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Water Reconciliation Strategy Study for the Large Bulk Water Supply Systems: Greater Bloemfontein Area

Final
Preliminary Reconciliation Strategy Report

June 2010

aurecon

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water affairs

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Water Reconciliation Strategy Study for the Large Bulk Water Supply Systems: Greater Bloemfontein Area

PRELIMINARY RECONCILIATION STRATEGY REPORT

FINAL

June 2010

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Directorate National Water Resource Planning

Water Reconciliation Strategy Study for the Large Bulk Water Supply Systems: Greater Bloemfontein Area

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Water Reconciliation Strategy Study for the Large Bulk Water Supply Systems: Greater Bloemfontein Area

Study Reports

Report Name	DWA Report Number	Aurecon Report Number
Inception	P WMA 14/C520/00/0910/01	402992/6231
Preliminary Reconciliation Strategy	**P WMA 14/C520/00/0910/02**	**402992/6232**
Interventions Report	P WMA 14/C520/00/0910/03	402992/6233
Water Quality Assessment	P WMA 14/C520/00/0910/04	402992/6234
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ABBREVIATIONS

ACRONYMS

BW	Bloem Water
CBD	Central business district
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
GIS	geographical information systems
IDP	Integrated Development Plant
ISP	Internal Strategic Perspective
MLM	Mangaung Local Municipality
PRVs	Pressure reducing valves
P/s	Pumpstation
RDP	Reconstruction and Development Programme
RO	Reverse Osmosis
RPST	Reconciliation Planning Support Tool
SDF	Spatial Development Plan
UAW	Unaccounted for water
URVs	Unit Reference Values
WC/WDM	Water Conservation and Water Demand Management
WMA	Water Management Area
WSDP	Water Service Development Plan
WTW	Water Treatment Works
WWTW	Wastewater Treatment Works

MEASUREMENTS

million m^3	Million cubic meters
km	Kilometres
m^3/s	Cubic meters per second
M	Meters
Ha	Hectares

1. BACKGROUND

1.1 PURPOSE

The Department of Water Affairs (DWA) has initiated a Reconciliation Strategy Study in the Greater Bloemfontein area to explore supply and demand side interventions that can be implemented to meet possible future water requirements. Climate change, and its possible impacts on water resource availability, will also be brought into consideration.

The objective of the Reconciliation Strategy Study is to develop a strategy that will set out a course of action to ensure adequate and sustainable reconciliation of future water requirements in the Greater Bloemfontein Area for a horizon of at least 25 years. This study will:

1. Estimate future water requirements scenarios for the Greater Bloemfontein Area;
2. Investigate possible Water Conservation and Water Demand Management (WC/WDM) interventions, groundwater interventions, re-use of treated effluent, and possible future surface water resource development options;
3. Investigate possible scenarios for reconciling the requirements for water with the available resources; and
4. Provide recommendations for development and implementation of interventions and necessary actions required.

This Interim Reconciliation Strategy Report describes the study area, available supply, future water requirements, supply and demand side interventions and potential future water balance scenarios. It further aims to describe the proposed actions and the associated responsibilities and timing of such actions that are urgently needed to prevent the risk of a water shortage becoming unacceptable.

1.2 OVERVIEW OF THE STUDY AREA

The Greater Bloemfontein Supply System provides the majority of potable water requirements to the towns located within the study area, namely Bloemfontein, Thaba Nchu, Botshabelo, Wepener, Dewetsdorp, Reddersburg, and Edenburg. The future water requirements of the rural villages surrounding Thaba Nchu, which currently utilise groundwater, will also be taken into consideration in the strategy development. These towns are located within the Mangaung Local Municipality (MLM), which falls within the Motheo District Municipality. Agricultural water requirements will also form part of this study, as these water requirements may impact on the reconciliation of supply and requirement.

The study area has been divided into two areas, namely a ***Primary Study Area*** and a ***Secondary Study Area*** **(Figure 1.1)**. The ***Primary Study Area*** includes the municipal boundary of MLM, all the towns identified within the Greater Bloemfontein Area, and main water resources. The ***Secondary Study Area*** includes the Caledon River, which is the main river system providing surface water to Bloem Water, and the quaternary catchments which drain into the Caledon River.

1.2.1 Bloemfontein

Bloemfontein is the capital of the Free State which is the third largest province covering 10.6% of the country's surface area. Bloemfontein is the judicial capital of the Republic of South Africa, the economic hub of the MLM, and the focal point for future development. The city is centrally located in South Africa and is served by major roads, such as the N1 which links Gauteng with the Southern and Western Cape, the N6 which links Bloemfontein to the Eastern Cape, and the N8 which links Lesotho in the east and Northern Cape in the west. The city has developed around the central business district (CBD) in a sectoral form, with the majority of the poor and previously disadvantaged communities living in the south-eastern section (SDF, 2005-2006).

Little economic activity has been stimulated recently, despite land being designated for commercial or small industrial activities in new extensions. There has been a major relocation of services to suburbs, which has led to under-utilised office space in the CBD. Commercial and industrial activity in the city centre has also shown a decline.

The community, social, and personal service sector is the strongest economic sector and biggest job provider in the city. Key service sector employers include provincial and local government, education, and health facilities and training institutions, sport and cultural events and facilities, services to the agricultural sector, and financial services (IDP, 2002).

1.2.2 Botshabelo

Botshabelo was established in 1978 as an apartheid-engineered town for displaced people in the Free State. Most of the people who migrated to the town were from rural areas and adjacent towns. The city was spatially designed as a linear development with a small shopping centre in the middle, an industrial area on the northern side next to the N8, and 59 schools. The area is characterised by an over-supply of school sites and public open spaces (IDP, 2002).

There has been a decline in the manufacturing sector, which is largely due to subsidy cuts to industries in Botshabelo. As a result there are limited employment opportunities and many residents have started their own business. Others seek employment opportunities outside of Botshabelo, giving rise to almost 13 000 people commuting on a daily basis between Botshabelo and Bloemfontein (SDF, 2005-2006).

1.2.3 Thaba Nchu

Thaba Nchu has a more scattered development pattern with 37 villages surrounding the urban centre, some as far as 35 km from the closest urban centre. Four of these villages have recently been formalised. The area is characterised by vast stretches of communal grazing areas that surround the urban centre. Thaba Nchu has a strong rural character and is mainly a dormitory town for workers in Bloemfontein (SDF, 2005-2006).

1.2.4 Rural areas

Approximately 23% of MLM is farmland, with a further 2% covered with smallholdings. The rural area with its commercial farms is a new challenge to the expanded Municipality. Although the area has basic infrastructure like roads, electricity and telephones, the main services are in the urban areas. Approximately 93% of all erven have at least RDP standard of water (access within 200m radius) but 39% are without water connections on the erf. In terms of sanitation, the biggest problem is the bucket system, with 38% of erven have buckets or own pit latrines (WSDP, 2006/2007).

Commercial livestock farming is the economic backbone of the rural areas. Crops like maize, wheat, and sunflower are also produced. Many farmers have struggled to adapt to open markets, new products, and lack of subsidies from government.

There are small farmers on the former Trust lands around Thaba Nchu and Botshabelo. There has been some land reform but the process has been slow (IDP, 2002).

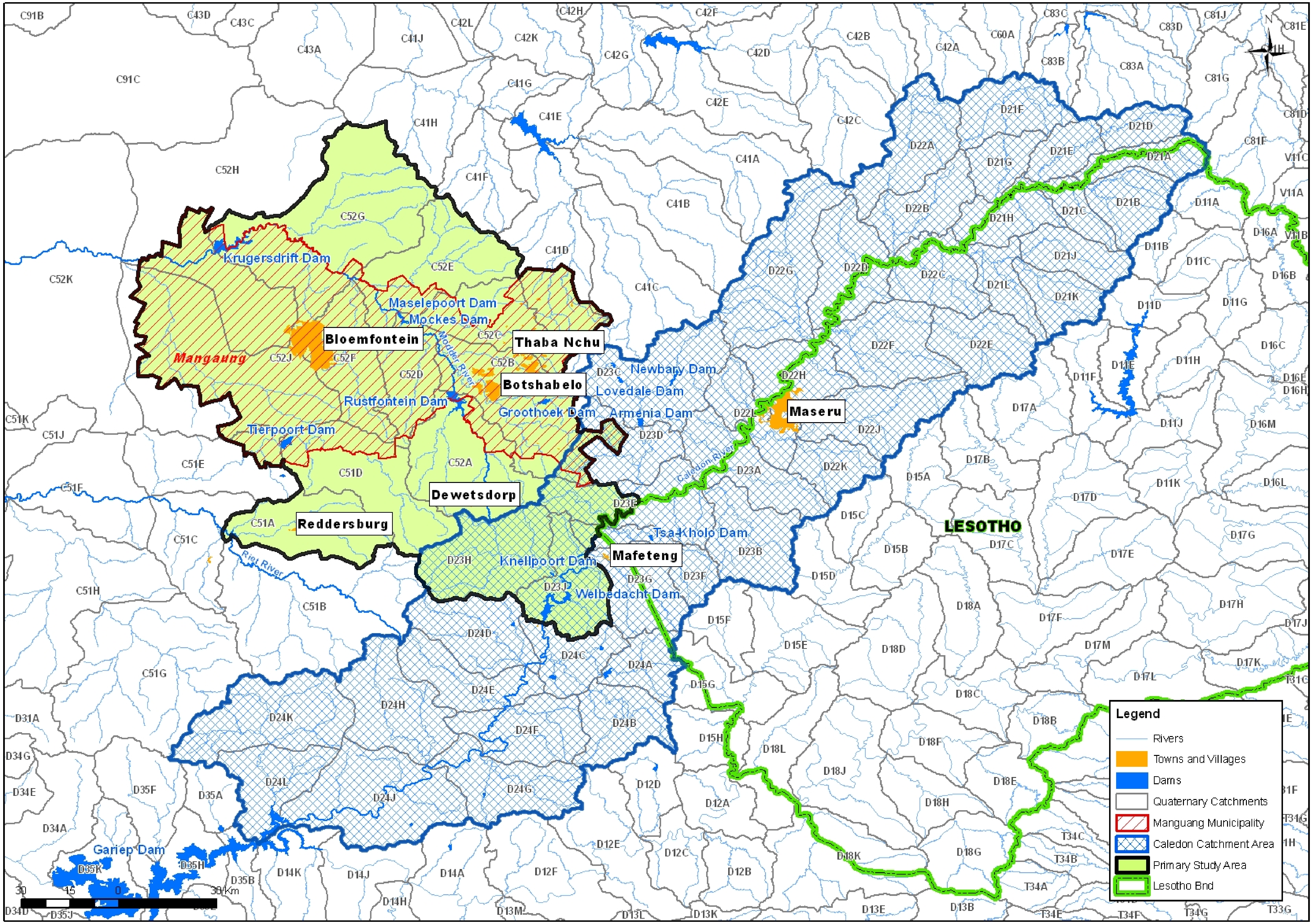

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Figure 1.1 The Greater Bloemfontein Bulk Water Supply System (Primary Study Area) and the Caledon Catchment Area (Secondary Study Area)

2. BULK WATER SUPPLY INFRASTRUCTURE

Bloem Water is the main supplier of bulk potable water to urban centres in the Modder / Riet sub-catchment. In order to meet current water requirements, water is transferred from the Orange and Caledon River Systems. The main transfer water supply schemes are: (1) the Caledon – Bloemfontein transfer which supplies Bloemfontein, Dewetsdorp, and small users from Welbedacht Dam, (2) the Maselspoort Scheme, and (3) the Caledon – Modder (also known as the Novo Transfer Scheme) which supplies water via the Rustfontein Treatment Works to Bloemfontein, Botshabelo, and Thaba Nchu. A brief description of these transfer schemes is provided in the following sections. The bulk water supply system serving the Greater Bloemfontein Area is shown in **Figure 2.1.**

2.1 THE CALEDON – BLOEMFONTEIN TRANSFER

The Caledon-Bloemfontein pipeline was commissioned in 1974 to supply potable water from the Welbedacht Dam on the Caledon River to Bloemfontein, Botshabelo, Thaba Nchu, Dewetsdorp, Reddersburg, and Edenburg. Due to the decreasing yield of the Welbedacht Dam as a result of siltation (gross storage capacity has reduced from the original 115 million m^3 to approximately 30 million m^3 in nine years) and the increasing demand on the Caledon-Bloemfontein Regional Water Supply Scheme, the DWA supplemented the yield of the Welbedacht Dam through the construction of the Knellpoort off-channel storage dam on the Rietspruit, a tributary of the Caledon River. Knellpoort Dam is supplied with water from the Caledon River by the Tienfontein Pump station. Water diverted from the Caledon River into Knellpoort Dam is then released back into the Caledon River to allow abstraction at Welbedacht Dam by Bloem Water all year round. The Novo Transfer Pump Station (discussed in **Section 2.3**) is located at the Knellpoort Dam and is able to transfer water into the Modder River, which supplies the Rustfontein and Mockes Dams.

Situated just downstream of Welbedacht Dam is the Welbedacht Water Treatment Works (WTW) with a capacity of 145 Ml/day. This water is pumped after purification via a 6.5 km pressure pipeline and a 106 km gravity pipeline to Bloemfontein. The average capacity of the pipeline is 1.7 m^3/s and the maximum capacity 1.85 m^3/s. This infrastructure is owned and operated by Bloem Water.

2.2 THE MASELSPOORT SCHEME

The Maselspoort Scheme includes the Maselspoort WTW (110 Ml/day) and the Maselspoort Weir, which is located on the Modder River downstream of Mockes Dam (which is downstream of the Rustfontein Dam). The Maselspoort WTW supplies approximately 25% of Bloemfontein's water needs and is owned and operated by the MLM.

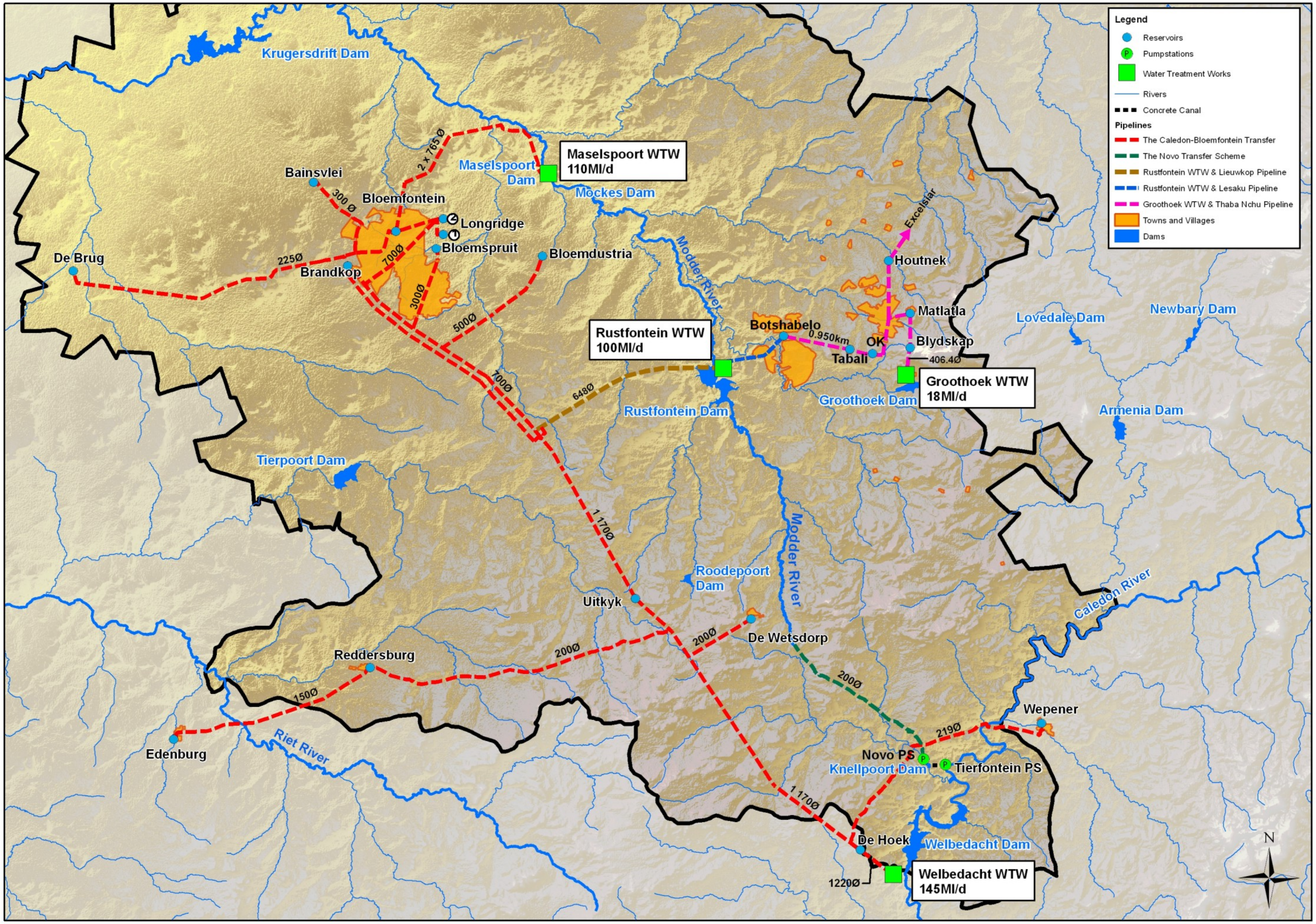

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Figure 2.1: Greater Bloemfontein Bulk Water Supply System

2.3 THE NOVO TRANSFER SCHEME

The Novo Transfer Scheme, which became operational in 1998, includes Tienfontein Pump Station, a pipeline and canal from Tienfontein Pump Station to the Knellpoort Dam, Knellpoort Dam, and the Novo Pump Station and pipeline. The Novo pump station (current capacity is approximately 1.5 m^3/s), which is situated on the northern side of the Knellpoort Dam, transfers water from Knellpoort Dam to the Modder River, via a 20 km pipeline running from Knellpoort Dam to the headwaters of the Modder River. From the outfall of the Novo pipeline, water flows down the Modder River to Rustfontein Dam, a distance of approximately 50 km. Water stored in Rustfontein Dam is treated at the Rustfontein WTW and pumped to Botshabelo/Thaba Nchu or Bloemfontein. As an alternative, water can be released from Rustfontein Dam to flow downstream into Mockes Dam from where it can be abstracted at the Maselspoort Weir, treated at Maselspoort WTW, and pumped to Bloemfontein. The above infrastructure is owned by DWA and operated by Bloem Water.

2.4 OPERATION OF SYSTEM

The Novo Transfer Scheme is aimed at being operated on the basis of maintaining a target water level of approximately 60% in Rustfontein Dam. This is, however, dependent on rainfall. In attempting to achieve the abovementioned target levels, the Novo Pump Station has been run since December 2008 on a virtually continuous basis, pausing in this period for three months only to allow for time to repair the pumps.

Tienfontein Pump Station currently abstracts and pumps the water to Knellpoort Dam for storage, on a virtually continuous basis throughout the year (dependent on water availability). This stored water in Knellpoort Dam is ultimately released back to Welbedacht Dam for abstraction by the Welbedacht WTWs or pumped to the upper reaches of the Modder River by Novo Pump Station. The Welbedacht WTWs, which abstracts water from Welbedacht Dam, is operated at full capacity throughout the year.

