



## water & sanitation

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Directorate: Water Resource Development Planning  
Department of Water & Sanitation  
Private Bag X313  
Pretoria  
0001  
South Africa  
Tel: 012 336 7500

# Greater Mangaung Water Augmentation Project Data Collection, Review & Analysis Report

## Xhariep Pipeline Feasibility Study



## water & sanitation

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Water and Sanitation  
REPUBLIC OF SOUTH AFRICA

Directorate Water Resource Development Planning

# Data Collection, Review & Analysis Report

## APPROVAL

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**CONSULTANT: ZUTARI (PTY) LTD**  
Approved for the Consultant:

**S KLEYNHANS**  
Design Director | Study Leader

**DEPARTMENT OF WATER & SANITATION**  
Directorate: Water Resource Development Planning  
Approved for Department of Water & Sanitation:

**M Muguma**  
Chief Engineer: Water Resource  
Development Planning

**C Fourie**  
Director: Water Resource  
Development Planning

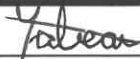
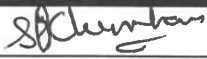
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**Document prepared by:**

Zutari (Pty) Ltd  
 Reg No 1977/003711/07  
 1 Century City Drive  
 Waterford Precinct  
 Century City  
 Cape Town  
 South Africa  
 PO Box 494  
 Cape Town  
 8000  
 Docex: DX 204

T +27 21 526 9400  
 E capetown@zutari.com

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<b>Author signature</b>		<b>Approver signature</b>	
			
<b>Name</b>		<b>Name</b>	
Frances A'Bear		Stephan Kleynhans	
<b>Title</b>		<b>Title</b>	
Principal Engineer		Design Director	

## Report Structure

This report forms part of the following suite for the study:

REPORT INDEX	REPORT NAME	DWS NUMBER
1	Inception Report	P WMA 06/D00/00/3423/1
2	Site Visit Report	P WMA 06/D00/00/3423/2
3	Stakeholder Management Report	P WMA 06/D00/00/3423/3
4	<b>Data Analysis and Collection Report</b>	<b>P WMA 06/D00/00/3423/4</b>
5	Pre-feasibility Study Report	P WMA 06/D00/00/3423/5
6	Main Feasibility Study Report	P WMA 06/D00/00/3423/6
7	Geological and Materials Investigations Report	P WMA 06/D00/00/3423/7
8	Topographical Survey and Mapping Report	P WMA 06/D00/00/3423/8
9	Feasibility Design Report	P WMA 06/D00/00/3423/9
10	Socio-Economic Impact Assessment Report	P WMA 06/D00/00/3423/10
11	Legal, Institutional and Financing Arrangements Report	P WMA 06/D00/00/3423/11
12	Land Matters	P WMA 06/D00/00/3423/12
13	Environmental Scoping Report	P WMA 06/D00/00/3423/13
14	Public Participation Report	P WMA 06/D00/00/3423/14
15	EIA Report with specialist studies	P WMA 06/D00/00/3423/15
16	Summary Feasibility Study Report	P WMA 06/D00/00/3423/16

## Editor's Note

During the drafting of this report, an important update was released in the Government Gazette 48954 on 13 July 2023, confirming the change of name from "Bloem Water" to "Vaal Central Water Board". Throughout this document, the term "Bloem Water" was used, which should be understood to be synonymous with the new name, "Vaal Central Water Board." Subsequent reports in this study will refer to the entity as Vaal Central Water Board for consistency.

## Reference

This report is to be referred to in bibliographies as:

Department of Water and Sanitation, South Africa. 2023. *Greater Mangaung Water Augmentation Project – Xhariep Pipeline Feasibility Study: Data Collection, Review & Analysis Report.*

