
- **Scenario A** is highlighted as viable in the long-term only and not economically feasible in the short –medium term. This is due to the high cost of a new dedicated line required from Nsezi WTW to the Southern Scheme (assuming connection to Esikhaleni WTW).

Mhlathuze Water did not select a preferred option from the scenarios listed. For the purpose of this study, Scenario B was selected to be analysed further, taking into consideration source sustainability, CAPEX and OPEX and household unit costs.

In this study, the 2035 raw water demand is estimated at 396Mℓ/day, including commercial, industrial, institution and domestic demand (See Section 4.6.1). Based on the estimation of 333Mℓ/day being available at the Mhlathuze Weir, an additional 63Mℓ/day of raw water is required to meet future demand. This demand assumes that water conservation and water demand management targets are met.

To meet the future demand, the information highlighted in Section 5.2, Table 30 (DWS Water Reconcilliation Strategy Interventions were considererd). The interventions proposed to meet the shortfall are listed in **Table 47**.

Table 47: Proposed Water Resource Interventions

Interventions	mill m³/a	Mℓ/d	Cap Cost (R million)	URV Value (R/m³)	Impl Prog: Years
Raising Goedertrouw Dam wall	3.9	10.7	R 78	R 1.61	4.5
uMfolozi off-channel storage	36.9	101.1	R 1 601	R 5.87	9.5

The cost for raising Goedertrouw Dam Wall is included in the Southern Scheme proposed infrastructure cost. The cost for the uMfolozi off-channel storage dam is included in the Nsezi Scheme.

8.2. Bulk Water Supply from Nsezi WTW and Esikhaleni WTW

The implications on the bulk water supply infrastructure (treatment, distribution and storage) based on Scenario B is detailed in the following subsections. The proposed use of only Nsezi WTW and Esikhaleni WTW to meet 2035 potable water demands results in the four (4) existing water schemes to be consolidated into two (2) future schemes, namely the Southern Scheme and Nsezi Scheme. The Southern Scheme boundary remains unchanged. The Nsezi Scheme is a consolidation of the existing Western, Empangeni and Northern Scheme.

Each of these schemes were analysed in terms of water demands, required infrastructure (treatment, distribution and storage capacity), financial implications and implementation plan.

8.2.1. Southern Scheme

8.2.1.1. Water Demands

A summary of the total population and raw water demands (AADD, GAADD and SDD) for the Southern Scheme is summarised in **Table 48**.

Table 48: Population and Water Demand for Southern Scheme

Demographics	2015		2025		2035	
	Probable	High	Probable	High	Probable	High
Households	35 116	35 195	39 475	39 963	43 570	44 697
Population	157 673	158 025	177 244	179 434	195 628	200 690
Demands (Ml/day)	**2015**		**2025**		**2035**	
	Probable	**High**	**Probable**	**High**	**Probable**	**High**
AADD	55.18	59.28	88.86	99.78	111.94	123.59
GAADD	78.79	84.47	111.07	124.73	139.93	154.49
SDD	92.57	99.62	128.53	144.40	161.77	178.85

These demands are inclusive of industrial, commercial, institutional and domestic demands. The following can be noted in terms of specific raw water supply demands that have been excluded from the sizing and costing of the bulk water supply infrastructure:

- Raw water supplied to Zulti South - 40Mℓ/day (2035 demand)
- Raw water supplied to Tronox (Hillendale) Mine – 55.4 Mℓ/day (2035 demand)

8.2.1.2. Water Supply Infrastructure

Abstraction and Treatment

The existing design capacity for Esikhaleni WTW is 36 Mℓ/day. The required potable water demand for 2035 calculated, is between 48 – 56 Mℓ/day thus resulting in a shortfall of 13 – 21 Mℓ/day of treatment capacity. A recommendation to upgrade Esikhaleni WTW to match this shortfall is suggested. The deficit in raw water supply is proposed to be supplied from the Mhlathuze Weir. The hydrology of Lake Chubu should be confirmed, as it may be pertinent to plan for full supply from the Mhlathuze Weir, as occurs currently under drought conditions.