2.5 POTABLE WATER BULK INFRASTRUCTURE

Bloem Water supplies about 100 million m^3/a to about 580 000 people and is the main supplier of bulk potable water to the urban centres in the Modder / Riet River sub-catchment. The total current capacity of reservoirs serving the Greater Bloemfontein is 0.425 million m^3 (this includes MLM's reservoirs). The capacity of Bloem Water's bulk reservoirs is 0.278 million m^3. The Thaba Nchu and Botshabelo reservoirs have capacities of 0.156 million m^3 and 0.052 million m^3 respectively.

Bloem Water together with MLM own and operate four WTWs with associated infrastructure **(Figure 2.1)**. Details of these WTW are provided in **Table 2.1.**

Table 2.1: Maximum Capacity of Bulk Water Supply Infrastructure (Bloem Water, 2008)

Infrastructure	Annual capacity (million m^3/a)	Capacity (Ml/d)	Owner	Area of Supply
Welbedacht WTW	51.465	145	BW	Bloemfontein / Mangaung
Rustfontein WTW	12.045	100	BW	Bloemfontein / Mangaung
Maselspoort WTW	40.150	110	MLM	Bloemfontein / Mangaung
Groothoek WTW	1.460	18	BW	Botshabelo / Thaba Nchu

2.6 MAJOR WASTEWATER TREATMENT WORKS

The re-use of treated effluent from wastewater treatment works (WWTW) could provide an alternative source to supply water to the Greater Bloemfontein Area in the future. **Table 2.2** lists the current WWTWs which serve Bloemfontein/Mangaung and Botshabelo/Thaba Nchu areas.

Table 2.2: Current Capacity of WWTWs which serve MLM

Area	WWTWs	Capacity (Ml/d)
Bloemfontein/Mangaung	Bloemspruit	56
	Sterkwater	10
	Welvaart	6
	Bainsvlei	5
	Northern Works	1
	Bloemdustria	< 1
Botshabelo/Thaba Nchu	Botshabelo	20
	Selosesha	6

The geographic location of the WWTWs is provided in **Figure 2.2**.

The MLM is in the design phase to construct the new WWTW (referred to as the North Eastern WWTW), to allow further development in the northern, eastern, and western parts of the city.

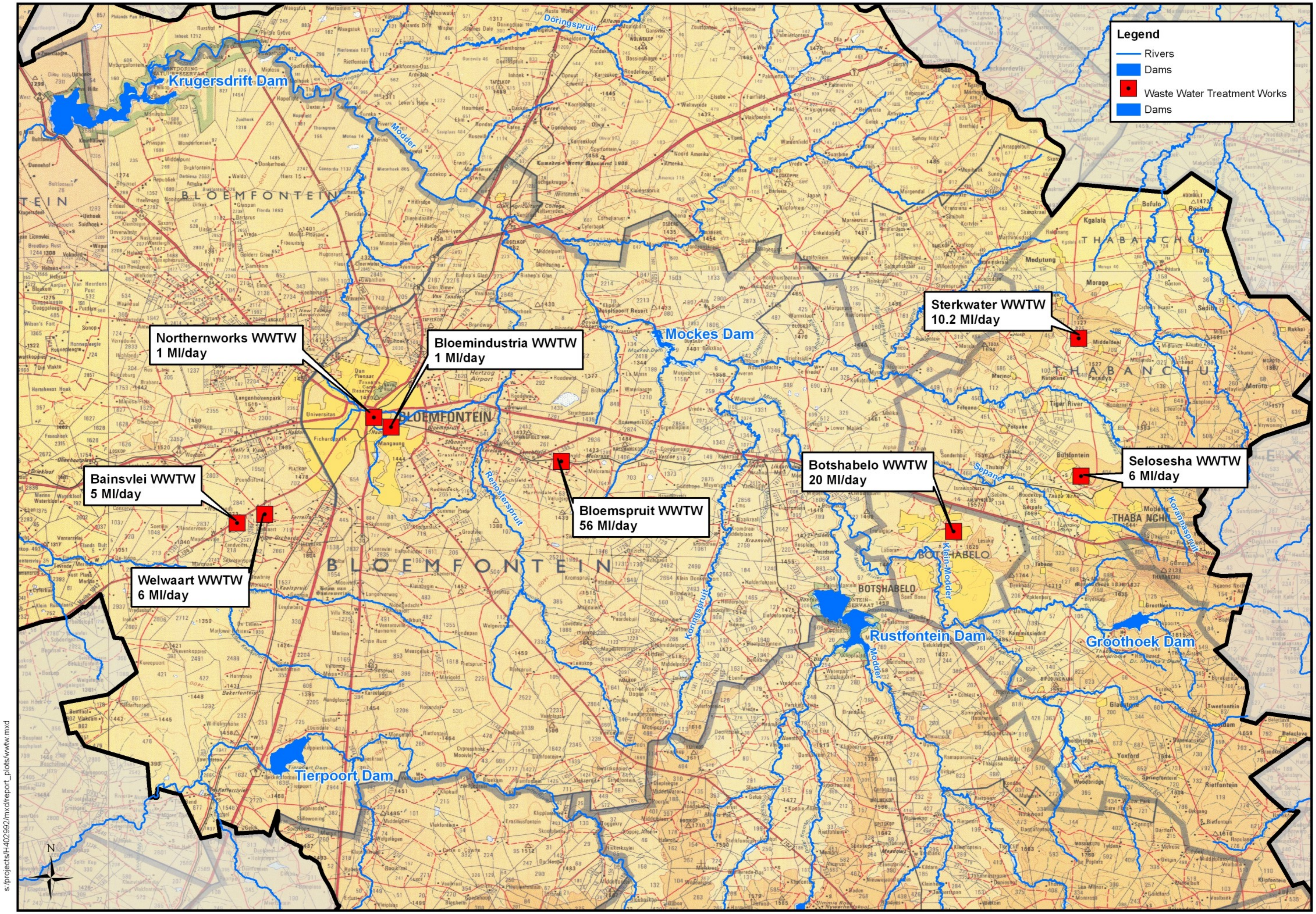

Figure 2.2: WWTWs located within the Primary Study Area

3. AVAILABLE SUPPLY

3.1 SURFACE WATER

Nearly 70% of the total surface runoff, which would flow through the Upper Orange Water Management Area (WMA) under natural conditions, originates from Lesotho and just more than 30% from within the WMA. The surface water resources, both within the Upper Orange WMA and in Lesotho, are well developed and have a high degree of utilisation.

The two largest dams in this WMA are the Gariep and Vanderkloof dams, which reduce the incidence of floods in the Lower Orange WMA by about 50%. Other major dams are the Welbedacht and Knellpoort dams in the Caledon catchment and the Krugersdrift, Rustfontein, and Kalkfontein dams in the Modder-Riet River catchment. A description of the major dams per sub-catchment is provided in the following sections and is shown in **Figure 3.1**.

3.1.1 Caledon River Sub-catchment

The *Welbedacht Dam* is situated on the Caledon River and supplies water to urban users in Bloemfontein, Botshabelo, Dewetsdorp, and various other smaller users, as well as irrigators downstream of Welbedacht Dam along the Caledon River. The irrigators downstream of Welbedacht Dam have no claim to any water in Welbedacht Dam and only the inflow is released for irrigation purposes. The Welbedacht WTW at Welbedacht Dam supplies water via the Caledon-Bloemfontein pipeline to Bloemfontein, Botshabelo, and other minor consumers.

As mentioned above, *Knellpoort off-channel storage dam* was constructed to mitigate the impact of the decreasing yield of the Welbedacht Dam as a result of siltation and the increasing demand on the Caledon-Bloemfontein Regional Water Supply Scheme. Knellpoort Dam is supplied with water from the Caledon River by the Tienfontein Pump station. Water diverted from the Caledon River into Knellpoort Dam is then released back into the Caledon River to allow abstraction at Welbedacht Dam by Bloem Water all year round.

Since 1973, when Welbedacht Dam was completed, the dam has lost more than 90% of its storage capacity due to the high siltation rates. Since there is minimal storage capacity in Welbedacht Dam, the Tienfontein pumps must operate at a high reliability on a run-of-river basis to supply Knellpoort Dam. The current pumps have a total discharge of approximately 2.5 m^3/s (design 3 m^3/s) and have experienced high maintenance costs as a result of fine debris and sediment which reach the pumps.

Tienfontein Pump Station is seen as the most critical component of the water supply infrastructure supplying Bloem Water with raw water, as Bloem Water receives approximately 70% of its water supply from Welbedacht Dam (via Tienfontein Pump station and Knellpoort Dam).

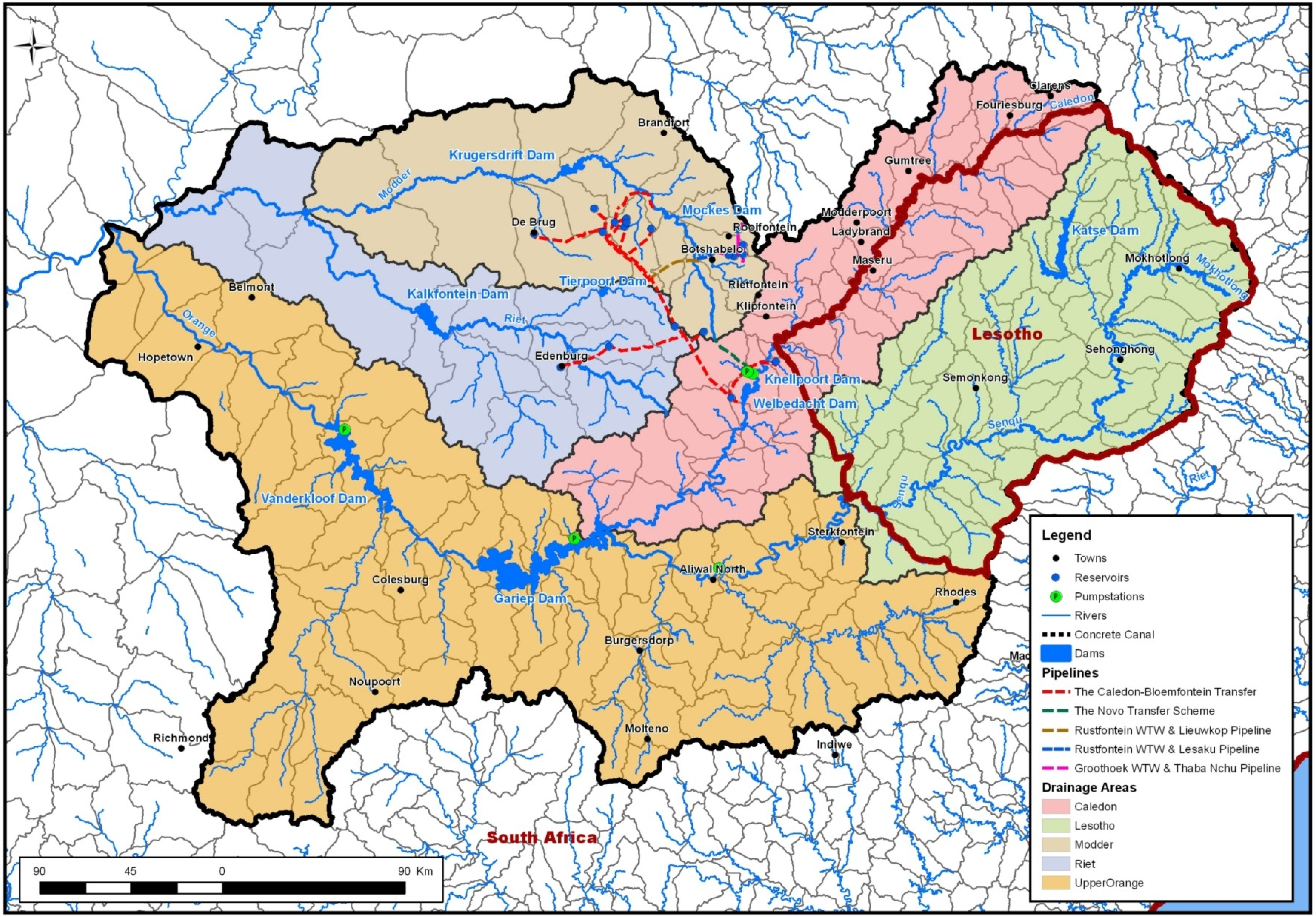

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Figure 3.1: Major Dams per Sub-Catchment

3.1.2 Modder River Sub-catchment

Krugersdrift Dam is located on the Modder River and supplies water for irrigation purposes to the Modder River Government Water Scheme. More than 50 weirs are constructed in the Modder River between the dam wall and the confluence with the Riet River.

Mockes Dam on the Modder River supplies water to Bloemfontein via the Maselspoort WTW. *Groothoek Dam* is located on the Kgabanyane River, a tributary of the Modder River, and supplies water to Thaba Nchu.

Rustfontein Dam is located on the Modder River and forms the major storage reservoir in the Modder River. Water is released from Rustfontein Dam to supplement the abstraction from Mockes Dam and currently provides the major portion of water supplied to Bloemfontein at Maselspoort.

3.1.3 Riet River Sub-catchment

Tierpoort Dam is situated on a tributary of the Riet River upstream of Kalkfontein Dam and supplies water to the Tierpoort Irrigation Board through a network of unlined canals.

Kalkfontein Dam is on the Riet River and supplies water for irrigation through a network of canals and syphons to the Riet River Government Water Scheme. Urban water is also supplied to the towns Koffiefontein and Jacobsdal through the aforementioned canal system.

3.1.4 Upper Orange River

The *Gariep Dam* and the *Vanderkloof Dam* are the two largest reservoirs in South Africa and are both situated in the Upper Orange River. These two reservoirs form the main component of the Orange River Project and are utilised to supply water to urban and irrigation users. They are also used for hydro power generation and flood control.

3.1.5 Lesotho

The *Katse Dam* in the Senqu sub-area is used for transfer of water to the Upper Vaal WMA. *Mohale Dam*, in the same sub-area, is also used to transfer water to the Upper Vaal WMA.

3.2 SUMMARY OF WATER RESOURCES SERVING THE GREATER BLOEMFONTEIN AREA

The Greater Bloemfontein area currently utilises surface water from three primary sources. The “yield” of these water resources (excluding river losses) and registered water use is given in the **Table 3.1.**

Table 3.1: Summary of Primary Surface Water Resources

<table>
<tr><th>Source</th><th>Registered Water Use (million m^3)</th><th>Historical Firm Yield (million m^3)</th></tr>
<tr><td>Rustfontein Dam</td><td>9.74</td><td rowspan="3">8</td></tr>
<tr><td>Mockes Dam</td><td>14.8</td></tr>
<tr><td>Groothoek Dam</td><td>0.74</td></tr>
<tr><td>Welbedacht and Knellpoort Dams</td><td>37</td><td>85</td></tr>
<tr><td>Total of individual yield (excluding losses)</td><td>62.28</td><td>93</td></tr>
</table>

The historical firm yield calculated for Welbedacht and Knellpoort Dams takes into account the estimated environmental water requirements downstream of Welbedacht Dam and existing and proposed agricultural water requirements, which includes the water requirements for resource poor farmers.

When all the resources supplying the Greater Bloemfontein Area are operated as a system, the yield of the system is greater than the sum of the yields of the individual resources. The river losses between the Welbedacht and Knellpoort Dams and Mockes Dam is, however, estimated to be in the order of 11 million m^3/a. The yields presented in **Table 3.2** represent the net system yields.

Table 3.2: Net System Yields

Source	Yield (million m^3/a)
Total individual yields	**93**
Estimate of Losses (evaporation, river losses)	**10.2**
Net System Yield (including losses, demand pattern)	**93.4**

For planning purposes the historical yield of the historical firm yield of the system was assumed to be 93.4 million m^3/a.

3.3 GROUNDWATER

Groundwater is currently not utilised as a water resource for the supply of potable water to Bloemfontein. However, groundwater is used by individuals for irrigation of gardens in residential areas. Groundwater is used extensive for agricultural purposes in the Bainsvlei / Kalkveld area and the area to the south-west of Bloemfontein. Groundwater is also utilised by small industry for bottling of water as well as micro irrigation of vegetables and nurseries (garden centres), which are in close proximity to the city limits.

Small towns and communities in the vicinity of Bloemfontein, such as Dewetsdorp, Reddersburg, and Edenburg, are solely or partially depended on groundwater for drinking and domestic purposes. Groundwater is therefore considered as an essential resource, specifically for the smaller towns. An estimate of the groundwater yields for the small towns in the vicinity of Bloemfontein is provided in **Table 3.3**.

Table 3.3: Estimated Groundwater Yields for Small Towns

Town	Estimated Average Yield of Existing Boreholes (million m^3/a)	Number of Boreholes
Wepener	0.071	4
Dewetsdorp	0.080	4
Reddersburg	0.160	9
Edenburg	0.213	12

4. SMALL TOWNS

4.1 WEPENER

Wepener is located in the south-eastern part of the Free State, close to the border with Lesotho, next to the Caledon River. Wepener has no large commercial or industrial sector and water users consist mainly of domestic type users.

Wepener receives water via a pipeline from Bloem Water's Welbedacht WTW, and from boreholes. However, the usage of boreholes has diminished over the years and the town is increasingly reliant on the Bloem Water supply.

The estimated population of Wepener (2009) is 10 946 inhabitants (All Towns Study data). Total water sold to the town by Bloem Water for the period July 2008-June 2009 amounted to 0.824 million m^3 (including internal losses). This implies an average per capita consumption of 206 l/c/d.

The theoretical water demand for Wepener, based on the assumed average per capita requirements from the "All Towns Study" (see **Table 4.1**), amounts to 0.506 million m^3/a. If an allowance of 20% internal losses is assumed, the theoretical water requirement which could be provided to Wepener would amount to about 0.607 million m^3/a. Thus, it appears that a water saving of some 0.2165 million m^3/a could possibly be achieved (about 26% of current bulk water sales to the town). However, it can be seen in the water requirement calculations done for Edenburg and Reddersburg, that the assumptions made for the water requirements for Wepener might be too low and not in line with typical planning requirements. The water saving potential for Wepener is estimated as being low.

Table 4.1: Updated Water Use Categories and Per Capita Use (All Towns Study, Oct 2009)

Category	Dwelling Type		Average Water Consumption (l/capita/day)
1	Flats		226
2	Clusters		255
3	Single residential	Low income	101
4		Medium income	189
5		High income	304
6		Very high income	442
7	Informal	RDP level	40
8		No services	12

4.2 DEWETSDORP

Dewetsdorp is located in the south eastern part of the Free State, between Bloemfontein and Wepener. The outfall of the Novo Transfer Scheme into the upper reaches of the Modder River is approximately 7 km to the east of to the town. Dewetsdorp has no large commercial or industrial sector and water users consist mainly of domestic type users.

Dewetsdorp receives water via a pipeline from Bloem Water's Welbedacht – Bloemfontein Pipeline and from local boreholes. However, it appears that the usage of boreholes has diminished over the years and the town is increasingly reliant on the Bloem Water supply.

The estimated population of Dewetsdorp (2009) is 9 857 inhabitants (All Towns Study data). Total water sold to the town by Bloem Water for the period July 2008-June 2009 amounted to 0.919 million m^3 (including internal losses). This implies an average per capita consumption of 255.6 l/c/d.