DWS Report Number: P WMA 06/D00/00/3423/4

Prepared by Zutari (Pty) Ltd



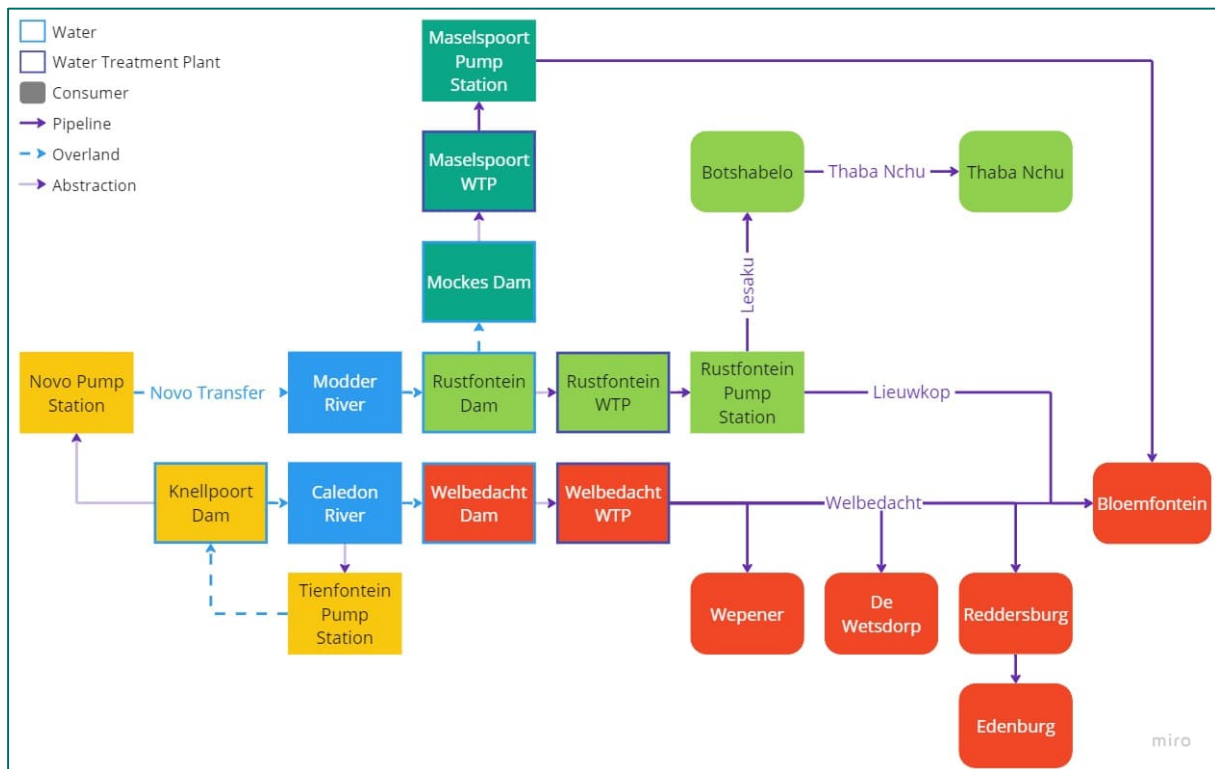
## Executive Summary

The 2012 Reconciliation Strategy Study for the Large Bulk Water Supply Systems: Greater Bloemfontein Area identified that the Greater Bloemfontein Water Supply System (GBWSS) highlighted the need to secure a sustainable water supply for the future. The Strategy recommended the development a major surface water augmentation scheme, known as the Greater Mangaung Water Augmentation Project – Xhariep Pipeline Feasibility Study. The project and route options from Gariep Dam were independently investigated by Bloem Water (BW) and Mangaung Metropolitan Municipality (MMM) but reached different conclusions as to the best route. The Department of Water and Sanitation (DWS) appointed Zutari as the Professional Service Provider (PSP) for the Xhariep Pipeline Feasibility Study. This study aims to consolidate previous studies, conduct additional investigations, and determine the optimal solution from a regional and national perspective.

The existing system includes:

- ▶ Four storage dams with a total active capacity of 181.5 million m<sup>3</sup>,
- ▶ Five pump stations, three of which are low lift and two form part of transfer schemes, and,
- ▶ Three water treatment plants (WTPs) with a total capacity of 355 Ml/day.

The schematic in Figure E-1 shows the sources, the WTPs, the high lift pump stations and the end consumers. Connecting the blocks are the abstraction pipelines, overland transfer, and the pressurised delivery pipelines.



**Figure E-1: Schematic of existing supply schemes**

This report captures the pertinent information from the previous studies, including dates, route options identified and costing. The nine reports directly related to the Xhariep Pipeline Feasibility Study date from 2012 to 2017. These reports were compiled for DWS, BW and MMM independently. The 2012 Reconciliation Study includes water supply options outside of the major surface water augmentation options, whereas the studies completed for BW and MMM consider only major surface water schemes.

At this stage it is not possible to compare all the options identified since 2012. This is due to the differing assumptions in the high-level design and resultant cost comparison. Additional complexities are introduced when trying to compare capital cost, operational cost, and unit reference value (URV) as

these have not been worked out and included in all reports. It should also be noted that some reports are missing pages and others are only the draft versions of the report.

Some of the studies assume that the interventions proposed by the 2012 Reconciliation Strategy will be implemented before the Xhariep Pipeline and therefore exclude the cost for upgrading pipelines, pump stations, WTPs and power supply. Others assume that the status quo will remain until the Xhariep Pipeline project is implemented and therefore include the costs for upgrading existing infrastructure.

In addition to the technical differences, the studies do not all include the operational costs or otherwise leave out the electrical costs of the operational budget. Several studies were also silent on the yields assumed for various interventions, making it impossible to determine net present values (NPVs) or URVs.

Due to the widely varying assumptions, and varying levels of detail, an accurate comparison is not possible. The studies, however, generally concluded that the transfer of water from Gariep Dam was considered the most feasible augmentation option once the interventions, as identified in the 2012 Reconciliation Strategy, have been implemented. As such, a comparison of options associated with the transfer of water from Gariep Dam will be undertaken as part of the pre-feasibility phase of this project.



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## Abbreviations

### Acronyms

Acronym	Description
<b>AADD</b>	Average Annual Daily Demand
<b>BW</b>	Bloem Water
<b>CBD</b>	Central business district
<b>DWS</b>	Department of Water & Sanitation
<b>EFR</b>	Environmental flow requirements
<b>EIA</b>	Environmental Impact Assessment
<b>GIS</b>	Geographical information systems
<b>IDP</b>	Integrated Development Plan
<b>ISP</b>	Internal Strategic Perspective
<b>MMM</b>	Mangaung Metropolitan Municipality
<b>NWRP</b>	DWA Directorate: National Water Resource Planning
<b>P/s</b>	Pumpstation
<b>PRV</b>	Pressure reducing valve
<b>RDP</b>	Reconstruction and Development Programme
<b>RO</b>	Reverse osmosis
<b>RPST</b>	Reconciliation Planning Support Tool
<b>SDF</b>	Spatial Development Plan
<b>SMC</b>	Study Management Committee
<b>UAW</b>	Unaccounted for Water
<b>URV</b>	Unit Reference Values
<b>WARMS</b>	Water Authorisation and Registration Management System
<b>WC/WDM</b>	Water Conservation and Water Demand Management
<b>WMA</b>	Water Management Area
<b>WSDP</b>	Water Service Development Plan
<b>WTP</b>	Water Treatment Plant