Distribution

Four (4) bulk water supply lines in this scheme were evaluated to determine if upgrades were required. The four bulk lines include:

1. Esikhaleni WTW to Forrest Reservoirs
2. Forrest Reservoirs to Vulindlela (SS-1)
3. Forrest Reservoirs to Felixton (SS-2)
4. Forrest Reservoirs to Esikhawini (SS-3)

The only upgrade required has been identified on the Esikhaleni WTW to Forrest Reservoirs. An additional line of size 400 – 500mm ND is recommended.

Storage

Forrest Reservoirs are considered the command reservoirs from this scheme area. The current collective capacity of these reservoirs equates to 60 Mℓ (3 x 20Mℓ). Based on a 48 hour storage capacity, the future potable water storage capacity is estimated to be between 67 – 80 Mℓ. An additional 7 – 20Mℓ storage capacity at Forrest Reservoirs is proposed.

8.2.1.3. Financial Implications and Implementation Plan

The estimated cost for the proposed upgrades is shown in **Table 49** below.

Table 49: Costing for Proposed Upgrades - Southern Scheme

Costing of Proposed Infrastructure	Cost on Probable Demand	Cost on High Demand
Consultants	R 12 458 752.52	R 20 437 263.84
Design and Tender Documentation	R 10 692 639.94	R 18 671 151.26
Geotech Survey	-	-
Land Survey	R 72 579.97	R 72 579.97
Cathodic Protection	-	-
Construction Monitoring	R 1 693 532.61	R 1 693 532.61
Construction	R 196 807 110.46	R 285 457 236.25
Pipelines	R 30 288 032.58	R 55 528 059.73
P&G	-	-
Pipeline Construction (Bulk)	-	-
Pipe Bridge/Jack	-	-
Pumpstation	-	-
Water Works	R 69 498 000.00	R 112 266 000.00
Storage (Reservoir)	R 19 021 077.88	R 39 663 176.51
Dam	78 000 000.00	78 000 000.00
Abstraction	-	-
Additional	R 75 660 408.49	R 130 623 486.47
Land Acquisition - 7.5%	R 8 910 533.28	R 15 559 292.72
Environmental, Community Liaison	R 2 000 000.00	R 2 000 000.00
Health & Safety, Quality Assurance	R 1 188 071.10	R 2 074 572.36
Project Office	R 4 158 248.87	R 7 261 003.27
Contingencies @ 50% excl. dam	R 59 403 555.23	R 103 728 618.12
TOTAL	**R 284 926 271.47**	**R 436 517 986.57**

8.2.2. Nsezi Scheme

8.2.2.1. Water Demands

A summary of the total population and raw water demands (AADD, GAADD and SDD) for the Nsezi Scheme is summarised in **Table 50** below.

Table 50: Population and Water Demands for Nsezi Scheme

Demographics	2015		2025		2035	
	Probable	High	Probable	High	Probable	High
Households	42 809	42 906	48 892	49 565	54 555	56 128
Population	192 215	192 647	219 526	222 546	244 954	252 015
Demands (Ml/day)	2015		2025		2035	
	Probable	High	Probable	High	Probable	High
AADD	140.14	153.09	164.62	191.93	204.95	235.21
GAADD	185.08	202.31	205.78	239.91	256.18	294.01
SDD	219.28	240.22	243.38	283.10	301.53	345.67

These demands are inclusive of industrial, commercial, institutional and domestic demands. The following can be noted in terms of water supply demands that have been excluded from the sizing and costing of the bulk water supply infrastructure:

- Supply of potable water to Mondi – a demand of approx. 90 Mℓ/day (2035 demand) has been included in the sizing and costing of the treatment works. It is excluded from the bulk pipelines as Mondi has a dedicated line from Nsezi WTW to Mondi.
- Supply of clarified water to Foskor Reservoir – a demand of approximately 21Mℓ/day has been included in the WTW sizing and costing. It is excluded from the bulk pipeline sizing as Foskor has a dedicated line from Nsezi WTW to Foskor Reservoir in Richards Bay.
- Supply of raw water to RBM from Lake Nsezi – This demand has been excluded from all infrastructure sizing and costing as RBM has a dedicated line from Lake Nsezi.