The theoretical water demand for Dewetsdorp, based on the assumed average per capita requirements from the "All Towns Study" (see **Table 4.1**), amounts to 0.4725 million m^3/a. If an allowance of 20% internal losses is assumed, the theoretical water requirement which could be provided to Dewetsdorp would amount to about 0.566.9 million m^3/a. Thus, it appears that a water saving of some 352.6 million m^3/a could possibly be achieved (about 38% of current bulk water sales to the town). However, it can be seen in the water requirement calculations done for Edenburg and Reddersburg, that the assumptions made for the water requirements for Wepener might be too low and not in line with typical planning requirements. The water saving potential for Dewetsdorp is estimated as being high.

4.3 EDENBURG

Edenburg is located in the southern part of the Free State, approximately 75 km south-west of Bloemfontein. Edenburg has no large commercial or industrial sector and water users consist mainly of domestic type users. Edenburg receives water via a pipeline from Bloem Water's Welbedacht – Bloemfontein Pipeline, and from local boreholes.

Bloem Water has investigated the water consumption of Edenburg and Reddersburg (they are supplied on a common main) due to the possible requirement to expand the water supply infrastructure. It was found that the local resources in combination with the existing pipeline should be sufficient for a number of years into the future. However, the existing levels of consumption were high and urgent WC/WDM was recommended to bring the water losses under control.

The estimated population of Edenburg (2009) is 8 006 inhabitants (All Towns Study data). Total water sold to the town by Bloem Water for the period July 2008-June 2009 amounted to 0.725 million m^3/a (including internal losses). This implies an average per capita consumption of 248.2 l/c/d.

The two different methods for calculating the theoretical water demand for Edenburg were used.

The first method is based on the assumed average per capita requirements from the "All Towns Study" (see **Table 4.1**), and amounts to 0.367 million m^3/a. If an allowance of 20% internal losses is assumed, the theoretical water requirement which could be provided to Edenburg would amount to about 0.441 million m^3/a. Thus, it appears that a water saving of some 0.283 million m^3/a could possibly be achieved (about 39% of current bulk water sales to the town).

The second method (used in Bloem Water's study) was based on analysing the theoretical demands based on the planning requirements for the town, i.e. based on the erf type and using the Engineering Guidelines for Urban Development (the so-called "Red Book"). This derived an estimated water requirement of 0.5182 million m^3/a (excluding internal losses). If an allowance of 20% internal losses is assumed, the theoretical water requirement which could be provided would amount to an estimated 0.621 million m^3/a. Thus, it appears that a water saving of some 0.1036 million m^3/a could possibly be achieved (about 14% of current bulk water sales to the town). Based on the above, the water saving potential for this town is estimated as being low.

4.4 REDDERSBURG

Reddersburg is located in the southern part of the Free State, approximately 60km south of Bloemfontein. Reddersburg has no large commercial or industrial sector and water users consist mainly of domestic type users. The town receives water via a pipeline from Bloem Water's Welbedacht – Bloemfontein Pipeline, and from local boreholes.

As mentioned above, Bloem Water has investigated the water consumption of Edenburg and Reddersburg and it was found that the local resources in combination with the existing pipeline should be sufficient for a number of years into the future. However, the existing levels of consumption were high and urgent WC/WDM was recommended to bring the water losses under control.

The estimated population of Reddersburg (2009) is 4 621 inhabitants (All Towns Study data). Total water sold to the town by Bloem Water for the period July 2008-June 2009 amounted to 0.901 million m^3/a (including internal losses). This implies an average per capita consumption of 527.1 l/c/d.

The two different methods for calculating the theoretical water demand for Reddersburg were used.

The first method is based on the assumed average per capita requirements from the “All Towns Study” (see **Table** 4.1), and amounts to 0.280 million m^3/a. If an allowance of 20% internal losses is assumed, the theoretical water requirement which could be provided to Reddersburg would amount to about 0.336 million m^3/a. Thus, it appears that a water saving of some 0.5648 million m^3/a could possibly be achieved (about 63% of current bulk water sales to the town).

The second method (used in Bloem Water’s study) was based on analysing the theoretical demands based on the planning requirements for the town, i.e. based on the erf type and using the Engineering Guidelines for Urban Development (the so-called “Red Book”). This derived an estimated water requirement of 0.523 million m^3/a (excluding internal losses). If an allowance of 20% internal losses is assumed, the theoretical water requirement which could be provided would amount to an estimated 0.628 million m^3/a. Thus, it appears that a water saving of some 0.2727 million m^3/a could possibly be achieved (about 30% of current bulk water sales to the town). Based on the above, the water saving potential for this town is estimated as being high.

A summary table of the water requirements and population data for all the small towns is provided in **Table 4.2.**

Table 4.2: Summary of Water Requirements and Population Data for Small Towns (08/09 FY)

Town	Population	Actual Water Sale (million m^3/a)	Per Capita Consumption based on Actual Sale (l/c/d)	“All Towns” Theoretical Water Consumption[1] (million m^3/a)	Water Saving (million m^3/a) (% UAW)	Red Book Water Saving (million m^3/a) (% UAW)
Wepener	10 946	0.506	206	0.607	0.216 (26%)	
Dewetsdorp	9 857	0.472	255.61	0.567	0.352 (38%)	
Edenburg	8 006	0.725	248.2	0.441	0.283 (39%)	0.103 (14%)
Reddersburg	4 621	0.901	527	0.336	0.564 (63%)	0.272 (30%)

[1] Includes allowance for 20% water losses.

5. EXISTING REQUIREMENTS

5.1 URBAN WATER REQUIREMENTS OF THE GREATER BLOEMFONTEIN AREA

Towns within the MLM receive the majority of their bulk water supply from Bloem Water. Smaller towns, by Contractual Agreement, receive between 70 and 80% of their total annual consumption from Bloem Water, with local groundwater supply making up the balance. Water provided by Bloem Water is abstracted from the water resource supply schemes in the Caledon and Modder River systems, as discussed in **Section 2**.

A summary of the total bulk water consumption for small towns (including groundwater) located within the Primary Study Area is provided in **Table 5.1.**

Table 5.1: Summary of Bulk Water Supplied to Smaller Towns (year 2008)

Town	Supply from BW (a)	Estimated Groundwater Supply (million m^3/a) (b)	Estimated Average Yield of Existing Boreholes (million m^3/a) [2]	Number of Boreholes	Estimated Total Annual Consumption (a + b)
Excelsior	0.169				0.117
Wepener	0.804		0.071	4	0.804
Dewetsdorp	0.844		0.080	4	0.844
Reddersburg	0.847	0.166	0.160	9	1.013
Edenburg	0.534	0.172	0.213	12	0.706

Bulk water consumption data (2007 to 2009) provided by Bloem Water (BW) and MLM is summarised in **Table 5.2**.

Table 5.2: Metered Bulk Water Consumption for Towns Supplied with Water from the Greater Bloemfontein System (excluding groundwater)

Year / Supplier	2007			2008			2009		
	BW	MLM	Total	BW	MLM	Total	BW	MLM	Total
Town	million m^3/a			million m^3/a			million m^3/a		
Bloemfontein/Mangaung	39.654	19.876	59.530	40.664	20.307	60.972	35.833	30.132	65.965
Botshabelo	8.491		8.491	8.181		8.181	9.209		9.209
Thaba Nchu	3.906		3.906	5.142		5.142	4.637		4.637
Excelsior	0.117		0.117	0.169		0.169	0.164		0.164
Wepener	0.697		0.697	0.804		0.804	0.824		0.824
Dewetsdorp	0.817		0.817	0.844		0.844	0.920		0.920
Reddersburg	0.847		0.847	0.847		0.847	0.858		0.858
Edenburg	0.533		0.533	0.534		0.760	0.528		0.528
Total	55.062	19.876	74.938	57.185	20.307	77.719	52.973	30.132	83.105

From the above tables, it is evident that water supplied to smaller towns accounts for only 4% of the total bulk water consumption. Indicating that water requirements from the smaller towns does not significantly influence the overall water requirements for the Greater Bloemfontein Supply System.

[2] *It should be noted that the estimated scheme yields were calculated by using the average sustainable yields of the Karoo geology well fields of Petrusburg / Bolokanang, Edenville / Ngwathe, and Ikgomotseng for all the groundwater interventions.*

The "Historical consumption with no losses" curve, represents the water requirements metered at the start of MLM's internal bulk reticulation system (**Figure 5.1)**. Based on information obtained from Bloem Water, bulk water transmission losses are estimated to be in the region of 12%.

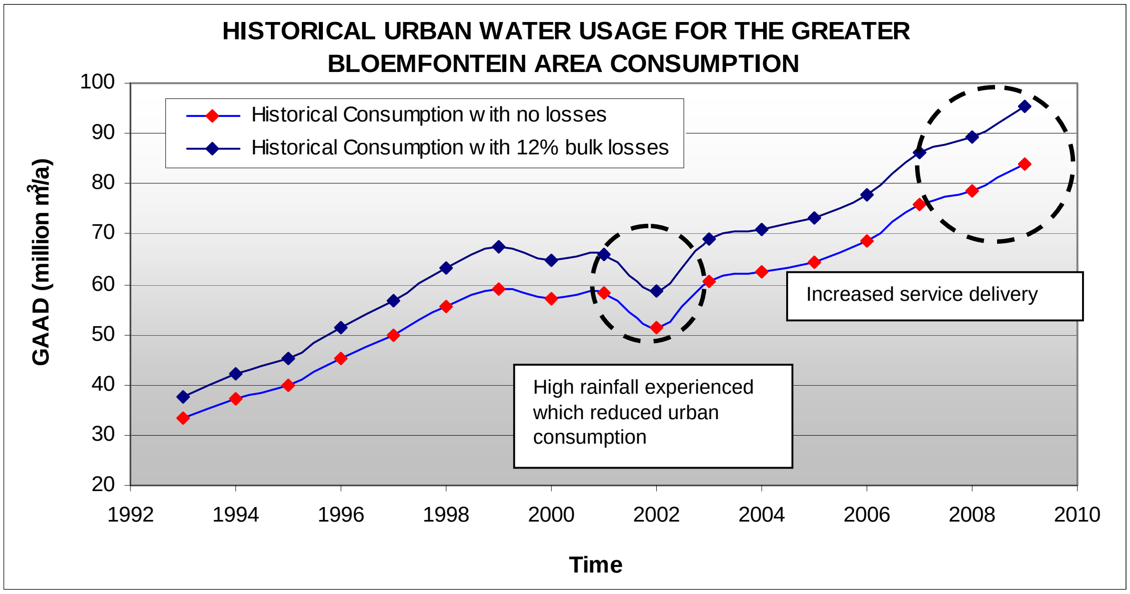

Figure 5.1: Historical Urban Water Usage for the Greater Bloemfontein Area

The following is noted with regards to the historical water consumption for Bloemfontein and surrounds since 1993:

- *Period of 1993 to 1999*: An average annual increase in water consumption of 8.6% per annum, triggered by an improvement in levels of service and delivery of basic services through the Government's various infrastructure programs. In addition, a significant number of people from surrounding areas (urban and rural centres) relocated to Bloemfontein for employment and other economic opportunities.
- *Period of 2000 to 2002*: There is a slight decline in water consumption resulting in an average annual decrease in water consumption of -3.4% per annum.
- *Period of 2003 to 2009*: An average annual increase in water consumption of 4.7% per annum. This can be attributed to a growth in local economy, supported by an improvement in levels of services in the poorer communities through various government projects like the eradication of the bucket system, provision of on-site water projects, and numerous low income housing projects.

5.1.1 Breakdown of Urban Consumption

Figures 5.2, **5.3**, and **5.4** provide a breakdown of potable water use as derived from the 2006/07 Water Service Development Plan for Bloemfontein, Botshabelo, and Thaba Nchu.

In the Bloemfontein area, "unaccounted for water" constitutes 39% of the total annual consumption. The second largest water consumption, accounting for 37% of the total annual consumption, is "residential use". Thirteen percent of the water is used for commercial purposes, 8.5% is classified as other, and 2% for industrial water.

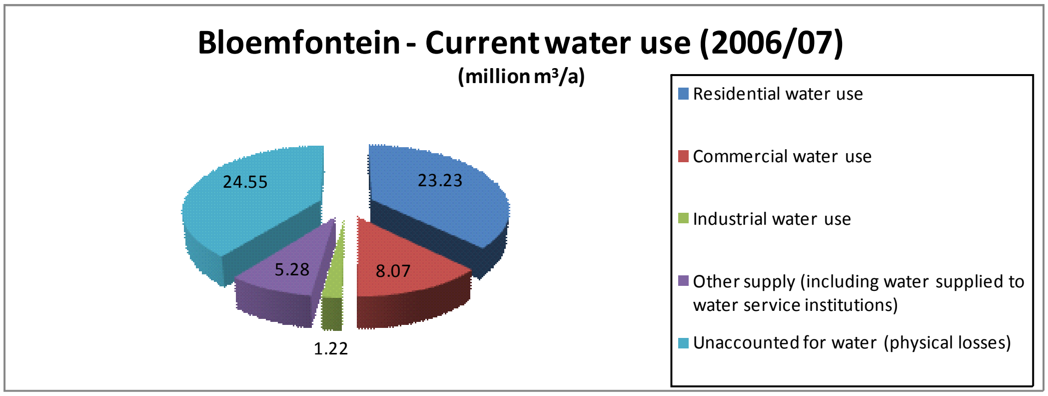

Figure 5.2: Current Water Use for Bloemfontein

In Botshabelo, the largest proportion of the current water use is residential use, representing 40.5% of the total use. "Unaccounted for water" comprises 31% of the total metered bulk water supplied. Commercial use accounts for 20% and other supply accounts for 8%.

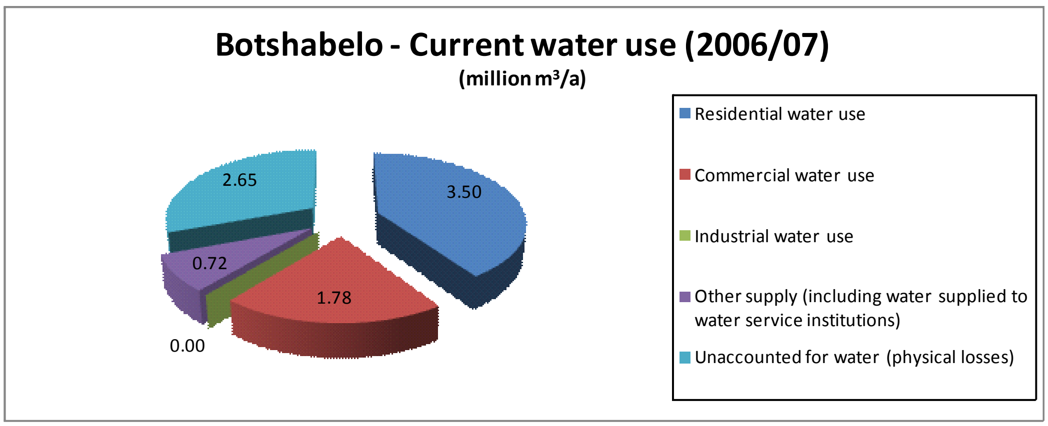

Figure 5.3: Current Water Use for Botshabelo

In Thaba Nchu, physical losses (unaccounted for water) accounts for 94% of the total water use, while residential and commercial use accounts for 3.5% respectively.

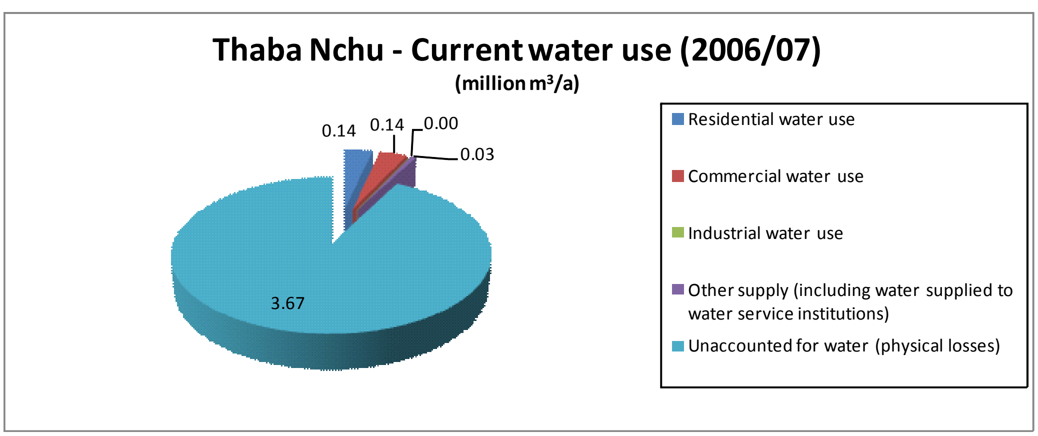

Figure 5.4: Current Water Use for Thaba Nchu

5.1.2 Agricultural Water Requirements

For the purposes of this study, agricultural water requirements were considered in two catchments, namely in the Modder-Riet Catchment upstream of Krugersdrift Dam and along the Caledon River. These catchments were selected as they overlap with the catchments from which Bloem Water and MLM abstract water for potable use.

Figure 5.5 shows the registered water use and resource allocation in the quaternary catchments surrounding the Greater Bloemfontein Area. Based on the allocations to the different water sectors (agriculture and urban) from the different sources of water (surface, groundwater, and scheme) it is evident that the two sectors do not share any allocation from dams situated within the Modder-Riet Catchment upstream of Krugersdrift Dam. For example, in quaternary catchment C52J, the register agricultural use is 49 million m^3/a and urban use is 1.3 million m^3/a. 46.1 million m^3/a is abstracted from boreholes, 1.89 million m^3/a is abstracted from schemes, and 0.1 Million m3/a is abstracted from rivers (run-of-river). As there are no towns within this catchment, one can assume that most of the groundwater, water provided by schemes, and run-of-river abstraction is used for agricultural purposes.

In terms of the yield modelling of the Welbedacht/Knellpoort System, the existing agricultural water requirements along the Caledon River, both upstream and downstream of Welbedacht Dam, and the proposed water requirements of the resource poor farmers, were taken into account.