### Measurement Units

Symbol	Description
<b>Ha</b>	Hectares
<b>km</b>	Kilometres
<b>m</b>	Metres
<b>m<sup>3</sup>/a</b>	Cubic metres per annum
<b>m<sup>3</sup>/d</b>	Cubic metres per day
<b>m<sup>3</sup>/s</b>	Cubic metres per second
<b>million m<sup>3</sup></b>	Million cubic metres
<b>mm/a</b>	Millimetres per annum
<b>Mm<sup>3</sup>/a</b>	Million cubic metres per annum

# 1 Introduction

## 1.1 Background

The Water Reconciliation Strategy Study for the Large Bulk Water Supply Systems: Greater Bloemfontein Area (2012) (henceforth referred to as the “2012 Reconciliation Strategy”) identified that the Greater Bloemfontein Water Supply System (GBWSS) would need to secure a sustainable water supply for the future water demands in the area. The Strategy recommended that the development of a major surface water augmentation scheme should be given consideration as a possible option.

Following from the 2012 Reconciliation Strategy, the area experienced water shortages and the major surface water augmentation scheme option, now called the Greater Mangaung Water Augmentation Project – Xhariep Pipeline, was accelerated. Bloem Water (BW) and Mangaung Metropolitan Municipality (MMM) independently investigated route options from Gariiep Dam to points within the Mangaung area (see Figure 1-1). Each institution reached a different conclusion as to the best route.

The project is of critical importance to address growing water demands on a regional basis; thus, the Department of Water and Sanitation (DWS, the Client) has appointed Zutari to complete the pre-feasibility study, including reviewing all previous studies, and recommending the optimal system from a national perspective, including routing and sizing to be taken forward to a detailed feasibility stage. Upon completion of the pre-feasibility stage, DWS will approve the favoured option and thereafter Zutari will carry out the detailed feasibility study, the water use license application and environmental authorisation.

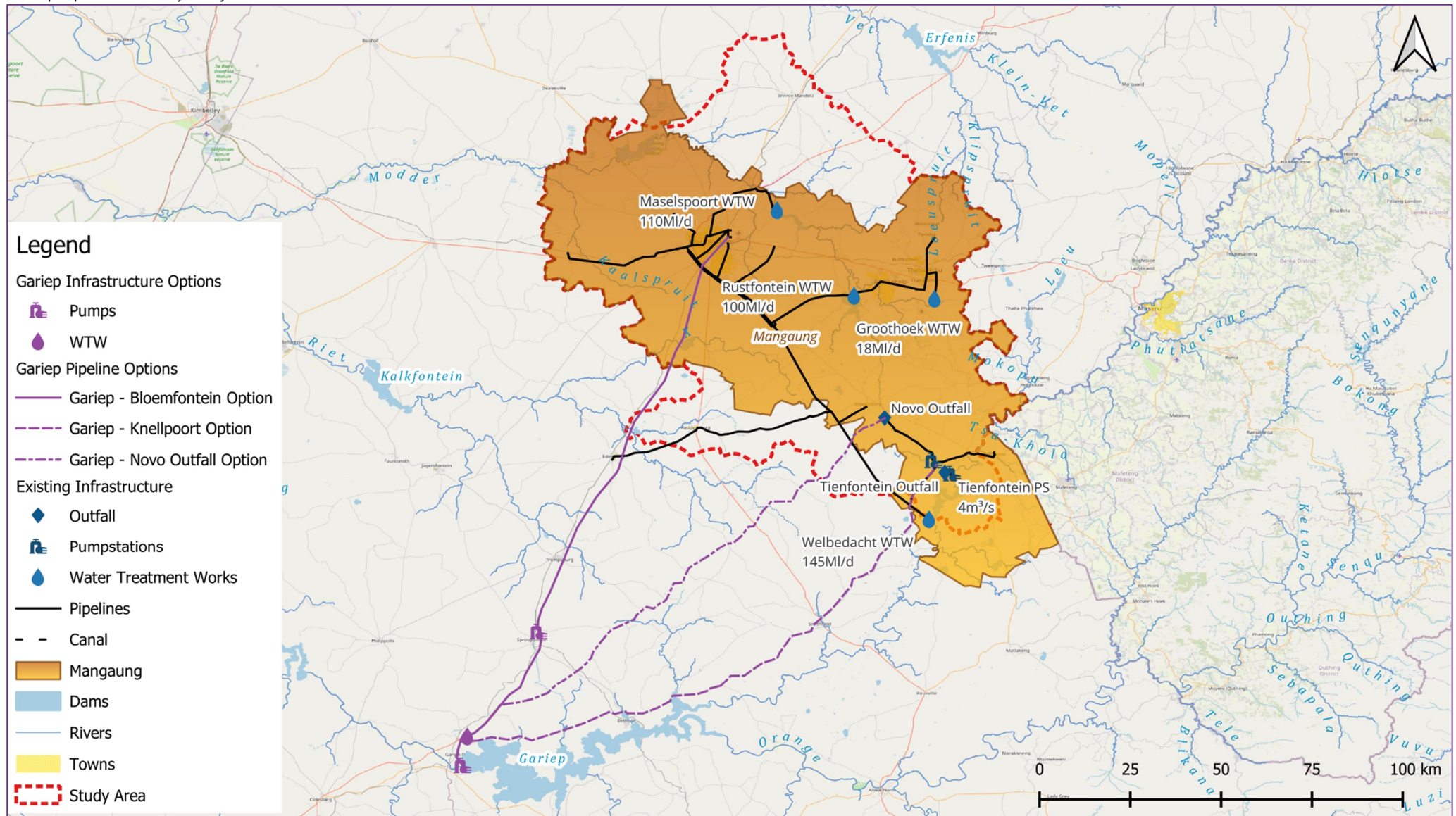


Figure 1-1 Previously studied route options from Gariep Dam to Greater Bloemfontein area



## 1.2 Study Objectives

This study must conduct an independent pre-feasibility investigation that builds on the information collected and analysed in previous work. The objective of this study is to:

- ▶ Evaluate options for the Greater Mangaung Water Augmentation Project with Gariep Dam as the source,
- ▶ Conduct additional necessary pre-feasibility level investigations, and,
- ▶ Select the optimal size, phasing, and configuration of the best water conveyance infrastructure option.