8.2.2.2. Water Supply Infrastructure

Abstraction and Treatment

Water is to be abstracted from Mhlathuze Weir and uMfolozi off-channel, as noted in **Section 8.1**. For the future abstraction required from Mhlathuze Weir, an upgrade to the raw water lines is required. The project currently under planning by Mhlathuze Water (see **Section 7.1.2**) is supported and has been included in the costing of proposed upgrades for this scheme.

The existing design capacity of Nsezi WTW is 204Mℓ/day. Based on the 2035 demands for potable water in this scheme area, the required capacity is estimated between 304 – 349Mℓ/day. An upgrade of 100 – 145Mℓ/day will be required to meet the 2035 demand for the Northern, Empangeni and Western Scheme. This aligns with the planned upgrade by Mhlathuze Water of 333Mℓ/day.

Storage

48 hour storage demands were calculated based on the potable water requirement in the Northern Scheme and Empangeni and Western Scheme. The existing command reservoir for the Northern Scheme is Madlazini Reservoir (95Mℓ) serving Richards Bay, Meerensee and Nseleni. The command reservoir for the Empangeni and Western Scheme has been identified as the Pearce Crescent and Hillview Reservoirs with a total existing capacity of 28Mℓ.

Based on the future 48 hour storage capacity demand at the command reservoirs, the following recommendations are noted:

- Additional 40 - 60Mℓ storage at Madlazini Reservoir
- Additional 60 - 85Mℓ storage at Pearce Crescent and Hillview Reservoirs

Bulk Distribution

Due to the proposal that Nsezi WTW becomes the main supplier of potable water to the Northern Scheme (Richards Bay and surrounding areas), a new dedicated line from Nsezi WTW to Madlazini is proposed. The new line is estimated to have 950Ø - 1000Ø mm ND pipe, 7700m in length.

To supply the existing Empangeni and Western Scheme, the following upgrades to existing lines is proposed:

- Upgrade Nsezi WTW to Junction 50003 with additional 300Ø mm line
- Upgrade Junction 50003 to Pearce Reservoir with additional 200Ø - 350Ø mm line

8.2.2.3. Financial Implications and Implementation Plan

The estimated cost for the proposed upgrades is shown in **Table 51**.

Table 51: Costing for Proposed Infrastructure - Nsezi Scheme

Costing of Proposed Infrastructure	Cost on Probable Demand	Cost on High Demand
Consultants	R 51 114 670.06	R 64 493 481.27
Design and Tender Documentation	R 42 628 554.61	R 56 499 614.73
Geotech Survey	-	-
Land Survey	R 61 658.09	R 107 093.75
Cathodic Protection	-	-
Construction Monitoring	R 1 438 688.79	R 2 498 854.05
Construction	R 2 394 187 960.33	R 2 578 310 850.54
Pipelines	R 99 773 818.97	R 133 608 149.26
P&G	-	-
Pipeline Construction (Bulk)	-	-
Pipe Bridge/Jack	-	-
Pumpstation		R 0.00
Water Works	R 223 863 750.00	R 299 376 000.00
Storage (Reservoir)	R 150 013 037.85	R 194 789 347.77
Dam	R 1 601 000 000.00	R 1 601 000 000.00
Abstraction	R 319 537 353.51	R 349 537 353.51
Additional	R 343 787 559.69	R 428 336 341.71
Land Acquisition - 7.5%	R 35 523 795.51	R 47 083 012.28
Environmental, Community Liaison	R 2 000 000.00	R 2 000 000.00
Health & Safety, Quality Assurance	R 4 736 506.07	R 6 277 734.97
Project Office	R 16 577 771.24	R 21 972 072.40
Contingencies @ 50%	R 236 825 303.41	R 313 886 748.52
TOTAL	**R 2 789 090 190.09**	**R 3 071 140 673.52**