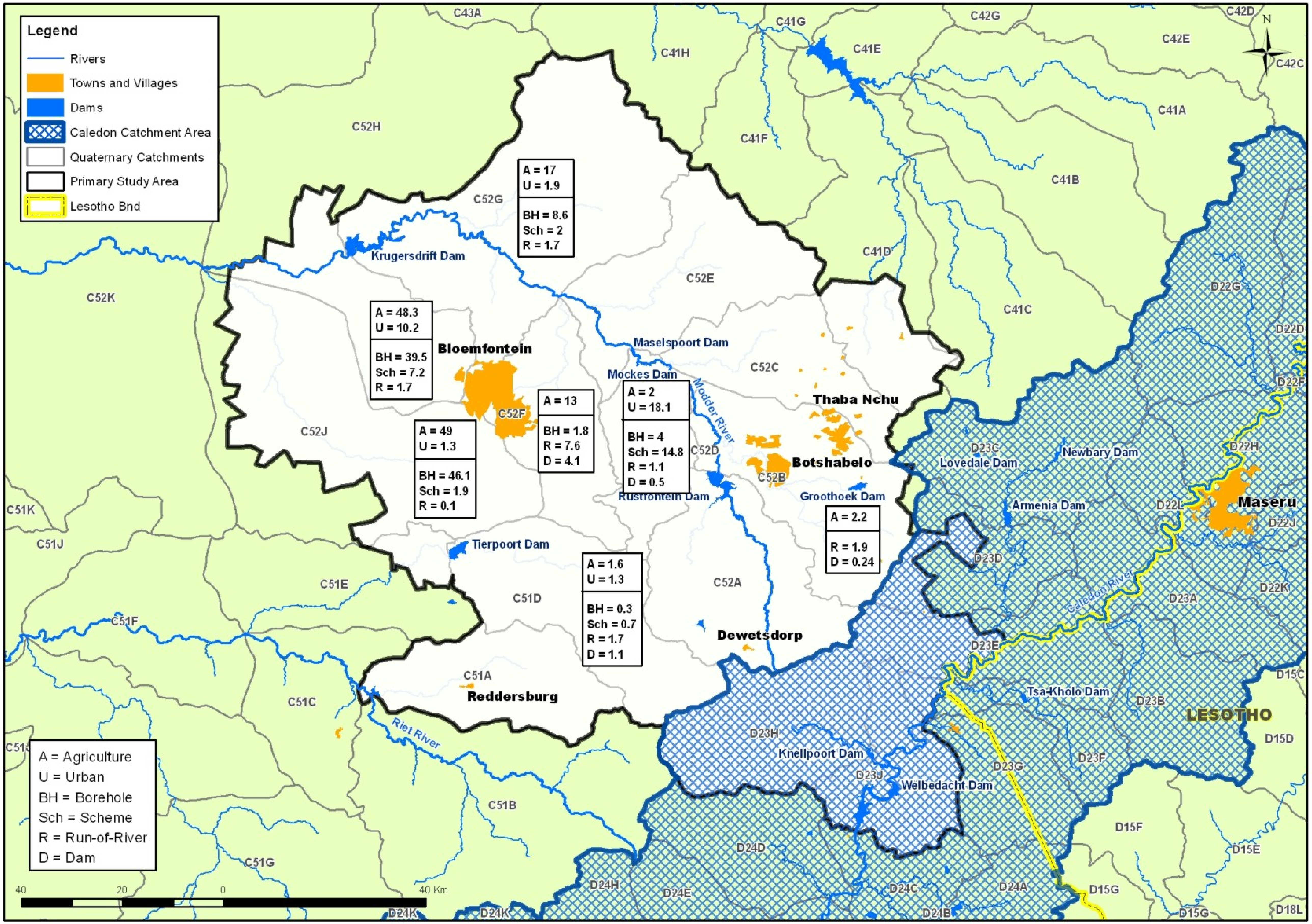

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Figure 5.5: Registered Water Use and Resource Allocation in the Quaternary Catchments Surrounding the Greater Bloemfontein Area

5.2 FUTURE WATER REQUIREMENTS

5.2.1 Future Urban Water Requirements of the Greater Bloemfontein Area

The prediction of water requirements for master planning purposes, or for a study of this nature, is usually based on two primary factors, namely population growth and local economic growth. These two factors are interlinked, as economic growth may stimulate population growth as a result of migration from the rural areas or other urban area with a poor economy. There are also numerous other factors that can impact future water requirements, and specifically for the Greater Bloemfontein area, these may include:

- Change in the level of service, as improvements in the water services, sanitation, and health awareness will most likely impact on future requirement scenarios. Typical initiatives in the study area include the eradication of water and sanitation backlogs linked to the UN Millennium Goals, as well as the delivery of houses to the poor to meet SA National target with regards to housing.
- The impact of HIV/AIDS is a significant factor, with the highest occurrence in the rural areas of South Africa.

Population Growth Scenarios:
Population growth rates are based on the birth rate, mortality rate, and migration. For purposes of this study, the following factors and assumptions were considered for the Population Growth Scenarios estimated for a 25 year horizon (Low, medium and high growth scenarios) for the various towns:

- Annual growth rate of existing population based on historic growth rates, which is higher for Bloemfontein than the more rural areas where economic opportunities are limited.
- Migration is proportional to economic growth rate, implying a strong economic growth with result in "immigration" whereas a decline in economic growth will result in "emigration". Migration adopted for this study is based on Provincial trends as abstracted from the "2009 StatsSA Mid Year Projections for the Orange Free State Province (2006 to 2011 Projection)". Migration affects the rural and smaller towns more significantly, as a result of people seeking economic and employment opportunities in the larger urban centres. Migration is assumed to vary between 0.00% and 0.25% for Bloemfontein and Botshabelo, assuming more people migrating to, and residing in these towns. For the smaller towns with less economic opportunity, the migration rates are assumed to vary between -0.4% and 0.0% assuming that current residents are leaving these towns to reside and seek opportunities in the larger centres.
- The impact of HIV/AIDS is a significant factor when estimating population projections, and more specifically, its influence on the mortality rate. The impact of HIV/Aids adopted for this study has been based on National statistics, where the highest occurrence is in the rural areas of South Africa. The mortality rates as a result of HIV/Aids has been assumed to vary as high as 0.4% for the urban towns, and as high as 0.75% for the rural towns and villages.

A summary of the approach to develop the "low" and "high" population growth scenarios is summarised below:

- ***Low-growth scenario***:
  - Low anticipated growth in existing population mainly attributed to a higher mortality rates as a result of HIV/Aids.
  - A lack of urbanisation in the smaller towns, and decline of development within Bloemfontein.
  - Higher emigration rates from the rural areas due to a stagnant and declining local economy, and a low immigration rate for Bloemfontein.

- ***Medium-growth scenario***:
  - Medium anticipated growth in existing population, more or less in line with the average between the low and high growth scenarios.
  - A lack of urbanisation in the smaller towns, but a more positive growth for development within Bloemfontein.
  - Higher emigration rates from the rural areas due to a declining local economy, and assuming these residents will immigrate to Bloemfontein and Botshabelo in seek of employment opportunities.

- ***High-growth scenario***:
  - High anticipated growth in existing population attributed to a lower mortality rate and a longer life expectancy as a result of HIV/Aids (supported by improved health services).
  - An increase in urbanisation in the smaller towns, and further development within Bloemfontein.
  - Emigration rates from the rural areas will decline, specifically to other provinces like Gauteng. A more positive immigration rate to Bloemfontein, specifically from other provinces such as the Northern Cape and Kwazulu Natal.

Table 5.3 shows the annual proposed growth rates for each of the towns within the Greater Bloemfontein supply system, which consider the impacts of the abovementioned factors.

Table 5.3: Annual Growth Rates Proposed for the Three Population Growth Scenarios

Annual Population Growth Rates			
Town	**Low**	**Medium**	**High**
Bloemfontein	0.64%	1.87%	3.10%
Botshabelo	-1.85%	-0.94%	0.17%
Thaba Nchu	-0.60%	0.30%	1.20%
Reddersburg and Edenburg	-0.25%	0.45%	1.30%
Wepener and Dewetsdorp	-1.39%	-0.59%	0.36%
Rural Towns/Villages	-1.14%	-0.77%	0.26%

The following conclusion can be drawn from the above population growth scenarios:

- Bloemfontein contributes significantly to the economy of the Province, and presents the most economic opportunities. As a result, the population and water requirements for Bloemfontein can be expected to increase significantly within the proposed projection horizon.
- Thaba Nchu, Edenburg, Reddersburg, Wepener, and Dewetsdorp are small urban towns with a local economy that caters for its current residents and the surrounding farming communities. The economy of these towns is not expected to grow, and a more conservative approach is adopted for the growth in population and water requirements over the projection horizon.
- The rural towns and villages are impacted severely by migration and HIV/Aids, resulting in a decrease in population and water consumption within these towns.

The 2007 population figures presented in **Table 5.4** and **Figure 5.6** have been used as the base year for the population projections. The population projections have been based on the proposed growth rates presented in **Table 5.4.**

Table 5.4: Population for the Total Study Area based on the Individual Growth Scenarios

Population - Study Area Total			
Year	**Low**	**Medium**	**High**
2007	721 495	721 495	721 495
2010	718 996	741 888	766 356
2020	714 168	819 774	944 949
2030	714 401	915 052	1 179 674
2035	716 300	970 213	1 323 842

Figure 5.6 presents the proposed growth curves for the total study area, and also includes projection scenarios developed for the "All Towns study for Central Region", dated June 2009. These curves have been included to visually compare the growth curves developed for this study with those developed for the All Towns Study. The All Towns Study high growth curve corresponds favourably to the Medium Growth Scenario developed as part of the Greater Bloemfontein Reconciliation Study. The All Towns Low Growth curve compares favourably with the Low Growth Scenario. Given the above, the Medium Growth Scenario is proposed to be adopted as the most likely planning scenario.

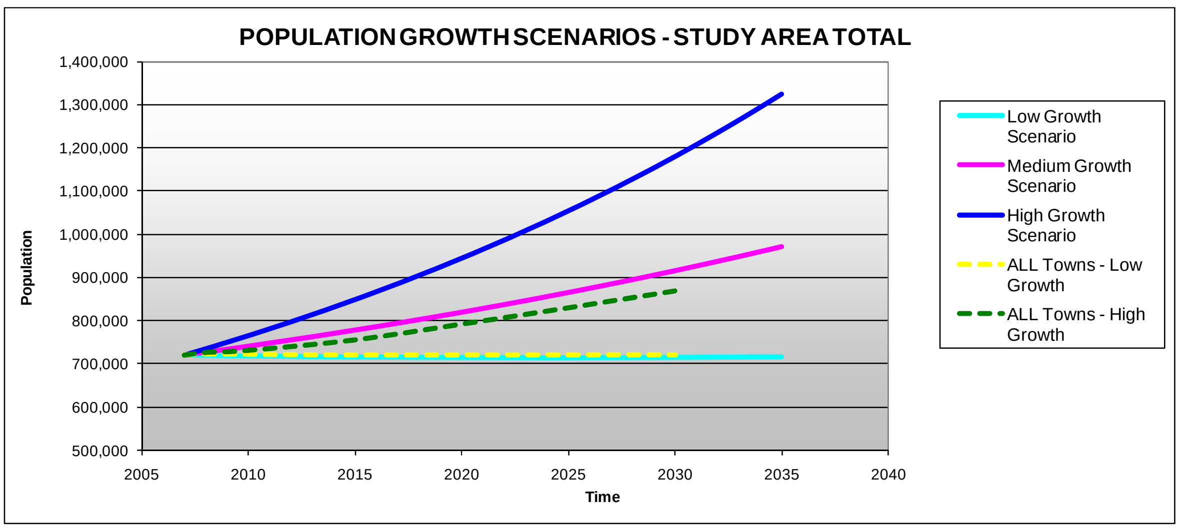

Figure 5.6: Population Growth Scenarios for the Study Area

Water Requirement Scenarios Projections

The water requirement scenarios presented in the **Table 5.5** are based on the product of the population growth scenarios proposed above and the historical (2009) water consumption unit demands. The water requirement projection scenarios up until 2035 are as follows:

Table 5.5: Water Requirement Growth Scenarios for the Study Area

Gross Annual Requirements - GAAD (million m^3/a)			
Year	**Low**	**Medium**	**High**
2007	93.711	93.711	93.711
2010	94.474	97.747	101.168
2020	97.381	113.024	131.325
2030	100.838	131.528	171.793
2035	102.767	142.184	196.983

Figure 5.7 presents the proposed water requirement curves for the total study area, and also includes the historical water consumption curve.

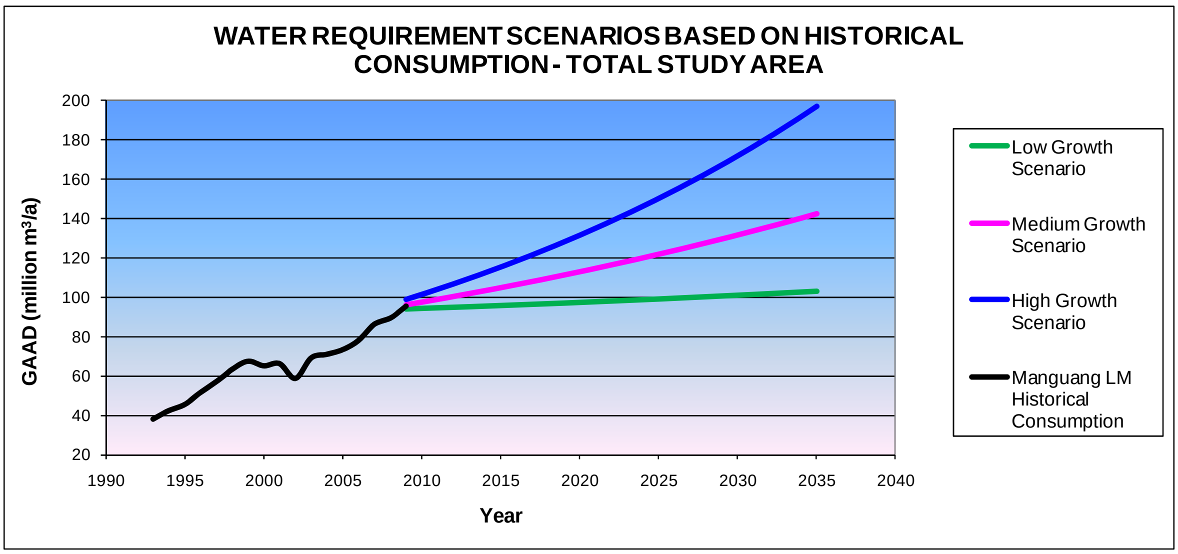

Figure 5.7: Water Requirement Scenarios for the Study Area

Note: The growth in the urban water requirements is mainly determined by the Bloem Water requirements (Bloemfontein, Botshabelo, Thaba 'Nchu) over the projection period.

5.2.2 Agricultural Water Requirements

The only expected growth in irrigation requirements is the allocation of 12 000 ha to resource poor farmers. The effect of the 12 000 ha (4 000 ha for the Upper Orange WMA, 4 000 ha for the Lower Orange WMA, and 4 000 ha for the Fish-Tsitsikamma WMA) is estimated to be in the region of 114 million m^3/a. The Implementation Strategy for the development of 3 000 ha irrigation in the Free State Province indicates that there is ± 200 ha available near Ficksburg (Caledon River) and ± 2 000 ha available next to the Orange-Riet Canal, which starts at the Vanderkloof Dam. The agricultural water requirement for the 200 ha near Ficksburg will be taken into account.

6. WATER BALANCE

6.1 THE ORANGE RIVER SYSTEM

The Upper Orange WMA is affected by the water requirements and developments in the Orange and Vaal River Systems. These systems have been the subject of various water balance and reconciliation studies. The latest water balance from the Orange River system indicated a surplus of 274 million m^3/a for the year 2008.

When the effect of the 12 000 ha earmarked for resource poor farmers is taken into account, the surplus of 274 million m^3/a will reduce further to only 130 million m^3/a. This net surplus is reserved for the growth in water requirements in the urban, industrial, and mining sectors in the Upper Orange WMA, the Lower Orange, and the Fish to Tsitsikamma WMAs. It was estimated that after the abovementioned water requirements are taken into consideration (estimated to be 90 million m^3/a), that there would be a net surplus in the Orange River system of 40 million m^3 in 2025.

The future Polihali Dam site is situated on the Senqu River approximately 1.5 km downstream of the confluence of the Senqu and Khubelu Rivers. Polihali Dam would increase the water delivered from Lesotho Highlands Water Project to the high value industries in the Vaal catchment, but would, in the long term, result in a reduction in the water available at downstream Gariep and Vanderkloof dams. It is envisaged that the Polihali Dam would reduce the yield of the Orange River downstream by approximately 283 million m^3/a. This is based on the assumption that overall yield of the system increases by 182 million m^3/a but an additional 465 million m^3/a might be transferred to Gauteng, causing a shortfall of 283 million m^3/a (465 – 182 = 283). The anticipated net deficit in 2037 (based on current water requirements and not the anticipated growth in water requirements) will be -243 million m^3/a. **Table 6.1** attempts to undertake a mass water balance of the Upper Orange WMA.

Based on the mass balance, the following conclusions can be drawn:

- There is currently surplus water available in the Orange River system (including the Caledon River) which can be allocated to the Greater Bloemfontein Area.
- It is most likely that the construction of Boskraai / Bosberg Dam, as well as other water resource development options on the Orange River will only become an option after the water requirements from the Vaal WMA have increased to such an extent that they reduce the availability of water in the Orange River, and a new supply intervention is implemented to augment the loss in yield.

Table 6.1: Orange River Water Balance (ISP, 2004)

Scenario Description	Surplus Yield (million m^3/a)
Year 2008 Surplus Yield*	274
Less allocation to resource poor farmers	-144
Net current yield available for growth in urban water requirements	**130**
Less growth in urban, industrial, and mining sectors in Orange and Eastern Cape	-90
Net yield available in 2025 **	**40**
Less transfer to Gauteng from Polihali Dam (estimated impact on the Orange) ***	-283
Anticipated net deficit in 2037 already (will be higher with additional growth in urban requirements	**-243**

Notes –
* Based on 2008 WRPM analysis 320 million m^3/a surplus at 1:150 minus 46 million m^3/a deficit mainly in Kraai as from ISP
** Net yield available at 2025 as if Polihali Dam is not in place

*** From comparative study results the total yield from Polihali will already be utilised in full by the Vaal WMA in 2037

The Orange River Balance described above is conceptual and has been included for illustrative purposes to demonstrate that there will ultimately be a deficit in the Orange River system and that future water resource developments will have to be put in place in the Orange River. Any future water resource development options along the Orange River could be used to augment the supply to the Greater Bloemfontein area.

The Upper Orange WMA has a large commitment to support the local water requirements and transfers to the Upper Vaal WMA, the Fish to Tsitsikamma WMA, as well as release obligations to the Lower Orange WMA. A number of augmentation interventions have been identified to provide additional yield to the Orange River System to make up the envisaged shortfall caused by transfers from Polihali Dam to the Gauteng area. Some of the interventions identified include: using the lower level storage in Vanderkloof Dam, the construction of Bosberg/Boskraai Dams, and the raising of Gariep Dam.

It is the intention of the DWA to initiate a separate reconciliation strategy study on the Orange River System, which will draw on the information from the Greater Bloemfontein Reconciliation Strategy Study.

6.2 THE GREATER BLOEMFONTEIN AREA

The anticipated surplus yield in the Orange River System (including the Caledon River) is approximately 44 Mm^3/a. According to the Internal Strategic Perspective for the Upper Orange River WMA, this surplus is reserved for the growth in demands in the urban, industrial, and mining sectors in the Upper Orange WMA, the Lower Orange, and the Fish to Tsitsikamma WMAs.

It is not anticipated that there will be any further growth in agricultural water requirements in the Greater Bloemfontein Area (with the exception of the allocation made to the resource poor farmers). As the agricultural sector and urban sector in the Greater Bloemfontein Area and surrounds do not share any yield from a common surface water resource, it is possible to undertake a reconciliation of supply and requirement based on the current urban water requirements and available yield of the surface water schemes serving the Greater Bloemfontein area and surrounds.

Figure 6.1 illustrates the comparison of available surface water supply and current water requirements for the Low, Medium, and High growth scenarios in the Greater Bloemfontein Area. The current water requirement is approximately 92 million m^3/a in comparison to the available supply of 93.4 million m^3/a (Historical Firm Yield).