After DWS has approved the selected option and the pre-feasibility stage has been concluded, the study will continue to the detailed feasibility stage where the objectives will be to:

- ▶ Assess technical, financial, economic and environmental feasibility,
- ▶ Assess the risks and redundancy of the proposed bulk infrastructure system when operated in conjunction with the existing bulk infrastructure,
- ▶ Assess the impact of the project on existing systems including the:
  - Orange River System,
  - Optimisation of the Orange River System Yield with the proposed abstractions, and
  - Integration and utilisation of the available capacities in the existing infrastructure,
- ▶ Conduct stakeholder engagement workshops.

As this study is complex in nature, the study must also consider:

- ▶ The physical condition and remaining useful life of existing infrastructure,
- ▶ Institutional arrangements for ownership and operation,
- ▶ Financing options,
- ▶ Affordability and bankability in line with the National Treasury guidelines,
- ▶ Attractiveness for private investors and off-balance sheet financing,
- ▶ Opportunities for phased implementation, and,
- ▶ Stakeholder preferences.

## 1.3 Study Parameters

The following parameters were specified in the Terms of Reference (ToR).

- ▶ The maximum average annual abstraction rate from the Gariep Dam is limited to 60 million  $m^3/a$ <sup>(1)</sup>
- ▶ The sizing horizon for the proposed Xhariep Pipeline Project is at least 30 years (i.e., 2050 or beyond)<sup>(2)</sup>

### **Notes:**

- (1) The quantity of 60 million  $m^3/a$  was mentioned in the 2012 Reconciliation Strategy as the possible additional yield that could be abstracted from the Caledon River/Orange River system.

While it is a study assumption that the 60 million  $m^3/a$  scheme yield from the Orange River system is available to be allocated, the adequacy of the 60 million  $m^3/a$  to meet the future water demands need to be confirmed as part of this study. In the event that the abstraction from Gariep Dam needs to be further increased, this could be considered under the provisions of Clause 3.1 of the Terms of Reference, which states that “*Unless otherwise reasonably motivated and approved during the study, the maximum annual abstraction rates from the Gariep Dam shall be limited to 60 million  $m^3/a$ .*”.

- (2) A planning horizon of 2050 will be adopted for this project for the following reasons:

- a. Other studies covering the same supply areas have adopted 2050 as planning horizon, which improves the reliability of the modelling results as information is available regarding proposed developments in the Caledon and Orange rivers; and
- b. No information is available in Lesotho on proposed developments or anticipated water demands beyond 2050, which will significantly reduce the accuracy of the results should the planning horizon be extended beyond 2050. Furthermore, updating of the water demands within Lesotho, as well as obtaining further information on proposed long-term developments, falls outside of the scope of this project.

## 1.4 Purpose of This Report

Since the 2012 Reconciliation Study, there have been several additional studies completed for the Greater Bloemfontein Water Supply System (GBWSS) from which this study can build. This report lists the reports received from DWS, and additional relevant reports (i.e., contextual reports) received and found, and summarises the salient information related to this Xhariep Pipeline Feasibility Study.

## 1.5 Report Structure

The next chapter of this report lists the reports that contain the previous studies and work done towards implementation of this pipeline; the same section also contains other relevant reports that are pertinent to this study.

Chapter 3 describes the existing GBWSS infrastructure and provides a description of the dams, raw water pump stations and water treatment plants as well as the routes and schemes that make up the bulk water supply system.

Chapter 4 is a summary of the options identified in the various studies and, where available, provides information on the capital cost, operating cost and Unit Reference Values (URVs) of the options evaluated under the relevant studies.

Comment is provided in Chapter 5 on the possible comparison of options between the various studies.

The final chapter, Chapter 6, concludes this report.



## 2 Previous Studies and Other Relevant Information

The Xhariep pipeline has been the subject of numerous studies since initially identified in the 2012 Reconciliation Study. As such, there are several studies and previous investigations that this study can use as foundational information. The directly related study documentation is listed in Table 2-1 and the other relevant (indirectly related) documentation is listed in Table 2-2.

### 2.1 Directly Related Study Documentation

The ToR provided a list of studies that were directly related to the Xhariep Pipeline Project. Included in them is the 2012 Reconciliation Strategy. Table 2-1 lists the commissioning institution, the study documentation, the organisation that prepared it, and the status of whether the study/document has been received by Zutari.

**Table 2-1 Directly related studies to the planning of the Xhariep Pipeline Project**

Institution	Year	Document Name	Prepared by	Received	Format Received	Date Received
Department of Water Affairs	2012/06/01	Water Reconciliation Strategy for the Large Bulk Water Supply Systems: Greater Bloemfontein Area, Strategy Report, Interventions Report and Water Quality Assessment Report	Aurecon South Africa	Yes	PDF	02-Nov-22
Department of Water and Sanitation	2014/05/01	Reconciliation Strategy for the Greater Bloemfontein Water Supply System, Review of Options to Augment Bloemfontein's Water Supply, Draft Report	Aurecon South Africa	No <sup>1</sup>		
Bloem Water	Undated Assumed 2014	Pre-Feasibility Investigation, Investigation for a Pipeline from Gariep Dam to Knellpoort Dam, Including Alternative Options	Babereki Consulting Engineers	Yes	PDF	02-Nov-22
Department of Water and Sanitation	2014/08/01	Accelerated Action Plan to Augment Bloemfontein's Water Supply, Draft Report	Aurecon South Africa	Yes	PDF	02-Nov-22
Bloem Water	2015/02/01	New Pipeline from Gariep Dam to Knellpoort Dam Feasibility, Final Study Report	Babereki Consulting Engineers	Yes	PDF	02-Nov-22

<sup>1</sup> This report was made available from the Zutari internal records.