8.3. Summary of Proposed Interventions

Table 52 summarises the interventions proposed in **Section 8.2.** These interventions are also detailed schematically in **Figure 20.**

Table 52: Summary of proposed interventions

Proposed Future Scheme	Proposed Infrastructure Component	Proposed Infrastructure Description	Estimated Cost		Year to be Commissioned				
			Probable	High	2015	2020	2025	2030	2035
Southern Scheme	Abstraction	Abstraction point: Mhlathuze Weir. Water to be augmented from Goedertrow Dam (raising dam wall). The Southern Scheme will be served exclusively by Mhlathuze Weir. Nsezi Scheme will also be supplemented with water from the Mhlathuze Weir.	R 284 926 271	R 436 517 987					
	Treatment	Upgrade existing Esikhaleni WTW with add. 13 - 21 Ml/d							
	Bulk Distribution	Upgrade Esikhaleni WTW to Forrest Reservoirs line with additional 400Ø - 500Ø mm line (9.0km)							
	Storage	Additional 7 -20 Ml storage at Forest Reservoir							
Nsezi Scheme	Abstraction	Mhlathuze Weir (augmentation costs included in Southern Scheme as this is a shared abstraction point); upgrade raw water line from Mhlathuze Weir to Nsezi WTW. Upgrade includes additional line from Mhlathuze Weir to Nsezi Offtake (1500Ø mm line (4km)) and Nsezi offtake to Nsezi WTW (1200Ø mm line (4km)) and raw water pumpstation.	R 2 789 090 190	R 3 071 140 674					
	Treatment	Upgrade Nsezi WTW with add. 67 - 112 Ml/d							
	Bulk Distribution	Upgrade raw water line from							
		New line (950Ø - 1000Ø mm) from Nsezi WTW to Madlazini Reservoir (7.7km)							
		Upgrade Nsezi WTW to Junction 50003 with additional 300Ø mm line (5.7km)							
		Upgrade Junction 50003 to Pearce Reservoir with additional 200Ø - 350Ø mm line (1.8km)							
	Storage	Additional 40 -60 Ml storage at Mandlazini Reservoir							
		Additional 20Ml storage at Hillview Reservoir							
		Additional 40 - 65 Ml storage at Hilltop Reservoir							
Total			**R 3 074 016 462**	**R 3 507 658 660**					