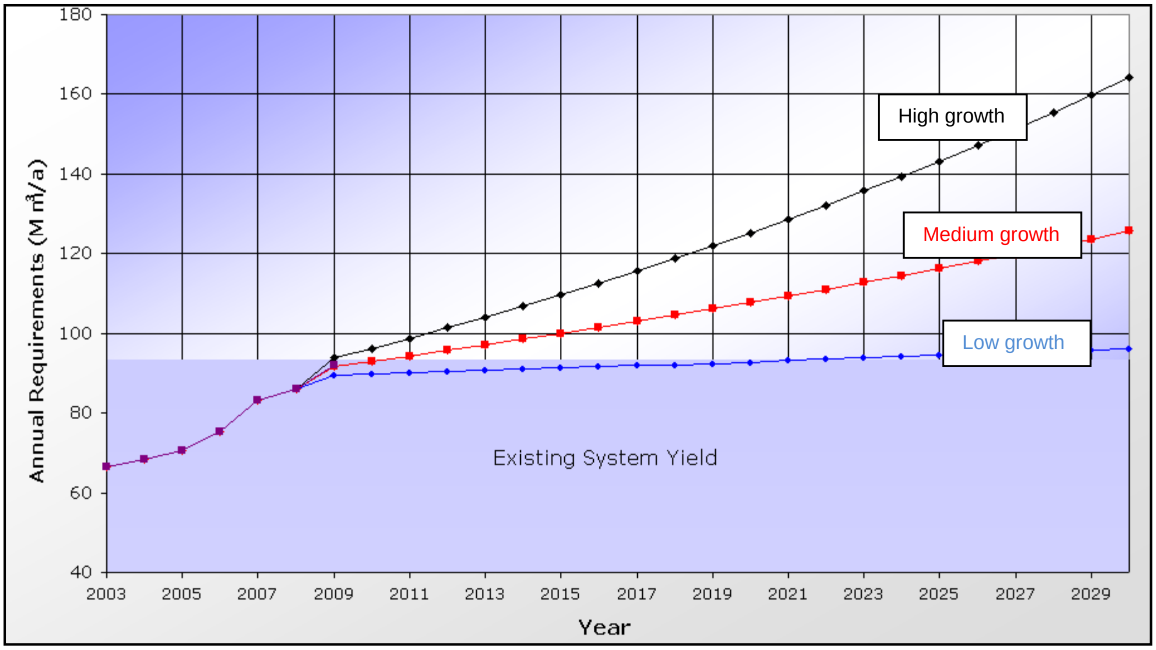

Figure 6.1: **Surface water balance for study area**

It appears that the present water requirement is currently in balance with available supply.

7. INTERVENTIONS AND SCENARIO PLANNING

7.1 INTERVENTION PLANNING PROCESS

This study will comprise of three phases, namely the Inception Phase, Development of the first draft Strategy, and Refinement of Strategy and Scenario Planning. The intervention planning process is illustrated in **Figure** 7.1. A brief overview of the activities that will be undertaken in each phase is provided below.

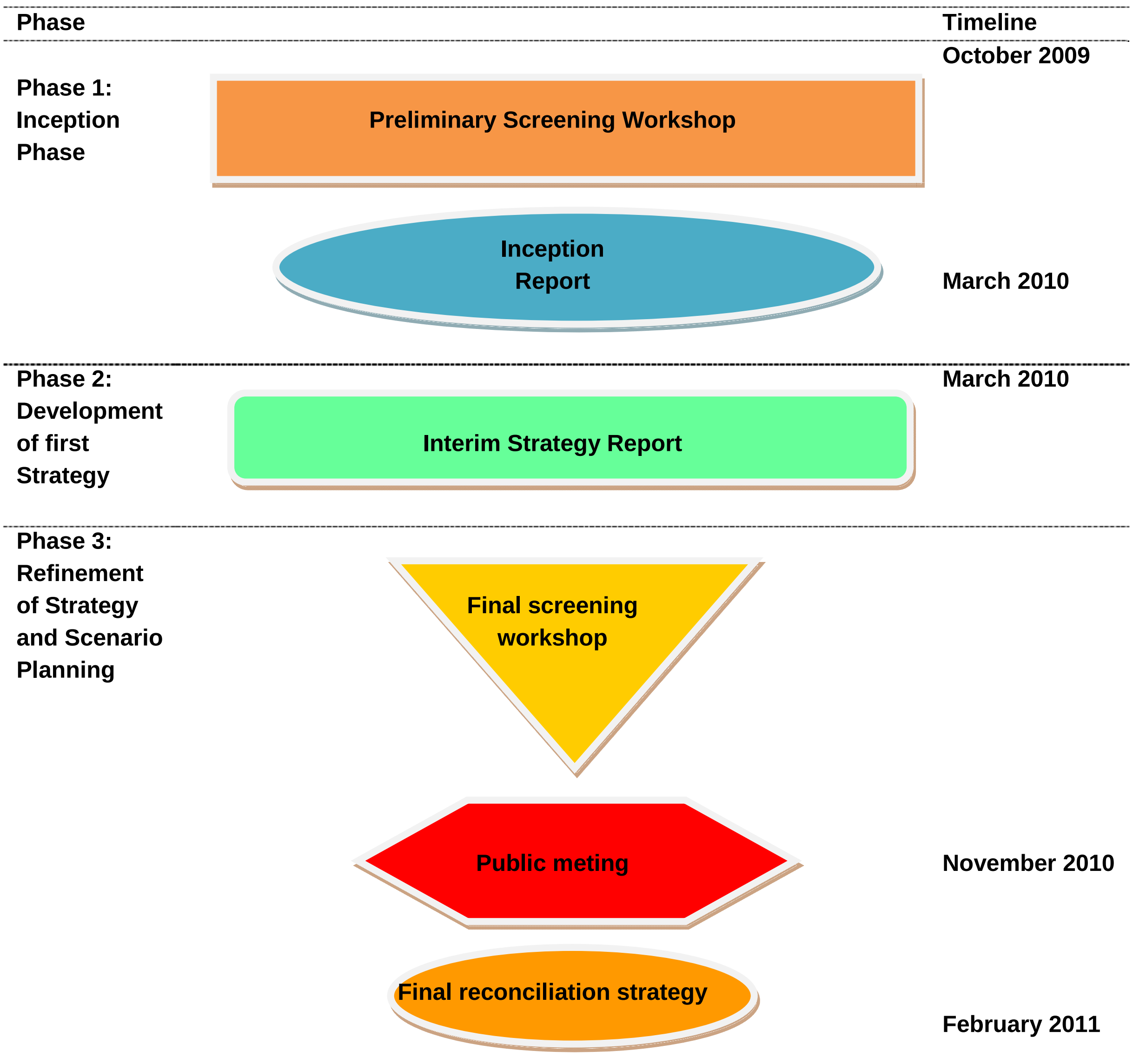

Figure 7.1: Intervention planning process

Phase 1: Inception Phase

- Assemble and assimilate relevant information; and
- Prepare Inception Report clarifying the details of how the project will be undertaken.

Phase 2: Development of first draft Strategy

- Assess the acceptability of the various interventions identified in previous studies in terms of technical, financial, environmental, and social criteria;
- Ascertain which intervention or combinations thereof would warrant further investigations at reconnaissance or pre-feasibility level, and what aspects should be investigated in this study;
- Determine the future water requirements based on population growth;
- Proposed water resource planning scenarios to meet future water requirements; and
- Document the first draft Strategy.

Phase 3: Refinement of Strategy and Scenario Planning

- Evaluate in more detail the interventions which are most likely to be implemented to address future water requirements;
- Refine the future water resource scenarios;
- Develop a sequence of interventions which need to be implemented to meet the future water resource scenarios;
- Document the reconciliation process; and
- Report on the final Reconciliation Strategy.

The First Reconciliation Strategy Report (this report) is the deliverable for Phase 2 and will inform and guide Phase 3 of the Reconciliation Strategy Study.

7.2 IDENTIFICATION OF INTERVENTIONS

A number of potential interventions which could contribute to meeting the future water requirements of the Greater Bloemfontein area were identified from previous and ongoing studies, as well as from expert knowledge through the Preliminary Screening Workshop. The following categories of interventions were identified:

- Urban and agricultural Water Conservation and Water Demand Management (WC/WDM);
- Surface water interventions;
- Re-use of treated effluent;
- Groundwater interventions;
- Trading of water use authorisations; and
- Other options, such as re-use of mine water and alternate storage in the Caledon River.

7.3 SELECTION OF INTERVENTIONS

A Preliminary Screening Workshop was held in Bloemfontein on 29 October 2009. The workshop was attended by key stakeholders, including DWA officials from the Regional and Head Office, Bloem Water, representatives from MLM, Motheo District Municipality, Eskom, Department of Agriculture, Forestry and Fishery, and representatives from the Water User Associations. The objectives of the Preliminary Screening Workshop were as follows:

- Assess the acceptability of the various interventions identified in previous studies in terms of technical, financial, environmental, and socio-economic criteria;
- Ascertain which intervention or combinations thereof would warrant further investigations at reconnaissance or pre-feasibility level, and what aspects should be investigated in this study;

- Augment the existing information with specialist inputs from the DWA and other key stakeholders; and
- Identify risks and any other issues/concerns of stakeholders which could impact on the reconciliation of supply and requirement.

Each of the interventions was considered in isolation during the workshop, however it was stressed that other issues, such as those listed below would ultimately also be important in formulating the best scenario for reconciling supply and requirement:

- The importance of improving the assurance of supply;
- The cost and timing of implementing a large intervention *versus* a number of smaller interventions;
- The need for diversification of sources allowing some redundancy in the resource system;
- The need to lower the risks associated with system failure;
- Health risks; and
- The ability to incrementally implement interventions.

This screening of interventions was based on a number of criteria, namely:

- Potential scheme yields, inclusive of the impact of the ecological Reserve;
- Updated financial cost estimates and unit reference values (URVs);
- Socio-economic implications; and
- Ecological impact. It must be emphasised that before being implemented, supply-side interventions will still have to go through the EIA process. During this process, the socio-economic implications and ecological impacts will be investigated and evaluated in greater detail.

Table 7.1 lists the interventions that were discussed and screened out at the Preliminary Screening Workshop. Overall, 34 interventions were discussed and five interventions were screened out.

Table 7.1: Interventions Considered for the Interim Strategy

Ref	Intervention	Description of Intervention	URVs (R/m^3)	Selected for Further Investigation	
				Yes	No
A1 & 2	Urban WC/WDM – Efficient use of water and loss management	The objective of WC/WDM is to ensure the optimal use of water and to minimise wastage. MLM has developed various water demand management strategies to achieve efficient WC/WDM, these include: • Network Losses Strategy • System Losses Strategy • Behind-Water meter Losses Strategy • Willingness to Pay Strategy		Yes. There will be no further augmentation of bulk water resources without WC/WDM being addressed first	
B1	Agricultural WC/WDM	A number of WC/WDM options for improving agricultural water use efficiency have been proposed, including: • River release management • Improved irrigation practices • Reduce irrigation canal losses and utilise flow meters to monitor and manage flow in the canals • Selection of crop type suitable for a particular area • Crop deficit irrigation			No
C1	Utilising surplus capacity in the Orange River by pumping to Knellpoort Dam from Gariep Dam	Surplus volume in the Gariep Dam can be accessed via one of the following interventions: • Utilising dead storage by altering the operating rules; or • Raising Gariep Dam by 5 or 10 meters.	5.3 (7)	Yes	
C2	Utilising surplus capacity in the Orange River by pumping to Knellpoort Dam from Vanderkloof Dam	Surplus volume in the Vanderkloof Dam can be accessed by utilising the dead storage by altering the operating rules to allow the water below the existing canal (bottom) inlets to be released to downstream users with no additional infrastructure being required.	6.7 (8.4)	Yes	
C3	Utilising surplus capacity in the Orange River by pumping to Knellpoort Dam from Bosberg / Boskraai Dam	Construction of the proposed Bosberg / Boskraai Dam on the Orange River downstream of the confluence with the Kraai River. Water will then be pumped from the Bosberg / Boskraai Dam to the Knellpoort Dam.	4.2 (5.9)	Yes	
C4	Modifications to Welbedacht Dam: Extend scour	Increasing the available yield from Welbedacht Dam by reducing the existing dead storage as a result of siltation in the dam.			Optimisation of the operation of Welbedacht Dam will be undertaken by a separate Bloem Water Study. Will not increase the yield of the system

Ref	Intervention	Description of Intervention	URVs (R/m^3)	Selected for Further Investigation	
				Yes	No
C5	Modifications to the Caledon-Modder System	The yield of the Caledon-Modder System can be increased by one, several, or a combination of the following interventions: • Increase the capacity of Novo Pump Station • Raising of Knellpoort Dam (1, 2, or 4 m) • Increase the capacity of Tienfontein Pump Station • Construct a pump station and pipeline between Welbedacht Dam and Knellpoort Dam	< 1.5	Yes	
C6	Polihali Dam – Lesotho Highlands Phase 2	The LHWP comprises of a number of phases, with Phase II culminating in the construction of the Polihali Dam. Water from the Polihali Dam would then be delivered from Katse Dam via the existing Transfer Tunnel to Muela Hydro Power Station and thence via the existing Delivery Tunnel to the Ash River. It is proposed that Phase II would be commissioned by January 2020 and Phase III would only be required by 2054. It is proposed that the Phase II water is released for Bloemfontein up to the year 2050. This supply could delay capital expenditure on improvements to the existing bulk infrastructure supplying Bloemfontein.	1.9	Yes. The URVs must be based on the correct tariff	
D1	Planned direct re-use: New North Eastern WWTW	The MLM is in the design phase to construct a new WWTW to allow further development in the north, eastern, and western parts of Bloemfontein. This intervention entails pumping effluent, which has been treated to potable standards using Ultra Filtration, Reverse Osmosis, and Ultra-violet Radiation, from the New North Eastern WWTW to the Maselspoort WTW or to the distribution reservoir on Navel Hill. The focus of this intervention is to abstract water for re-use at the New North Eastern WWTW.	4.1	Yes	
D2	Planned indirect re-use: Transfer to upstream of Mockes Dam	Treated effluent from the New North Eastern WWTW would be pumped over the escarpment into the stream feeding Mockes Dam. The treatment facilities at the Maselspoort Weir (a few kilometres downstream of Mockes Dam) will be extended with new treatment technology and equipment. Required treatment process includes Reverse Osmosis in order to remove the build-up of dissolved salts in the river system.	4.8	Yes	
D3	Planned indirect re-use: Krugersdrift Dam	All WWTWs for Bloemfontein, Botshabelo, Mangaung, and Thaba Nchu (except Welvaart WWTW) discharge their treated wastewater into the Krugersdrift Dam catchment area. Currently, no wastewater from Botshabelo or Thaba Nchu reaches Krugersdrift Dam, as it is intercepted at the Maselspoort Weir. The only water reaching the dam is excess surface run-off not intercepted by Mockes Dam and Rustfontein Dam, and the surplus wastewater from the Bloemfontein/Mangaung WWTW's.	5.0	Yes	

Ref	Intervention	Description of Intervention	URVs (R/m^3)	Selected for Further Investigation	
				Yes	No
		Water can be abstracted at Krugersdrift Dam and pumped back to Bloemfontein. The raw water at the Krugersdrift Dam will have to be purified using Ultra Filtration, followed by a Reverse Osmosis and Ultra-Violet radiation for disinfection, to purify water to potable standards. This treated water will then be pumped back to the main Bloem Water reservoir.			
D4	Planned direct re-use: Bloemspruit WWTW	The focus of this intervention is to utilise the existing treated effluent from the Bloemspruit WWTW for potable use and replace this with treated effluent discharged from the proposed New North Eastern WWTW. The treated wastewater from the Bloemspruit WWTW would be purified to potable standards (this will typically include Ultra Filtration, followed by a Reverse Osmosis, and Ultra-Violet radiation for disinfection) and then pumped to a reservoir serving the Greater Bloemfontein area.	3.7	Yes	
D5	Re-use of treated effluent: Direct use for irrigation	A dual system could be implemented where treated effluent is re-used in the city for the irrigation of municipal gardens, public open spaces, school fields, and green street reserves.		Yes	
E1	Groundwater abstraction at Ikgomotseng	This small community is located approximately 45 km north-west of Bloemfontein near the Krugersdrift Dam. Ikgomotseng derives their domestic water from the Krugersdrift Dam. It is proposed that 10 boreholes be drilled. The abstracted groundwater is to be pumped to the Ikgomotseng main reservoir for conjunctive use with the surface water (Krugersdrift Dam) as well as for dilution of the potential high fluoride concentrations or for treatment if necessary.	5.08	Yes	
E2	Groundwater abstraction at Bloemfontein	The city of Bloemfontein currently does not utilise groundwater resources for their water requirements. The Bainsvlei irrigation area is situated to the northern and western side of Bloemfontein. The water used for irrigation in this area is predominantly provided by groundwater resources. The area is a known source of groundwater in relative large volumes. It is therefore proposed that the area as a whole or a section of the area be utilised for the groundwater needs of Bloemfontein should it be required in the future	15.58		No
E3	Groundwater abstraction at Thaba Nchu	The Thaba Nchu area is situated approximately 58 km east from Bloemfontein. The area are characterised by group very small to medium sized communities that are depended on surface water (Bloem Water) and groundwater for their domestic water needs. An unknown number of boreholes are utilised for water supply purposes. For the groundwater intervention it is proposed that a typical rural water supply approach be followed for the small communities of Thaba Nchu.	5.35	Yes	
E4	Groundwater abstraction at Reddersburg	The community of Reddersburg is located 60 km south-east of Bloemfontein. The current domestic water need for Reddersburg is derived mainly from surface water resources (Bloem Water) and to a lesser extent from groundwater resources of the	9.22	Yes	

Ref	Intervention	Description of Intervention	URVs (R/m^3)	Selected for Further Investigation	
				Yes	**No**
		commonage. The local municipality has an agreement with Bloem Water that a certain volume of water derived from surface water (pipeline) must be utilised on a monthly scale. The groundwater intervention proposed entails the drilling of eight new boreholes.			
E5	Groundwater abstraction at Edenburg	The community of Edenburg is located 60 km south-east of Bloemfontein. The current domestic water need for Edenburg is derived mainly from surface water resources (Bloem Water) and to a lesser extent from groundwater resources of the commonage. The local municipality has an agreement with Bloem Water that a certain volume of water derived from surface water (pipeline) must be utilised on a monthly scale. The groundwater intervention proposed entails the drilling of eight new boreholes.	10.08	Yes	
E6	Groundwater abstraction at Dewetsdorp	The community of Dewetsdorp is located 68 km south east of Bloemfontein. The current domestic water need for Dewetsdorp is derived mainly from surface water resources (Bloem Water) and to a lesser extent from groundwater resources of the commonage. The groundwater intervention proposed entails the drilling of seven new boreholes.	7.35	Yes	
E7	Groundwater abstraction at Wepener	The community of Wepener is located 104 km south east of Bloemfontein. The current domestic water need for Wepener is derived mainly from surface water resources (Bloem Water) and to a lesser extent from groundwater resources of the commonage. The groundwater intervention proposed entails the drilling of seven new boreholes.	7.52	Yes	
E8 & 9	Well field developments along the route of the existing pipelines	This intervention entails developing well fields along the route of existing pipelines, such as the Botshabelo / Thaba Nchu pipeline, Dewetsdorp pipeline, Edenburg pipeline, and the Caledon pipeline be investigated.	9.42 (De Hoek Reservoir) 10.30 (Lieuwkop off-take chamber)		No
F1	Water trading	Not all water allocated to agricultural users is currently being utilised. Therefore, there is potential for purchasing water rights from those agricultural users who are not fully utilising their allocations.			This is a long-term possible intervention
G1	Tunnel from the Caledon River	This scheme entails a flood structure in the vicinity of Jammersdrift Weir and a tunnel approximately 42 km long diverting flood water into the Modder Catchment. A dam in the Modder River catchment with a capacity of equivalent to at least the MAR of the Caledon River was proposed.			No
G2	New dam on the Caledon River	Construction of an additional dam on the Caledon River.			No
G3	Transfer of mine water	This intervention entails abstracting water from closed gold mines in Welkom and/or Virginia, treating it to an acceptable standard, and then pumping it to the Greater Bloemfontein area.	4.6	Yes	

Ref	Intervention	Description of Intervention	URVs (R/m^3)	Selected for Further Investigation	
				Yes	No
G4	Canal option (to be still developed)			Yes	

7.4 CONCLUSIONS

The proceedings of the Preliminary Screening Workshop leads to the following conclusions regarding future surface water and groundwater development.