Institution	Year	Document Name	Prepared by	Received	Format Received	Date Received
Mangaung Metropolitan Municipality	2015/03/01	Water Supply Augmentation to the Greater Bloemfontein Area from the Orange River, Assessment of Potential Bulk Water Supply Schemes, Draft Report	Bigen Africa	Yes	PDF	02-Nov-22
Mangaung Metropolitan Municipality	2015/05/01	Water Supply Augmentation to the Greater Bloemfontein Area from the Orange River, Technical Feasibility Study Report, Draft Report	Bigen Africa	Yes	PDF	02-Nov-22
Department of Water and Sanitation	2015/09/01	The Greater Bloemfontein Reconciliation Strategy Support Study: The Greater Bloemfontein Bulk Water Supply Augmentation Options, Draft Report	Aurecon South Africa	Yes	PDF	02-Nov-22
Mangaung Metropolitan Municipality	2017/05/01	Mangaung Xhariep Water Augmentation Project (MGWAP): Bankable Feasibility Study: High Level Transfer Option Analyses, Incomplete Draft Report	Bigen Africa	Yes	PDF	02-Nov-22
Mangaung Metropolitan Municipality	Jun-15 to Oct-17	MGWAP: Various reports related to Environmental Scoping, Environmental Impact Assessment (EIA) and Water Use License Applications (WULA)	GladAfrica	No		
Free State Department of Environmental Affairs	2018/03/07	MGWAP: Environmental Authorisation	Free State Department of Environmental Affairs	Yes	PDF	02-Nov-22
Mangaung Metropolitan Municipality	2018/08/01	MGWAP: Scenario Analyses for the Greater Bloemfontein Water Supply System (Hydrological System Analyses)	WRP under leadership of Bigen Africa	Yes	PDF	02-Nov-22
Mangaung Metropolitan Municipality	until 2019	MGWAP various further study reports prepared by Bigen Africa	Bigen Africa	No		
		Various ongoing reviews and updates of the GBWSS status and operational condition as routinely conducted by BW, MMM and DWS		No		

## 2.2 Additional Relevant Reports

The ToR also provided a list of studies that were indirectly related to the Xhariep Pipeline Project, which include studies completed for the Vaal and Orange River systems. Table 2-2 lists the commissioning institution, the study documentation, and the organisation that prepared it. None of these reports have been received by Zutari.

**Table 2-2 Indirectly related studies to the planning of the Xhariep Pipeline Project**

Institution	Year	Document Name	Prepared by
Department of Water and Sanitation	2014/06/02	Development of Reconciliation Strategies for Large Bulk Water Supply Systems: Orange River (report Numbers: P RSA D000/00/18312/1 to 14) (ORECONS)	
ORASECOM	2014/08/02	The Orange-Senqu River Integrated Water Resources Management Plan (ORIWRMP)	
Department of Water and Sanitation	2017/07/01	Determination of Ecological Water Requirements for Surface Water and Groundwater in the Lower Orange WMA	Rivers for Africa e-Flows Consulting (Pty) Ltd
Department of Water and Sanitation	2021/04/01	Continuation of the Integrated Vaal River System Reconciliation Strategy Phase 2. Report P RSA C000/00/4406	Batatise/UWP/WRP JV
Permanent Water Commission	2020/03/01	Noordoewer/Vioolsrift Dam Feasibility Study - a suite of study reports	Aecom-WCE JV
Department of Environmental Affairs	2019/03/01	National Climate Change Adaptation Strategy	Department of Environmental Affairs
Department of Water and Sanitation	2021/03/01	Continuation of the Orange River System Reconciliation Strategy. Study in progress and likely to run in parallel with this study	
ORASECOM	2018 to date	Preparation of Climate Resilient Water Resource Investment Strategy and Plan, and the Lesotho-Botswana Water Transfer Multipurpose Transboundary Project: A suite of study reports containing latest information for the Orange River System, including updated water requirements, core development scenarios, operating rules, system, and yield analyses models, etc. Study still in progress, but certain specialised reports are already available.	
Department of Water and Sanitation	2021/03/01	Determination of Ecological Water Requirements for Surface Water (river, estuaries and wetlands) and Groundwater in the Upper Orange WMA. Study in progress and likely to run in parallel with this study	

## 3 Existing Greater Bloemfontein Water Supply System

Since the publication of the 2012 Reconciliation Study, several additional studies have been commissioned by DWS, BW and MMM to develop the Xhariep Pipeline option further. Each study began with a description of the existing Greater Bloemfontein Water Supply System (GBWSS) and its operation. For ease of reference and clarity, this report follow suit.

Figure 3-1 shows the layout of the existing GBWSS, including routes, pipe lengths and diameters and the towns that receive the water. Groothoek dam is not operational, and its infrastructure has not been included in this summary description.

### 3.1 Existing Infrastructure Details

#### 3.1.1 Dams

There are four dams within the system, listed in Table 3-1, Welbedacht, Knellpoort, Rustfontein and Mockes. As is well documented, Welbedacht has less than 5% remaining of its designed capacity due to siltation problems in the Caledon River. Knellpoort Dam was built because of the siltation problems and serves as a secondary storage dam for the Welbedacht Water Treatment Plant (WTP). Rustfontein and Mockes Dams are situated on the Modder River.