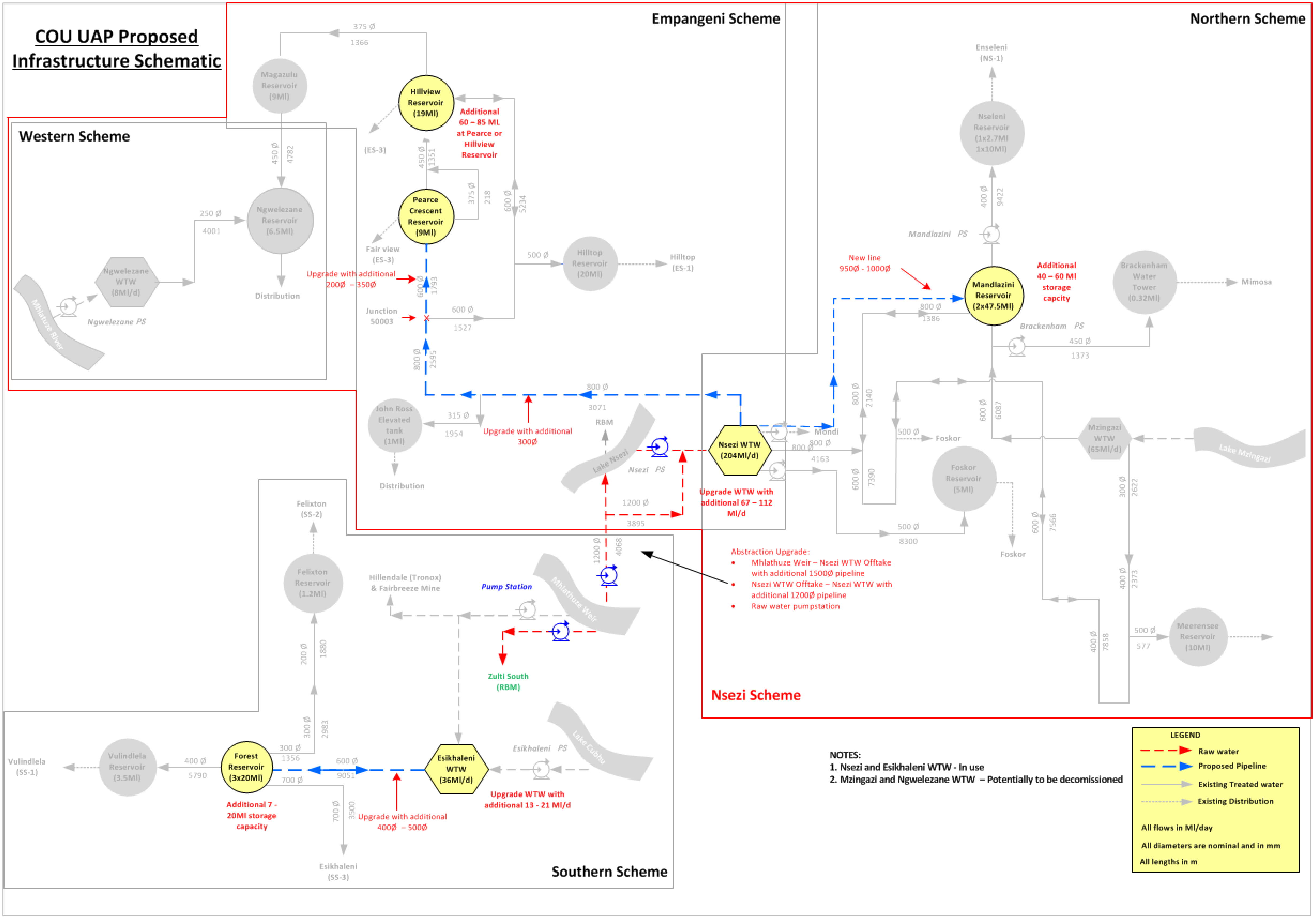

Figure 20: Proposed Upgrades to Bulk Infrastructure (Annexure F)

9. RECOMMENDATIONS

The objective of this reconnaissance study was to establish a conceptual regional bulk water supply plan to eradicate current water supply backlogs and meet demands for the next 30 years (2015 - 2045) in CoU.

In line with the specific targets outlined in **Section 1.3**, the following key findings have been established:

- The total water supply backlog in CoU as of March 2015, stands at 3%. Current water service backlogs are located most predominantly in Vulindlela, in the South of CoU.
- CoU's current and future GAADD is estimated at 264Mℓ/day and 470Mℓ/day, respectively. This equates to a 78% increase.
- The primary water source for the area is the Mhlathuze catchment, with water being abstracted from the river, and the coastal lakes. This water is insufficient however, and there is a transfer from the Thukela River that supplements supply. Richards Bay Minerals also supplements their supply from the Mfolozi River. Current DWS allocations are sufficient to meet demand, however these appear to be significantly in excess of the firm yield of the system, and additional water is needed. Based on the 2035 GAADD for CoU, the total raw water demand required is 396Mℓ/day. The future available water resource at Mhlathuze Weir is currently estimated at 333Mℓ/day. To attain the remaining 63Mℓ/day raw water shortfall, the following DWS Reconciliation Interventions are, as shown in **Table 53** below.