7.4.1 Surface water supply interventions

Interventions relating to the abstraction of water from Gariep and Vanderkloof Dams respectively have a high URV and without additional water resource development on the Orange River System, can only be implemented whilst there is a surplus in the Orange River system. Thereafter more costly changes will be required to access water from these dams.

It is most likely that the construction of Boskraai / Bosberg Dam, as well as other water resource development options on the Orange River will only become an option after the water requirements from the Vaal WMA have increased to such an extent that they reduce the availability of water in the Orange River, and a new supply intervention is implemented to augment the loss in yield.

7.4.2 Groundwater supply

The groundwater intervention option for Bloemfontein proposes that Bainsvlei be developed with a potential yield 28 million m^3/a. This is equal to the average annual recharge available to the area and therefore can be sustainably abstracted. Approximately 645 boreholes are required to abstract 28 million m^3/a of groundwater from the Bainsvlei area. The well field will be developed over a large surface area. Linked multiple storage facilities are envisioned that will be eventually lead to a main storage facility at the well field site from where water will be pumped 15 to 20 km to Bloemfontein. Bainsvlei and De Brug / Hagesdam could be combined as one option that can potentially yield 43.3 million m^3/a, but this will result in the cessation of all commercial irrigation activities and appropriation of private landowner's properties on large scale making this groundwater intervention unfeasible due to the socio-economical impacts. For this reason large scale groundwater development is not considered as a viable supply option for the Greater Bloemfontein Area.

8. WATER CONSERVATION AND DEMAND MANAGEMENT

MLM has developed strategies to reduce their unaccounted-for water which is in excess of 40%. There are four major themes, each theme consisting of a number of strategies.

Network Losses Strategy
a) Strategy 1: Development of preventative maintenance strategy
b) Strategy 2: Implementation of pressure management systems
c) Strategy 3: Embarking on regular communication to capacitate communities

System Losses Strategy
a) Strategy 4: Continuous data analyses of water treasury (sales) data
b) Strategy 5: Zoning of the MLM water network with zone meters
c) Strategy 6: Identify the erven with legal connections without meters
d) Strategy 7: Identify wrong meter reading or meter tampering

Behind-Watermeter Losses Strategy
a) Strategy 8: Educate community on how to perform first line inspections.
b) Strategy 9: Repair any leaks found on site and depending on the pro policy
c) Strategy 10: Focus on improving the quality of service delivered

Willingness to Pay Strategy
a) Strategy 11: Restrict supply for non payment and excessive use
b) Strategy 12: Investigate technologies for controlling/ dispensing water consumption.

MLM is currently struggling with the full implementation of these strategies. One of the reasons behind this is that the strategies to address the real and apparent losses are not easy to achieve, as water and sanitation services has not been captured in a management information systems. A typical management information systems will include information such as consumer billing data, geographical information systems (GIS), pressure management information from the pressure reducing valves (PRVs), water flows, losses and depths in reservoirs, water balances, information from zone meters and other essential services such as customer relations management.

An estimate of the water use in the Bloemfontein, Botshabelo, and Thaba Nchu areas for the 2006/2007 financial year is given in **Table 8.1** (information sourced from the WSDP, 2006/2007). The unaccounted for water (UAW) is 30.87 million m^3/a, which represents 41% of the bulk water supplied to the area.

Table 8.1: Detailed Breakdown of Water Use in Bloemfontein, Botshabelo, and Thaba Nchu Areas (2006/07)

Water Sector	Use (million m^3/a)
Bulk Water Supplied	74.95
Metered domestic/commercial and industrial water use	44.08
Actual 41% UAW	**30.87**

A breakdown of the authorised consumption and water losses within the Bloemfontein/Mangaung area, for the 2007/2008 financial year, is given in **Table 8.2**. The total bulk water supplied to the Bloemfontein/Mangaung area was 62 million m^3/a. The water losses amounted to 23.7 million m^3/a (or 39% of total bulk water supplied to this area).

Table 8.2: Unaccounted for Water – Bloemfontein/Mangaung Area (2007/2008 FY)

<table>
<tr><td rowspan="10">Input Volume

62.04 million m^3/a</td><td rowspan="4">Authorised Consumption (Estimated)

38.65 million m^3/a
62.3%</td><td rowspan="2">Billed Authorised Consumption

32.26 million m^3/a
52.0%</td><td>Billed metered connections</td><td rowspan="2">Revenue Generating Water

32.26 million m^3/a
52.0%</td></tr>
<tr><td>Billed unmetered connections</td></tr>
<tr><td rowspan="2">Unbilled authorised consumption

6.38 million m^3/a
10.3%</td><td>Unbilled metered connections (Free Basic Water)</td><td rowspan="8">Non-revenue generating water

29.78 million m^3/a
48.0%</td></tr>
<tr><td>Unbilled unmetered connections (communal taps)</td></tr>
<tr><td rowspan="6">Water losses (unaccounted for water)

23.40 million m^3/a</td><td rowspan="3">Apparent losses

7 million m^3/a
30%</td><td>Unavoidable losses</td></tr>
<tr><td>Illegal connections</td></tr>
<tr><td>Metering inaccuracies</td></tr>
<tr><td rowspan="3">Real losses

16.4 million m^3/a
70%</td><td>Main leaks</td></tr>
<tr><td>Reservoirs overflows</td></tr>
<tr><td>Service connection leaks</td></tr>
</table>

For the purposes of this Interim Reconciliation Strategy, the WC/WDM interventions have been divided up into three categories, namely:

- Reduction in Bloem Water UAW
- Loss management (MLM)
- Improved efficiency (MLM)

8.1 REDUCTION IN BLOEM WATER UAW

The bulk water losses for Bloem Water have been calculated as the difference between the volume of water abstracted from the various sources and the volume of water sold to consumers. Representatives from Bloem Water have indicated that their total overall losses are in the vicinity of 12% of the bulk water treated. **Table 8.3** unpacks the water losses in the bulk water system network of Bloem Water.

Table 8.3: Detailed Breakdown of Water Losses in the Bulk System Network of Bloem Water (BW) (million m^3/a)

	Financial Year				
	2005	**2006**	**2007**	**2008**	**2009**
Bulk water supplied from BW's WTWs	53.13	55.27	59.33	62.40	54.82
Less: Bulk meters to MLM	46.20	49.24	52.05	53.99	49.68
Less: Supply to other Local Authorities	2.01	2.34	3.01	3.20	3.29
Bloem Water Conveyance loss downstream of WTP	**4.93**	**3.69**	**4.27**	**5.21**	**1.85**
% water loss downstream of WTP	**9.6%**	**7.0%**	**7.6%**	**8.8%**	**3.6%**
Bloem Water abstraction from Source	54.91	58.01	62.60	65.87	57.13
Loss in WTW	1.78	2.74	3.25	3.47	2.30
% water loss in WTW	3.2%	4.7%	5.2%	5.3%	4.0%
Bloem Water Total water loss	6.71	6.43	7.52	8.68	4.15
% Total water loss	**12.2%**	**11.1%**	**12.0%**	**13.2%**	**7.3%**

It would appear that conveyances losses are in the order of 7% to 9% per annum. Bloem Water has an active database monitoring system, where the water losses of the different supply systems are monitored and respective reports are generated. Each of the regional managers within Bloem Water is responsible for managing their system water losses. The current levels of water losses do not appear inordinately high. A significant portion of this water loss could also be attributed to the regular bursts which occur on the Caledon-Bloemfontein pipeline, which is approximately 50 years old.

The water loss in the WTWs is in the order of 4% to 5% of the source abstracted volume. The most significant part of this loss can be attributed to the high sediment loads in the Caledon River, abstracted at Welbedacht Dam and treated at Welbedacht WTW.

For the purposes of this study it was assumed that no significant water saving could be made through targeting water losses in the Bloem Water's supply system.

8.2 LOSS MANAGEMENT

A 2003/2004 estimate of water consumption in the Bloemfontein/Mangaung area, where the UAW (water losses) amounted to 23.7 million m^3/a (or 39% of total bulk water supplied), put the apparent losses at 7.1 million m^3/a (30% of the total water loss) and the real losses at 16.6 million m^3/a (70% of the total water loss). The UAW in the Bloemfontein/Mangaung area of supply for the 2007/2008 financial year was estimated to be in the region of 23.4 million m^3/a. For the purposes of this Strategy it was conservatively assumed that in 2007/2008 a saving of 14.5 million m^3/a through water loss management could realistically be achieved for the Bloemfontein/Mangaung area of supply. Examples of water loss management interventions are given below:

- Pressure management;
- Retrofitting and removal of wasteful devices;
- Improved management (sectorisation, metering, billing, legislation);
- Mains replacement; and
- Leak detection and repair.

8.3 IMPROVED EFFICIENCY

The estimated authorised consumptive water use within the Bloemfontein area is estimated to be 38.6 million m^3/a. It has been assumed that with improved efficiency the town of Bloemfontein could reduce its authorised consumptive use by 15% or by 5.8 million m^3/a. It was further assumed that a 15% saving could also be achieved on the future water requirements projections. Examples of interventions/actions which could lead to an improved efficiency are given below:

- Efficient appliances: (washing machines, toilet cisterns etc);
- Low flow shower heads; and
- Water-wise gardening practices.

8.4 SUMMARY OF WC/WDM INTERVENTIONS

Table 8.4 tabulates the potential savings which could be achieved from the interventions described above. Potential savings estimated for the implementation of water use efficiency and water loss interventions for the Bloemfontein/Mangaung area of supply have been derived from figures sourced from the MLM. For the Botshabelo and Thaba Nchu area of supply, and for the smaller towns the same potential savings percentage has been pro-rated to the actual use to give an overall planning estimate of the total potential saving that could be achieved.

Table 8.4: Potential Savings that could be achieved from WC/WDM Interventions

Type of Intervention	Bloemfontein / Mangaung (million m^3/a)	% of Overall Supply	Botshabelo and Thaba Nchu (million m^3/a)	Smaller Towns (million m^3/a)	Total Based on Extrapolation (million m^3/a)
Reduction in BW UAW	0				0
Water Loss	14.5	22%	2.5	0.73	17.739
Water Use Efficiency	6	9%	1.35	0.56	7.65
TOTAL	**20.52**		**3.85**	**1.03**	**25.4**

The estimated potential water saving as result of water loss interventions in the study area is 17.7 million m^3/a (16.5 million m^3/a + 3.22 million m^3/a). It is estimated that the potential saving through improved water use efficiency could be as high as 7.65 million m^3/a. **Table 8.5** illustrates the impact of implementing a water loss intervention to reduce the current UAW from 41% to 17%.

Table 8.5: Potential Savings that can be achieved through the Implementation of Water Loss Interventions

Water Sector	Use (million m^3/a) Bloemfontein, Botshabelo and Thaba Nchu Areas
Bulk Water Supply metered to MLM and all WSAs	83.15
Less: Estimated potential of water loss interventions by MLM and WSAs	(17.74)
Estimated target bulk water supply metered to MLM and WSAs	65.42
Less Metered domestic/commercial and industrial water use	(51)
Remaining UAW **	**14.41 (or 17%)**

** NOTE: This is the estimated UAW after the potential water savings in **Table 8.4** have been implemented.

9. CALEDON-BLOEMFONTEIN TRANSFER SCHEME

Following an analysis of the Caledon-Bloemfontein Transfer Scheme it became apparent that significant additional yield could be made available from this system with limited additional infrastructure requirements in comparison to the other water augmentation interventions.

The yield of the Caledon-Bloemfontein Transfer Scheme can be increased by one, many or a combination of interventions **(Figure 9.1)**. These are listed below:

1) Increase capacity of Novo Pump Station (P/S)
2) The raising of Knellpoort Dam
3) Increasing the Capacity of Tienfontein (TFT) Pump Station
4) Implementing a pump station and pipeline between Welbedacht Dam and Knellpoort Dam
5) A combination of the abovementioned interventions

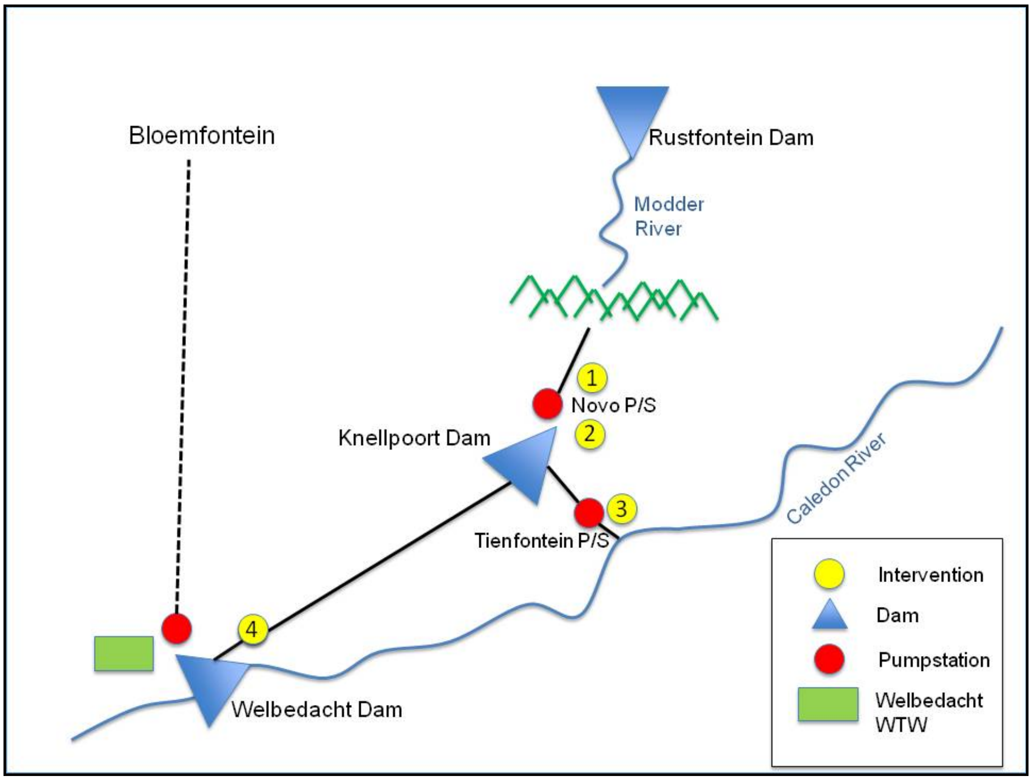

Figure 9.1: Caledon-Bloemfontein Transfer Scheme Interventions

The civil structure of Novo Pump Station was initially constructed to house pumps with a capacity of 4.8 m^3/s. The current installed capacity of Novo Pump Station is 1.5 m^3/s. The pipeline from Novo pump station to the head waters of the Modder River has a capacity of 2.4 m^3/s. If the capacity of Novo Pump Station is increased beyond 2.4 m^3/s, an additional pipeline from Novo Pump Station would have to be constructed.

For the existing situation (assuming agricultural water requirement upstream and downstream of Welbedacht Dam, an estimate for environmental water requirements and an allocation of 200 ha for resource poor farmers), the initial constraint on the yield of the Caledon Modder System is the capacity of Novo Pump Station. Thereafter the constraint is either the capacity of Knellpoort Dam or the capacity of Tienfontein Pump Station. The capacity of Novo Pump Station would also have to be further increased should additional storage capacity or inflow capacity be provided.

Table 9.1 indicates what the incremental increase in yield would be for the various interventions identified, as well as the additional infrastructure capacity required.

Table 9.1: Incremental Increase in Yield for the Caledon-Bloemfontein Transfer Scheme Interventions

Intervention	Increase in Capacity of Novo P/S from 1.5 m^3/s	Increase in Capacity of TFT P/S from 3 m^3/s	Capacity of WB Pump Station	Raising of Knellpoort Dam	Additional Yield Obtained
Unit	**(m^3/s)**	**(m^3/s)**	**(m^3/s)**	**(m)**	**(million m^3)**
(5a) Increase capacity of Novo Pump Station	0.2				4.5
(5b) Raising of Knellpoort Dam	0.3			1	1.2
	0.3			2	1.3
	0.3			4	1.3
(5c) Increase capacity of Tienfontein Pump Station	0.5	1			12.5
	0.8	2			20
	1.1	3			27
(5d) New Pump Station at Welbedacht Dam	0.7		1		18
	1.2		2		30
	1.6		3		39
(5e) Combination of Options	2.7	3	3	4	67

Note: The shaded areas indicate where the capacity of the pipeline from Novo Pump Station will have to be increased.

For the purposes of this interim Strategy, three possible development options were taken forward in the scenario planning process. The three identified interventions, shown in **Table 9.2**, are illustrative examples of the types of interventions which could be implemented on the Caledon-Bloemfontein Transfer Scheme. Each intervention shows the incremental increase in pump station capacity and the incremental increase in yield.

Table 9.2: Examples of the Types of Interventions which could be implemented on the Caledon-Bloemfontein Transfer Scheme

Intervention	Increase in Capacity of Novo P/S	Increase in Capacity of TFT P/S from 3 m^3/s	Capacity of WB Pump Station	Raising of Knellpoort Dam	Additional Yield Obtained
Unit	**(m^3/s)**	**(m^3/s)**	**(m^3/s)**	**(m)**	**(million m^3)**
Increase capacity of Novo Pump Station	0.2				4.5
Increase capacity of Tienfontein Pump Station	0.9	3			22.5
Combination of Options	1.6		3	4	40

In order to test the sensitivity of the historical firm yields from the Caledon-Bloemfontein Transfer Scheme, an analysis was undertaken where the monthly flows at Jammersdrift weir (upstream of Tienfontein Pump

Station) were decreased by 20% and 40% respectively to see if potential future upstream development would have any impacts on the historical firm yield of the Caledon-Bloemfontein Transfer Scheme. The results of the analysis are shown in **Table 9.3.**

Table 9.3: Impact of Potential Future Upstream Development on the Historical Firm Yield of the Caledon-Bloemfontein Transfer Scheme

Intervention	Historical Firm Yield (HFY)	HFY with 20% Decrease in flow due to Increased Demand upstream of Jammersdrift Weir	HFY with 40% Decrease in flow due to Increase Demand upstream of Jammersdrift Weir
Unit	**(million m^3/a)**	**(million m^3/a)**	**(million m^3/a)**
Current Caledon-Modder System historical firm yield	85.3	81.9	72.9
Annual flow	411	329	247

10. RECONCILIATION PLANNING SUPPORT TOOL

The selection of interventions, either to study further or to implement, to reconcile water availability with the requirement for the Greater Bloemfontein Study area is a complex task, with many diverse criteria to consider. To ensure that the multiple criteria are taken into consideration the Reconciliation Planning Support Tool (RPST) has been used for the "Scenario Planning Process". The purpose of the RPST is to provide graphical support to assist managers in planning how best to meet users' water requirements from the bulk water supply system servicing the Greater Bloemfontein Study area. The RPST will facilitate the selection of a suite of potential interventions for a particular water requirement scenario (specific selected forecasting graph or graphs) and/or for a particular scenario, which is being investigated.