**Table 3-1 Summary of dam capacity information**

Storage Dam	Total Active/Net Storage Volume (million m <sup>3</sup> ) <sup>(1)</sup>	Full Supply Level (masl)
Welbedacht	5.4	1,402.9
Knellpoort	111.1	1,452.1
Rustfontein	61.7	1,373.0
Mockes	3.3	1,303.6
<b>Total</b>	<b>181.5</b>	<b>-</b>

(1) Total active/net storage volumes as contained in the Water Resource Planning Model used by DWS for the 2022/23 Annual Operating Analysis

#### 3.1.2 Raw Water Pump Stations

There are several raw water pump stations in the system, listed in Table 3-2. Three are low lift pump stations feeding WTPs, and the other two are part of transfer systems. The Tienfontein Transfer Scheme pumps water from the Caledon River to Knellpoort Dam. The Novo Transfer Scheme pumps water from Knellpoort Dam into the upper reaches of the Modder River catchment from where it flows under gravity to Rustfontein Dam.

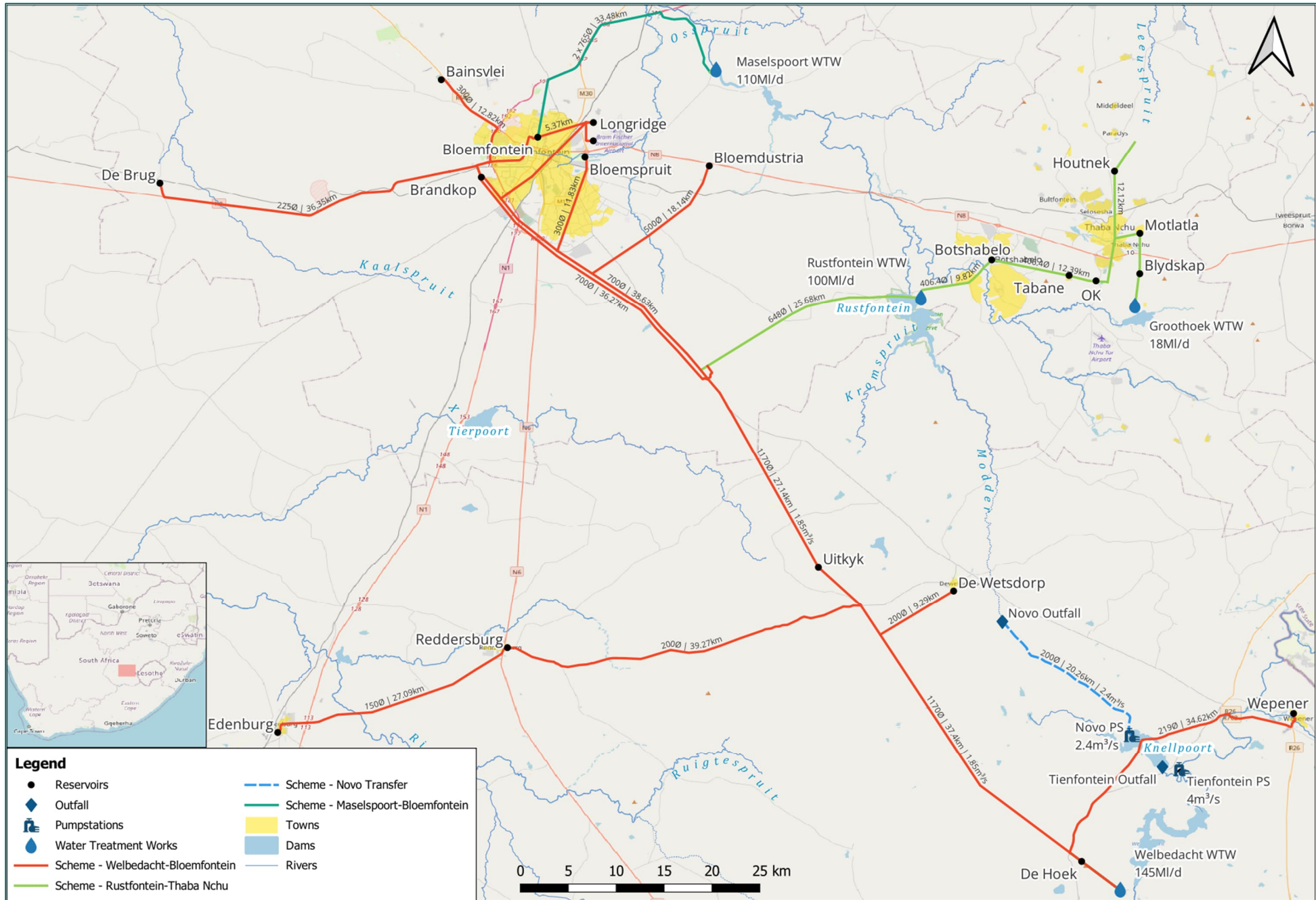


Figure 3-1 The existing water supply system for the Greater Bloemfontein Area

**Table 3-2 Summary of pump station information and capacity**

Abstraction Pump Station	Extracting from	Pumping to	Installed Capacity (l/s)	Maximum Operating Capacity (l/s)
Welbedacht Low Lift	Welbedacht dam	Welbedacht WTP	Not available	Not available
Tienfontein	Caledon river	Knellpoort dam	5,700	3,800
Novo	Knellpoort dam	Modder river	2,950	2,200
Rustfontein Low Lift	Rustfontein dam	Rustfontein WTP	Not available	Not available
Maselspoort Low Lift	Mockes dam	Maselspoort WTP	Not available	Not available

### 3.1.3 Water Treatment Plants

There are three water treatment plants (WTP) in operation, listed in Table 3-3. As noted in all previous studies, Welbedacht WTP capacity is hindered by the high levels of turbidity especially in the summer months / periods of high rainfall. The total treatment capacity available is 355 MI/d but this is not evenly distributable throughout the system. BW supplies 66% of the potable water and MMM, through Maselspoort WTP, provides the remainder.