Table 53: Interventions from the DWS Reconciliation Strategy (2014)

Interventions	mill m³/a	Mℓ/d	Cap Cost (R million)	URV Value (R/m³)	Impl Prog: Years
Raising Goedertrouw Dam wall	3.9	10.7	R 78	R 1.61	4.5
uMfolozi off-channel storage	36.9	101.1	R 1 601	R 5.87	9.5

- There are four (4) water treatment works in the City – Nsezi, Mzingazi, Esikhaleni, and Ngwelezane. The **Nsezi** works is the most significant, supplying Empangeni at all times, and supplementing Richards Bay, and Ngwelezane, depending on drought levels. At present Nsezi provides the full supply to all these areas. The **Esikhaleni** WTW is the second key WTW, providing water from Lake Cubhu (except in drought) and supplemented from the Mhlathuze Weir, to Esikhaleni, Vulindlela and South into the neighbouring LM. The yield of the lake needs to be confirmed, as a recent study shows it to only be 1.1Mℓ/day. If this is true, then abstraction from the lake may need to cease, and all water come from the Weir. A study to confirm this is necessary. The **Mzingazi** WTW abstracts from Lake Mzingazi, but the yield of the lake is half of the treatment capacity, and the lake has failed more than once in the last decade. Water re-use interventions are recommended to supplement the water available from Mzingazi Lake, and take advantage of the available treatment capacity at this works. This will assist with both the increase of system yield, and also help justify the operational costs of this large works currently sitting in disuse. **Ngwelezane** WTW is a small works that has a run of river abstraction from the Mhlathuze River. Water levels result in operational issues, and it is recommended that this WTW is decommissioned, which will reduce overall operational costs.

- The following bulk line upgrades are recommended:
  - Southern Scheme:
    - Upgrade bulk line from Esikhaleni WTW to Forest Reservoir with additional 400 – 500mm diameter line
  - Northern Scheme:
    - New dedicated line from Nsezi WTW to Mandlazini Reservoir (950 – 1000mm ND line)
    - Upgrade line from Nsezi WTW to Junction 50003 with additional 300mm diameter line
    - Upgrade line from Junction 50003 to Pearce Crescent Reservoir with additional 200 – 350 mm ND line

Based on the aforementioned findings, the recommendations being put forward are, as follows:

- A detailed hydrological modelling exercise looking at the impact of <u>NOT</u> utilising the Mzingazi and Cubhu Lakes, and the impact this will have on the overall system yield. As a part of this study, the yields of the lakes should be confirmed. This eventuality should be planned for from a water resource provision perspective, considering the history of these lakes failing.
- The further investigation and implementation of the water resources yield improvement intervention.
- The planned upgrade to the raw water line from Mhlathuze Weir to Nsezi WTW is recommended to meet future water demands.
- The upgrade of some of the bulk pipelines, and reservoirs is required to meet future demand.

The total cost of the proposed interventions are summarised in **Table 54** below.

Table 54: Total cost of proposed interventions

Scheme Name	Total Households (Census 2011)	Cost Based on Probable Demand	Cost per Household Based on Probable Demand	Cost Based on High Demand	Cost per Household Based on High Demand
Southern Scheme	36 591	R 284 926 271	R 7 787	R 436 517 987	R 11 930
Nsezi Scheme	49 798	R 2 789 090 190	R 56 008	R 3 071 140 674	R 61 672
Total	**86 389**	**R 3 074 016 462**	**R 35 583**	**R 3 507 658 660**	**R 40 603**

10. REFERENCES

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ANNEXURE A

<u>CoU CONTEXT MAPS</u>

ANNEXURE B

DEMAND INPUTS AND RESULTS

ANNEXURE C

WATER RESOURCE MAP

ANNEXURE D

EXISTING INFRASTRUCTURE MAPS AND SCHEMATIC

Annexure E: CoU Bulk Water Master Plan – Planned Infrastructure Maps

ANNEXURE E

CoU BULK WATER MASTER PLAN – PLANNED INFRASTRUCTURE MAPS

ANNEXURE F

UAP PROPOSED INFRASTRUCTURE MAPS AND SCHEMATIC (KEY MAP)