The tool allows the user to compare the potential interventions with one another, and with one or more selected future water requirements scenarios. The output graphically shows when decisions to investigations selected interventions need to be taken to achieve water balance, in order to influence the requirements or to make the yield (annual volume of water available) from a new source available by a certain date (year).

The Reconciliation Planning Support Tool (RPST)

- Information relating to the various water requirement scenarios, the current system yield, intervention programmes, planning studies (including Environmental Impact Assessments (EIAs), design, construction, etc), yields, and financial parameters has been populated in the RPST and can easily be updated or added to.
- The RPST facilitates the comparison of potential interventions, or groups of interventions, with one another, and with one or more selected future water requirements scenarios. It has the ability to handle the complexity of the comparison and the selection of a large number of diverse interventions.
- The RPST is run in MS Excel, with Visual Basic macro-programmes.
- The RPST graphically shows when decisions regarding investigations for selected interventions need to be taken to achieve a water balance. It also shows the time-related implementation programmes for the selected interventions, the effects of WC/WDM in reducing requirements and the increases in system yield provided by water schemes. The required study start dates, for the various interventions of a selected suite that comprise a scenario, are shown.
- The RPST therefore aids scenario planning, by facilitating the selection of a suite of potential interventions, to meet a particular water requirement curve and/or for a particular identified scenario, to ensure water balance for the Greater Bloemfontein area's bulk water supply system.
- It contains financial parameters, namely unit reference values, operating costs and capital costs, and displays the unit cost of water per intervention selected. It calculates the net present value and expected cash flow for a selected suite of interventions. Further financial evaluations could be undertaken, should the relevant supporting financial information be available.
- Output from the RPST graphically shows when decisions to study selected interventions need to be taken to achieve a water balance, in order to implement demand management measures, or to make the yield from a new source available, by a certain date (year).

11. INTERIM SCENARIO PLANNING PROCESS

11.1 OBJECTIVE

The objective of the Scenario Planning Process is to identify, evaluate and assess alternative groupings and phasing of interventions so as to determine the most appropriate combination of interventions that should be implemented to reconcile water supply and requirement in the Greater Bloemfontein area, up to 2035. The combination of interventions selected to meet the requirement, is termed a scenario. Due to the lead times required for feasibility studies, interventions need to be identified well in advance so that they are ready for implementation within the required time frame. While conducting the feasibility studies, some interventions may be found not to be suitable for implementation. For that reason, the scenario planning process considers a range of possible scenarios to reconcile water supply and requirement. The objective is not to select one "favourable scenario" but to identify which interventions should be studied to allow consideration of a range of possible scenarios. This will allow the DWA, and other stakeholders, such as MLM and Bloem Water, the maximum amount of flexibility in making informed decision on which interventions to implement. The outcome of the process will be a list of interventions that should be studied, by specific dates, so as to facilitate the implementation of a range of reconciliation scenarios.

11.2 IDENTIFICATION OF SCENARIOS

The two key current uncertainties which would impact on the reconciliation of supply and requirement for the Greater Bloemfontein System are:

- The potential to implement WC/WDM interventions, and
- The future growth in water requirement.

It is therefore proposed that the interim strategy develop scenarios around these two key uncertainties in order to see how they could impact on the programme for the timing of future interventions. The scenarios which were identified are listed in **Table 11.1.**

Table 11.1: Intervention Scenarios Analysed in the Scenario Planning Process

Scenario	Description
Scenario 1	Medium water requirement and WC/WDM successfully implemented. WC/WDM phased in over 10 years.
	Objective: To determine the impact of successful implementation of WC/WDM measures over a period of 10 years and medium future water requirements
Scenario 2	Medium Water Requirement and WC/WDM only 50% successful. WC/WDM phased in over 5 years.
	Objective: To determine the impact of implementing WC/WDM measures only 50% successful over a period of five years and medium future water requirements
Scenario 3	High water requirement curve and WC/WDM successfully implemented. WC/WDM phased in over 10 years.
	Objective: To determine the impact of successful implementation of WC/WDM measures over a period of 10 years and high future water requirements
Scenario 4	High water requirement curve and WC/WDM only 50% successful. WC/WDM phased in over 10 years.
	Objective: To determine the impact of implementing WC/WDM measures only 50% successful over a period of 10 years and high future water requirements

More possible scenarios exist between the two extremes of Scenario 1 and Scenario 4, but if solutions could be found for these two scenarios, all others should be covered. Should the water requirement follow the “Low Water Requirement Curve” and not the “Medium” or “High Water Requirement Curve” (refer to **Section 2.1** of this Report), the required implementation date of interventions would be delayed and therefore more options for implementation would be available to select from.

11.3 INPUT DATA USED

The data on which the scenarios were determined and analysed was considered to be the best data available at the time. It is important to note the following with respect to the data:

a) It was assumed that WC/WDM would be implemented over a 10-year period.
b) The capital costs, yields, and URVs for the various interventions were based on June 2009 prices.

As information becomes available, it is important to review and update the scenarios investigated. This is of particular importance with regard to the WC/WDM interventions, as the yield and implementation dates of anticipated water savings interventions has a significant impact on the study and implementation programme for further interventions.

11.4 DETERMINING THE IMPLEMENTATION PROGRAMME

In order to determine and analyse scenarios, the Intervention Data Sheet in the RPST needs to be completed. A key parameter in the sheet is the implementation programme required (i.e. time to implement each intervention taking consideration of the various approval processes required), with the duration in years (or parts of years to the nearest 0.25 years). The preliminary assessment of the programmes for the implementation of each intervention was determined by utilising the judgement of the study team (details of the input data for each intervention is provided in **Appendix A**).

The time to implement an intervention is determined by the various processes and procedures that must be undertaken, with estimates of possible lag times (or delays) that might occur in the process. Based on the existing level of information for each intervention, different studies or processes are required (i.e. Level 1: Reconnaissance Study, Level 2: Pre-feasibility Study, Level 3: Feasibility Studies and Level 4: Construction or Implementation). The timing and duration of each level of study is dependent on budget lead time, time to appoint consultants, Environmental Impact Assessment (EIA) process, and other regulatory processes (information on the above mentioned Levels is provided in **Appendix B**).

11.4.1 Assumptions

The following assumptions were made in terms of the implementation programmes for some interventions:

- Pre-feasibility studies would not be required for the Gariep Dam (reference: **C1**), Vanderkloof Dam (**C2**), and Welbedacht Dam (**C4**) interventions.
- Pre-feasibility and feasibility studies would not be required for suite of interventions relating to the modification of the Caledon-Bloemfontein Transfer Scheme (**C5**). It was assumed that the EIA process and associated specialist studies would take one year.
- Only a feasibility study would be required for obtaining water from Polihali Dam (**C6**). However, it was estimated that it would take two years for the approvals and any amendments which need to be made to the Lesotho Highlands Water Project Treaty signed in October 1986.
- For all the re-use interventions (**D1-5**) it was assumed that feasibility and pre-feasibility studies would take one year and in addition to the approval processes which would also take one year.

- For the groundwater interventions (**E1-7**) it was assumed that the consultants appointed to conduct the feasibility study, which would include the siting of boreholes, would also design the network.
- The transfer of mine water intervention (**G3**) would require pre-feasibility and feasibility studies, environmental authorisation and authorisation from the DWA.

12. DISCUSSION ON PLANNING SCENARIOS

12.1 SCENARIO 1: MEDIUM WATER REQUIREMENTS AND WC/WDM SUCCESSFULLY IMPLEMENTED

Objective: To determine the impact of successful implementation of WC/WDM measures over a 10 year period and medium future water requirements

Scenario 1 was developed to determine what the impact would be of successfully implementing WC/WDM over a ten year period. The "medium growth" water requirement scenario was used in the analysis. The outcome of this scenario was that a new intervention would be required by 2028 (**Table 12.1**). The intervention selected, which has the lowest URV and has the lowest lead-time for design and construction, is the upgrade to the Novo Pump Station **(Figure 12.1)**. This intervention would only provide sufficient water two years before the next intervention is required. The first two interventions identified entail further infrastructure development to the Caledon-Bloemfontein Transfer Scheme. As the first intervention only provides sufficient water for two years, it may be prudent to increase the capacity of both Novo Pump Station and Tienfontein Pump Station at the same time as this could result in an additional incremental yield of 27 million m^3/a.

Table 12.1: Medium Water Requirements and 100% WC/WDM

	Intervention	Year of First Water or Saving	Yield (million m^3/a)	Total Lead Time	Study Start Date	Time to Full Yield / Saving
1	Leak Repair	2011	17.4	1	2010	10
2	Water Efficiency	2011	10.4	1	2010	10
3	Increase Capacity at Novo P/S (0.2 m^3/s)	2028	4.5	4	2024	1
4	Increase Capacity of Tienfontein (3 m^3/s) and Novo P/S (1.1 m^3/s)	2030	22.5	5	2025	1

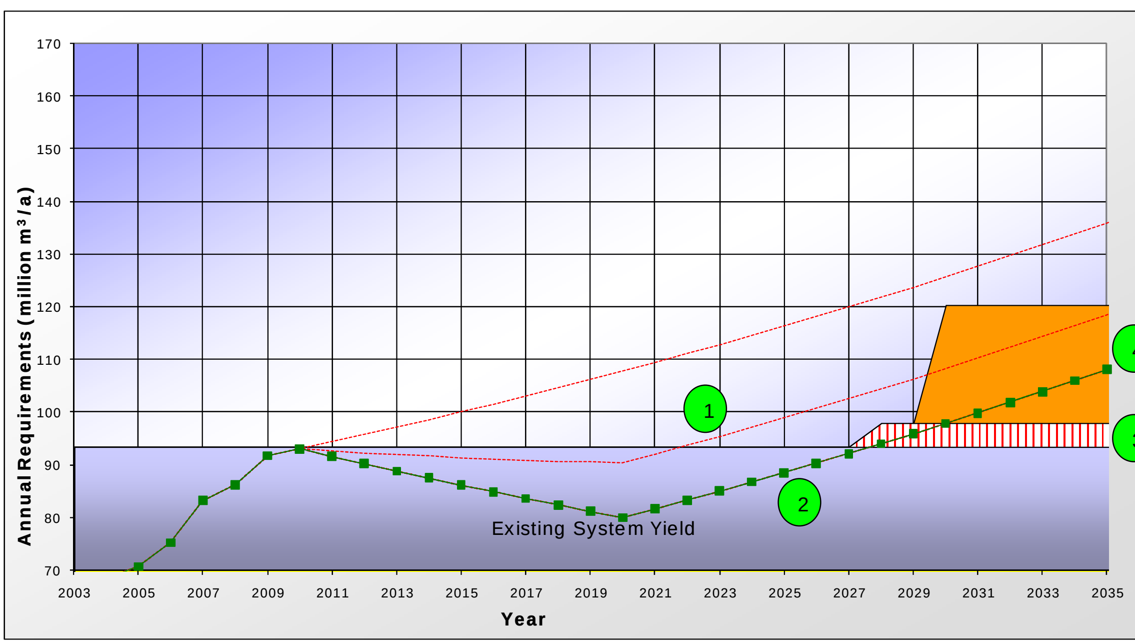

Figure 12.1: Scenario 1: Medium Water Requirements and 100% WC/WDM

12.2 SCENARIO 2: MEDIUM WATER REQUIREMENTS AND WC/WDM NOT SUCCESSFUL

Objective: To determine the impact of implementing WC/WDM measures only 50% successfully over a five year period and medium future water requirements

Scenario 2 was developed to assess the impact on the reconciliation of supply and requirement should the implementation of WC/WDM only be 50% successful over a five year period. The outcome of this scenario is that a new intervention would be required by 2020 (**Table 12.2** and **Figure 12.2**). Due to the fact that the future water requirements is below the available supply the implementation of WC/WDM over a five or ten year period results in the same date for the implementation of the next intervention.

Table 12.2: Medium Water Requirements and 50% WC/WDM

	Intervention	Year of First Water or Saving	Yield (million m^3/a)	Total Lead Time	Study Start Date	Time to Full Yield / Saving
1	Leak Repair	2011	8.7	1	2010	5
2	Water Efficiency	2011	5.2	1	2010	5
3	Increase Capacity at Novo P/S (0.2 m^3/s)	2020	4.5	4	2016	1
4	Increase Capacity of Tienfontein (3 m^3/s) and Novo P/S (1.1 m^3/s)	2023	22.5	5	2018	1

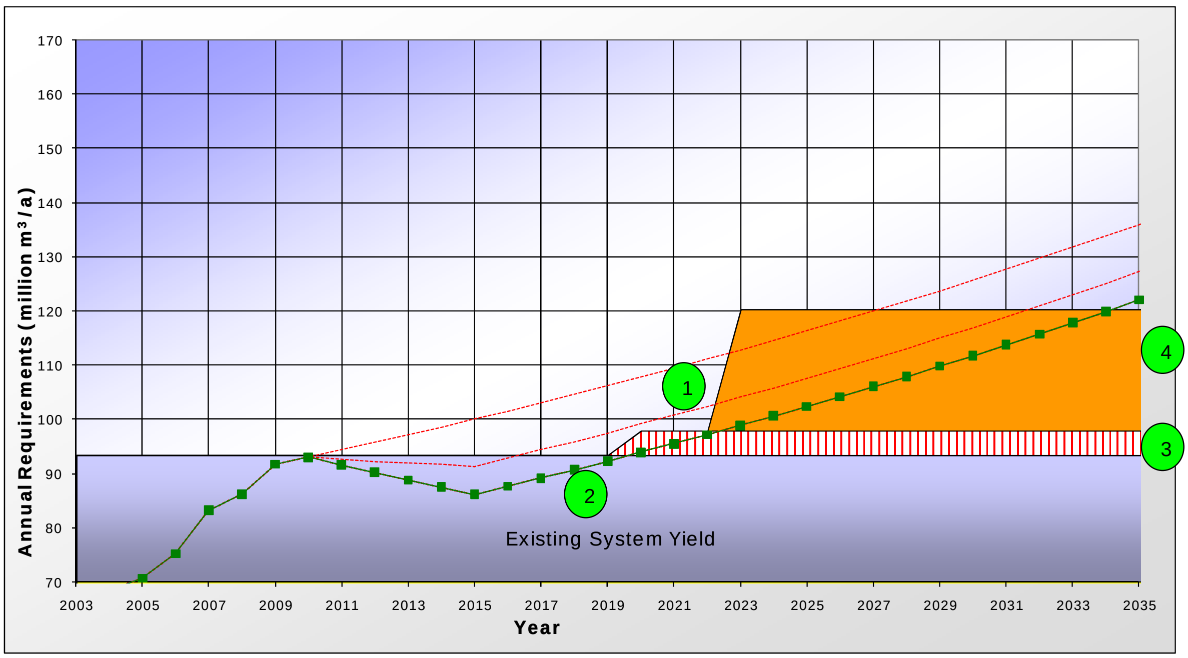

Figure 12.2: Scenario 2: Medium Water Requirements and 50% WC/WDM

12.3 SCENARIO 3: HIGH WATER REQUIREMENTS AND WC/WDM SUCCESSFULLY IMPLEMENTED

Objective: To determine the impact of successful implementation of WC/WDM measures over a ten year period and high future water requirements

This scenario was developed to assess the impact of the "high growth" water requirement scenario on the reconciliation of supply and requirement. It was assumed for this scenario that the implementation of WC/WDM would be 100 % successful over a ten year period. The outcome of this scenario was that water requirements exceed the current supply by 2010. It is not possible to implement a supply side intervention prior to 2014 (**Table 12.3**). The earliest date which an intervention can be implemented is 2014 (upgrade of Novo pumpstation). This intervention could, however, be fast-tracked by 1 to 2 years to deliver water by 2012/2013. Increasing the capacity of Novo pumpstation would provide sufficient lead time to allow for the implementation of the next intervention (increase in capacity of Tienfontein pumpstation). By implementing an increased capacity at Novo Pump Station (0.2 m^3/s) the implementation dates of the next intervention would be delayed by eight years **(Figure 12.3).**

Table 12.3: High Water Requirements and 100% WC/WDM

	Intervention	Year of First Water or Saving	Yield (million m^3/a)	Total Lead Time	Study Start Date	Time to Full Yield / Saving
1	Leak Repair	2011	17.4	1	2010	10
2	Water Efficiency	2011	12.5	1	2010	10
3	Increase Capacity at Novo P/S (0.2 m^3/s)	2013	4.5	4	2009	1
4	Increase Capacity of Tienfontein (3 m^3/s) and Novo P/S (1.1 m^3/s)	2021	22.5	5	2016	1
5	Increase abstraction capacity by add. 3m^3/s, raise Knellpoort by 4 m and Novo P/S (2.7m^3/s)	2027	40.0	10	2017	1

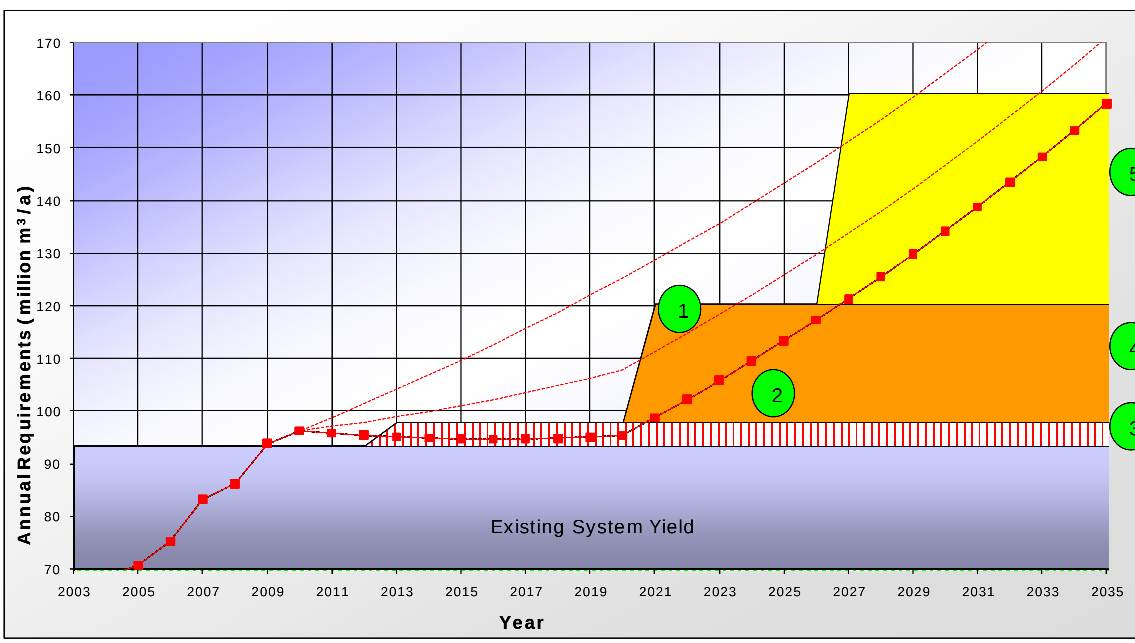

Figure 12.3: Scenario 3: High Water Requirements and 100% WC/WDM

12.4 SCENARIO 4: HIGH WATER REQUIREMENTS AND NO WC/WDM

Objective: To determine the impact of implementing WC/WDM measures only 50% successfully over a ten year period and high future water requirements

This scenario was developed to assess the impact of both the "high growth" water requirement scenario, and WC/WDM only being 50% successful on the reconciliation of supply and requirement. Under this scenario, the earliest date one would be able to reconcile supply and requirement is by 2013 (a fast-tracked increase in capacity of Novo Pump Station) (**Table 12.4**). Infrastructure development options around the Caledon-Bloemfontein Transfer Scheme could provide an additional historical firm yield of 67 million m^3/a or more. The realisation of this additional yield would be dependent on any future potential development on the Caledon River upstream of Tienfontein Pump Station. It must be noted that should the monthly flows at Jammersdrift weir (upstream of Tienfontein Pump Station) decrease by 20% and 40% respectively then the historical firm yield of the Caledon-Bloemfontein Transfer Scheme would decrease by 3.4 million m^3/a and 12.4 million m^3/a. Under this scenario, planned indirect re-use of water from Krugersdrift Weir would be required by 2033 **(Figure 12.4)**.