**Table 3-3 Summary of WTP information**

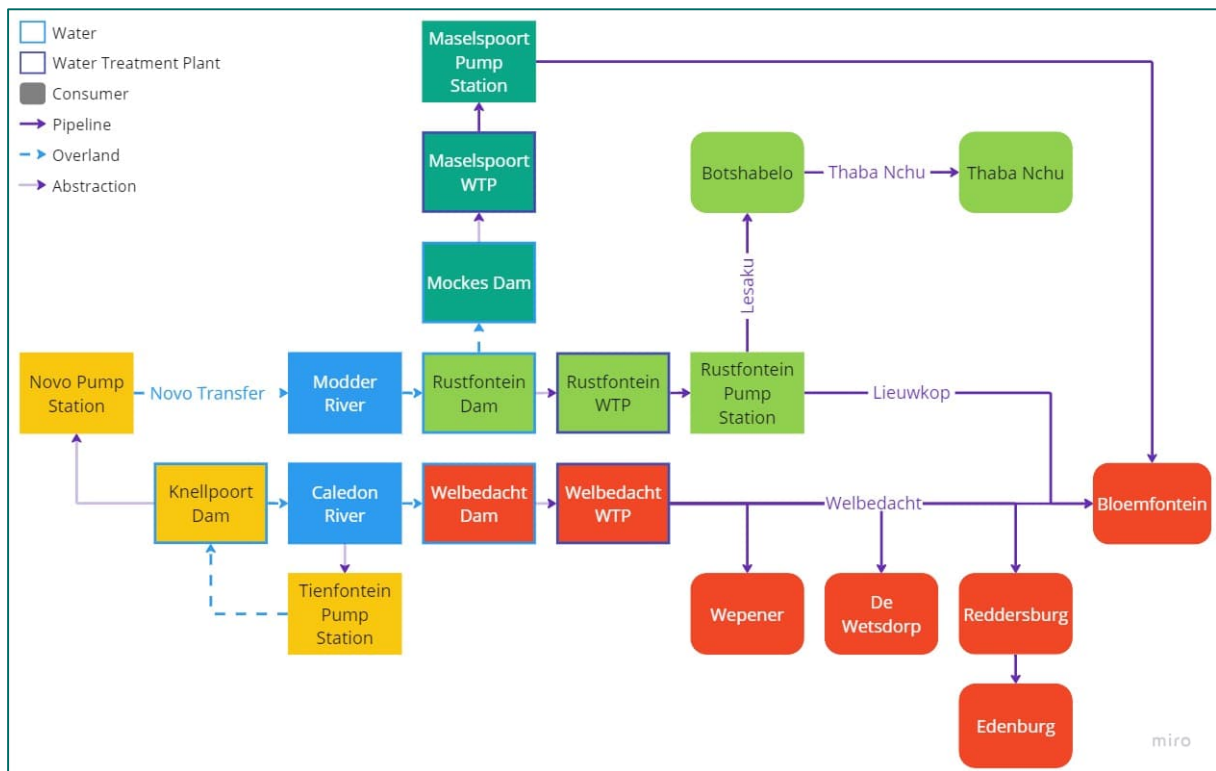
WTP	Description	Current Capacity (MI/d)	Operator
Welbedacht	Supply to Brandkop Reservoir with off-takes to towns and MMM Reservoirs	145 <sup>2</sup>	BW
Rustfontein	Primary supply to Botshabelo and Thaba Nchu with connection to Bloemfontein	100	BW
Maselspoort	Dedicated to Bloemfontein supply	110	MMM
<b>TOTAL</b>		<b>355</b>	

## 3.2 Existing Routes and Schemes

The schematic in Figure 3-2 shows the sources, the WTP, the high lift pump stations and the end consumer. Connecting the blocks are the abstraction pipelines, overland transfer, and the pressurised delivery pipelines.

<sup>2</sup> Capacity reduced to 90-100 MI/d in summer due to high turbidity levels





**Figure 3-2 Schematic of existing supply schemes**

Each scheme has a colour associated to it. The Welbedacht Dam scheme supplies smaller towns and Bloemfontein (red blocks). The Rustfontein scheme (light green) supplies Botshabelo and Thaba Nchu and has the capability of supplementing the Welbedacht-Bloemfontein pipeline. The smallest supply scheme is from Mockes Dam to Bloemfontein (dark green). The Rustfontein and Mockes dams can be supplemented by the Tienfontein-Knellpoort-Novo transfer (yellow blocks).



## 4 Summary of Options Identified

Since the publication of the 2012 Reconciliation Study, several additional studies have been commissioned by DWS, BW and MMM to develop the bulk augmentation option further. Gariiep Dam was the source for many of the studies, but other potential sources were also identified. The studies are not all costed to allow for easy comparison, so where possible, information regarding the maximum pumping head, capital cost, operational cost, and the unit reference value (URV, R/m<sup>3</sup>) are included. Figure 4-1 shows the routes and sources identified.

This section of the report will chronologically summarise the investigations and route options identified in the various reports, starting with the 2012 Reconciliation Study.