Table 12.4: High Water Requirements and 50% WC/WDM

	Intervention	Year of First Water or Saving	Yield (million m^3/a)	Total Lead Time	Study Start Date	Time to Full Yield / Saving
1	Leak Repair	2011	8.7	1	2010	10
2	Water Efficiency	2011	6.3	1	2010	10
3	Increase Capacity at Novo P/S (0.2 m^3/s)	2013	4.5	4	2009	1
4	Increase Capacity of Tienfontein (3 m^3/s) and Novo P/S (1.1 m^3/s)	2015	22.5	5	2010	1
5	Increase abstraction capacity by add. 3m^3/s, raise Knellpoort by 4 m and Novo P/S (2.7m^3/s)	2023	40.0	10	2013	1
6	Planned Indirect Re-use Krugersdrift Dam	2033	10.8	11.5	2021.5	3

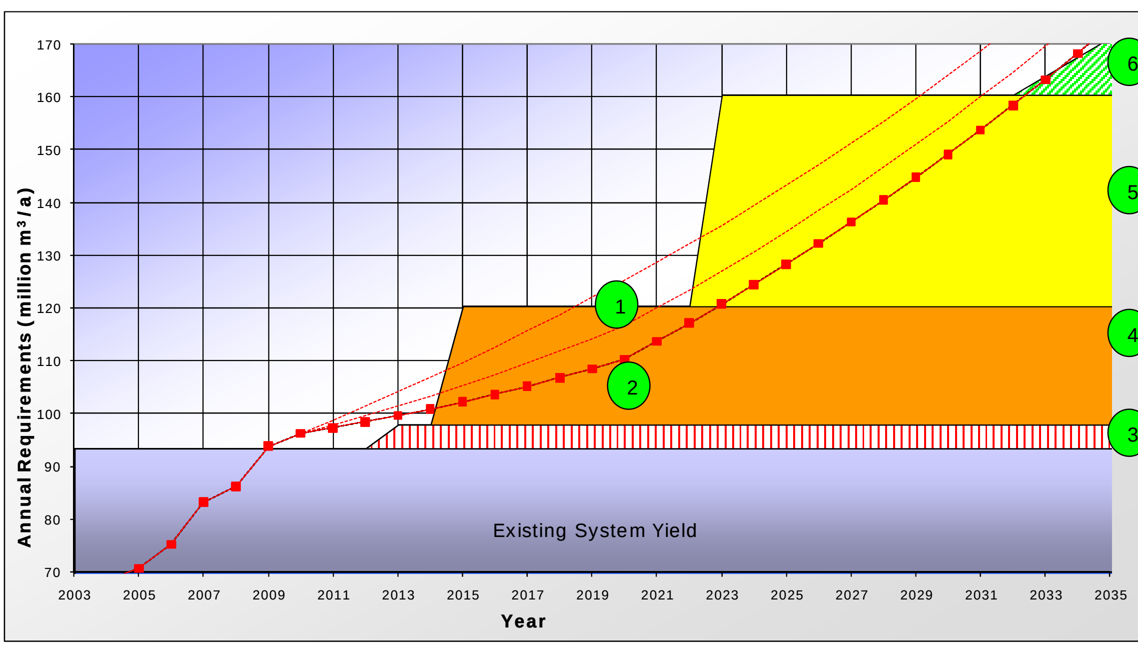

Figure 12.4: Scenario 4: High Water Requirements and 50% WC/WDM

13. CONCLUSIONS

The available supply and current water requirement of the Greater Bloemfontein system are currently in balance. However over the next couple of years it is anticipated that the water requirements will exceed the available supply. To reconcile the available supply with future water requirements, the following conclusions have been drawn based on this interim assessment.

WC/WDM is an essential intervention and its implementation should be afforded the highest priority. It should be used as a proactive measure to lower water requirements, instead of spending significant amounts of capital on water supply infrastructure that may not be optimally utilised. WC/WDM strategies that have been developed by MLM are discussed in **Section 8**. It is imperative that MLM and the other Water Service Authorities receiving water from the Greater Bloemfontein Water Supply System implement WC/WDM measures in order to reduce the risk of having to impose water restrictions and to ensure the longer term to reconciliation of supply and requirement. Implementation of increased and effective WC/WDM (see scenario 1) would delay the implementation of other interventions by an estimated 18 years. Should the implementation of WC/WDM only be 50% successful, the implementation date of the next augmentation scheme could be delayed by 10 years (see scenario 2).

The most favourable interventions, with the lowest URVs, are the interventions related to increasing the capacity of existing infrastructure associated with the Caledon-Bloemfontein Transfer Scheme and the Novo Transfer Scheme. It is recommended that Bloem Water consider increasing the capacity of the Novo Pump Station by 0.2 m^3/s by 2012/2013. Bloem Water should initiate a study to determine how to most optimally utilise the surplus water in the Caledon River from the Welbedacht system.

Upstream development on the Caledon River could reduce the yield of the Welbedacht-Modder supply systems and will bring forward the implementation dates. Depending on development upstream in the Caledon River and the associated impact this development would have on the current available yield, it is estimated that additional water resource development on the Orange River will not be required as an interventions prior to 2030.

The potential use of mine water will be further investigated in Phase 3 of the Strategy.

Water re-use remains a possible option as a future source of water. Depending on development upstream in the Caledon River and the associated impact this development would have on the current available yield, it is estimated that water re-use will not be required as an interventions prior to 2030.

14. INSTITUTIONAL ARRANGEMENTS

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

It is recommended that a Greater Bloemfontein Strategy Steering Committee be established towards the end of the Reconciliation Strategy Study. In the meantime, the current Study Steering Committee would need to confirm the interim strategy recommendations, and would facilitate communications between the various stakeholders. The Strategy Steering Committee has as its main functions and objectives:

- To ensure implementation of the recommendations of the Greater Bloemfontein Reconciliation Strategy.
- To update the strategy to ensure that it is relevant.
- To ensure that the Strategy and its recommendations are appropriately communicated.

The successful development and implementation of the identified actions requires the main stakeholders in the study area to be actively involved in the Study Steering Committee. Organisations represented on the Steering Committee must ensure that recommendations made in the Strategy document are implemented and assume a collective responsibility for ensuring the ongoing reconciliation of supply and requirement.

High-level management and political support will in the meantime be required to ensure that the recommendations are implemented.

15. INTERIM RECOMMENDATIONS AND STRATEGY ACTION PLAN

15.1 URBAN WATER CONSERVATION AND DEMAND MANAGEMENT

a. **Action**: The existing WC/WDM Strategy and Programme of Mangaung Local Municipality should be urgently implemented.
Responsibility: MLM
Timing: WC/WDM Programme: Ongoing

b. **Action**: Undertake a study to identify specific WC/WDM interventions and to determine the saving and costs associated with the Interventions.
Responsibility: MLM
Timing: Upon approval of the Interim Strategy

c. **Action**: Wepener, Dewetsdorp, Reddersburg, and Edenburg should develop WC/WDM strategies, actions plans, and programmes.
Responsibility: Smaller towns
Timing: Upon approval of the Interim Strategy

d. **Action**: DWA's: Water Use Efficiency, to assist and support the Water Service Authorities in the development and implementation of their WC/WDM strategies.
Responsibility: DWA D: WUE
Timing: Upon approval of the Interim Strategy

15.2 IMPLEMENTATION OF SUPPLY SIDE INTERVENTIONS

e. **Action**: Bloem Water should initiate a study to determine how to most optimally utilise the surplus water in the Caledon River from the Welbedacht system.
Responsibility: Bloem Water
Timing: Upon approval of the Interim Strategy

f. **Action**: Optimise the use of borehole water to supply the towns of Wepener, Dewetsdorp, Reddersburg, and Edenburg where it is technically and economically feasible.
Responsibility: Relevant Water Service Authorities
Timing: Upon approval of the Interim Strategy

15.3 ESTABLISHMENT OF A STRATEGY STEERING COMMITTEE

g. **Action**: A Strategy Steering Committee, supported by an Administrative and Technical Support Group, should be formed in order to make recommendations, on an annual basis, on long-term planning activities required to ensure reconciliation of water requirement and available supply in the Greater Bloemfontein System.
Responsibility: DWA
Timing: Upon approval of the Reconciliation Strategy

15.4 PUBLIC PROCESS

a. **Action**: Notify and invite key stakeholders and the general public of the Public Meeting which will be held in Bloemfontein
Responsibility: The Study Team
Timing: September / October 2010

b. **Action**: Present the Reconciliation Strategy at a public meeting in Bloemfontein
Responsibility: The Study Team, DWA, and MLM
Timing: October 2010

16. FURTHER REFINEMENTS REQUIRED TO THE STRATEGY

The following further refinements will be made to the Interim Strategy during Phase 3 of the Study:

- Update and refine the water requirements with the latest available information, taking into account potential changes in standards of service.
- Refine schemes and update the estimated URVs where necessary and include the additional scheme identified at the Preliminary Screening Workshop (e.g. construction of a canal to Knellpoort Dam).
- Understand the upstream and downstream water requirements on the Caledon River and identify the future impacts that development and compliance with the EWR may have on water availability and the current and future yields of the Welbedacht/Knellpoort System.
- Develop reconciliation strategies specifically for small towns, which includes an evaluation of the use of groundwater *versus* supply of water from the Greater Bloemfontein system. The conveyance capacity of bulk infrastructure will have to be assessed in order to determine at what point ground water development could become an attractive alternative to implement.
- Investigate illegal agricultural abstractions between Maselspoort and Rustfontein Dam.
- Undertake scenario planning and update strategy.
- Send out Newsletters and Public Meeting to inform the final Strategy.

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APPENDIX A

RECONCILIATION PLANNING SUPPORT TOOL INPUT DATA

INTERVENTION PROGRAMMES			Reconnaissance (years)			Pre-feasibility (years)			Feasibility (years)				Construction/Implementation (years)						Zero Yield at Start (years)														
			max time			max time			max time		concurrent	concurrent	max time		concurrent	concurrent			Full Yield at End (years)														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Min Time			Max Time										
Select / de-select	Scheme	Ref No	Lag time (budget delay)	TOR / Appoint Consultant	Recon-naissance	Lag time (budget delay)	TOR / Appoint Consultant	Pre-feasibility	Lag time (budget delay)/ Pilot study	TOR / Appoint Consultant	Feasibility Study/ EIA	DWA Reserve determination	Lag time (budget delay)	TOR / Appoint Consultant	DWA licensing process (Reserve)	DEA&DP approval process	Design / tender prepar. & award	Construct /Implement/Council Bylaw	Warm up /First filling	Minimum time to develop yield			Maximum time to develop yield		Study Status Completed	Implementation lead time	Capital Cost (R million)	Operating Cost	Annual Operating Cost	WDM Implementation Date	Time to Implement (min/max)	Yield (million m^3/a)/Saving	URV (eeconomic evaluation)
																			Start	End	Start	End	Start	End									100%
.	.																																.
Selected	Leak Repair																			10					R	1	-	-		2010		16.4	1
Selected	Water Efficiency																			10					R	1	-	-		2010		5.8	1
Selected	Increase Capacity at Novo P/S (0.2m3/s)	C5a											1	1			1	1	0	1	2	3	3	4	R	3	-	-			Min	4.5	2
Selected	Increase Capacity of Tienfontein (3) and Novo P/S (1.1m3/s)	C5c											1	1		1	1.5	1.5	0	1	3	4	4	5	R	5	-	-			Max	22.5	2
Selected	Temporary allocation from Polihali	C6							1	1	2										1	1	2	2		2	-	-			Max	10.0	3.38
Selected	Planned direct Re-use Bloemspruit	D4				1	1	1	0.5	0.5	1.5	1.5	1	1	1	1	1.5	1.5	0	3	4	7	8.5	11.5	R	11.5	144		26		Max	10.8	3.7
Selected	Planned Direct Re-use from new North Eastern	D1				1	1	1	0.5	0.5	1.5	1.5	1	1	1	1	1.5	1.5	0	3	4	7	8.5	11.5	R	11.5	188	-	28		Max	10.8	4.1
Selected	Bosberg to Knellpoort	C3							1	1	2	2	1	1	1	1	2	2	0	1	8	9	10	11	F	11	254		50		Max	10.0	4.2
Selected	Transfer of Mine Water	G3				1	1	1	0.5	0.5	1.5	1.5	1	1	1	1	2	2	0	1	7	8	11.5	12.5		12.5	633		59		Max	20	4.6
Selected	Planned Indirect Re-use Transfer to u/s of Mockes Dam	D2				1	1	1	0.5	0.5	1.5	1.5	1	1	1	1	1.5	1.5	0	3	4	7	8.5	11.5		11.5	257	-	29		Max	10.8	4.8
Selected	Planned Indirect Re-use Krugersdrift Dam	D3				1	1	1	0.5	0.5	1.5	1.5	1	1	1	1	1.5	1.5	0	3	4	7	8.5	11.5	R	11.5	277	-	31.1		Max	10.8	5
Selected	Groundwater: Ikgomotseng	E1							1	1	1	1			1	1	1	1	0	1	4	5	5	6	R	6	8.4		0.24		Max	0.18	5.08
Selected	Gariep to Knellpoort	C1							1	1	2	2	1	1	1	1	2	2	0	1	8	9	10	11		11	371		53		Max	10.0	5.3
Selected	Groundwater: Thaba Nchu Aquifer	E3							1	1	1	1			1	1	1	1	0	1	4	5	5	6	R	6	32.7		2.1		Max	0.9	5.35
Selected	Vanderkloof to Knellpoort	C2							1	1	2	2	1	1	1	1	2	2	0	1	8	9	10	11		11	493		59.4		Max	10.0	6.7
Selected	Groundwater: Dewetsdorp	E6							1	1	1	1			1	1	1	1	0	1	4	5	5	6	R	6	5.7		0.2		Max	0.09	7.35
Selected	Groundwater: Wepener	E7							1	1	1	1			1	1	1	1	0	1	4	5	5	6	R	6	5.9		0.2		Max	0.09	7.52
Selected	Groundwater: Reddersburg	E4							1	1	1	1			1	1	1	1	0	1	4	5	5	6	PF	6	6.7		0.28		Max	0.09	9.22
	Groundwater: De Hoek Reservoir	E8																			0	0	0	0	R	0	43		0.8		Max	0.44	9.42
Selected	Groundwater: Edenburg	E5							1	1	1	1			1	1	1	1	0	1	4	5	5	6	R	6	7		0.33		Max	0.09	10.08
	Groundwater: Lieukop off take chamber	E9																			0	0	0	0	R	0	43.3		0.96		Max	0.43	10.3
	Groundwater: Bloem Aquifer	E2																			0	0	0	0	R	0	4743		39		Max	28	15.58
Selected	Re-use: Irrigation	D5																			0	0	0	0	R	0					Max		
Selected	Increase abstraction capacity by add. 3m3/s, raise Knellpoort by 4 m and Novo P/S (2.7m3/s)								1	1	1	1	1	1	1	1	2	2	0	1	7	8	9	10	PF	10					Max	40.00	

APPENDIX B

DETERMINING THE IMPLEMENTATION PROGRAMME

DETERMINING THE IMPLEMENTATION PROGRAMME

In order to determine and analyse scenarios, the Intervention Data Sheet in the RPST needs to be completed. A key parameter in the sheet is the implementation programme required (i.e. time to implement each intervention taking consideration of the various approval processes required), with the duration in years (or parts of years to the nearest 0.25 years). The preliminary assessment of the programmes for the implementation of each intervention was determined by utilising the judgement of the study team.

The time to implement an intervention is determined by the various processes and procedures that must be undertaken, with estimates of possible lag times (or delays) that might occur in the process. Based on the existing level of information for each intervention, different studies or processes are required (i.e. Level 1: Reconnaissance Study, Level 2: Pre-feasibility Study, Level 3: Feasibility Studies and Level 4: Construction or Implementation). The timing and duration of each level of study is dependent on budget lead time, time to appoint consultants, Environmental Impact Assessment (EIA) process, and other regulatory processes.

Level 1: Reconnaissance Study

A Reconnaissance Study is required to provide sufficient information to assess whether an intervention should be considered for further study. The RPST requires information on yield, financial parameters (URV, capital cost and operating cost); and information on various other criteria (such as Environmental Impact Assessment (EIA) and social-economic implication). A Reconnaissance Study is therefore normally required before an intervention can be meaningfully compared in the RPST.

The following processes, which will form part of the Reconnaissance Study, have been identified are:

- The lag time that arises on account of the need to budget well in advance for the Reconnaissance Study.
- The development of Terms of Reference for the appointment of a Consultant (or Professional Service Provider) and the tender and appointment process.
- The time that it would take the Consultant to undertake the Reconnaissance Study.

Level 2: Pre-feasibility Study

A Pre-feasibility Study may be needed to evaluate some options in more detail so that sufficient information is available to make a reliable selection between options. The various pre-feasibility processes identified are virtually identical to those for the Reconnaissance Study as described above.

Level 3: Feasibility Studies

Feasibility Studies will initially be conducted on those selected by the Pre-Feasibility Study and on a number of other potential interventions for which Pre-Feasibility or Feasibility Studies have previously been undertaken. A full Feasibility Study is usually required before implementation. Feasibility Studies are likely to be conducted on a number of interventions and will comprise the following processes:

- The lag time for budgeting and the process of appointing a consultant as outlined above for the Reconnaissance Study.
- The Feasibility Study and EIA are processes that are usually undertaken together.
- As the DWA is responsible for determining the ecological Reserve this has been shown as a separate process but taking place concurrently with the Feasibility Study and EIA. It has been assumed that the programme will be dictated by the longer of these two processes, i.e. the Feasibility and EIA process and the ecological Reserve processes.

Level 4: Construction or Implementation

The Construction or Implementation of an intervention will involve a number of processes as follows:

- The lag time for budgeting and the process of appointing a consultant is the same as outlined above for the Reconnaissance and Pre-Feasibility Studies.
- Detailed design, preparation of the construction tender, calling for and preparing tenders, tender evaluation and award.
- Construction implementation period or bylaw enacted by Council.
- Warm-up or first filling.