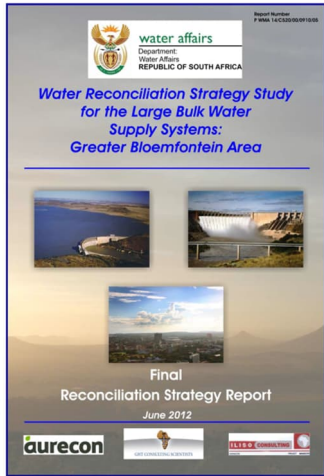
### 4.1 DWS, Water Reconciliation Strategy Report, 2012

The Water Reconciliation Strategy Report 2012 (hereafter referred to as the 2012 Reconciliation Strategy) was the project that initiated the studies in the years since. The strategy summarised the water resources and bulk supply infrastructure, analysed the water availability, analysed the existing and projected water demands, identified various interventions and their potential yields, and finally described the recommended interventions for the GBWSS. Following studies based their assumptions and analyses on the 2012 Reconciliation Strategy.

#### 4.1.1 Document Information

Table 4-1 shows the document information of the 2012 Reconciliation Strategy.

**Table 4-1 Document information for the 2012 Reconciliation Strategy report**

	Institution	Department of Water Affairs
	Document Name	Water Reconciliation Strategy for the Large Bulk Water Supply Systems: Greater Bloemfontein Area, Strategy Report, Interventions Report and Water Quality Assessment Report
	Date	June 2012
	Prepared by	Aurecon South Africa

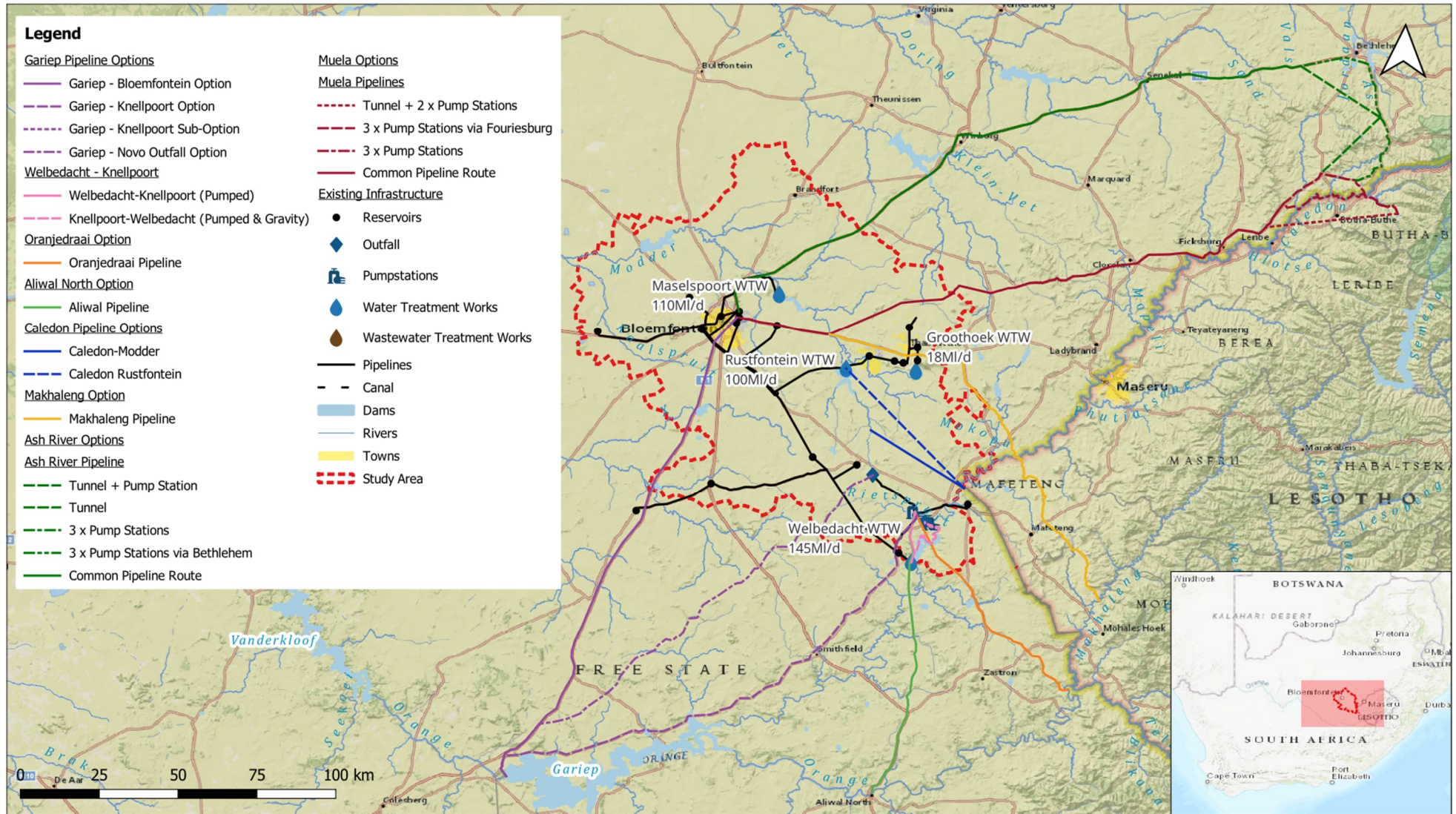


Figure 4-1 All options identified augmenting the GBWSS.

## 4.1.2 Augmentation Options

Several augmentation options were identified in the 2012 Reconciliation Strategy, these are summarised in Table 4-2 including estimated yields and costs (at the time). The interventions were not limited to the Xhariep pipeline, but it was included as an intervention to be implemented once the other interventions were in effect.

**Table 4-2 Summary of options identified in the 2012 Reconciliation Strategy**

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2012 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
1	MMM to implement WC/WDM strategy	Implement interventions to reduce Unaccounted for Water	11.5	240		1.5
2	Upgrade Tienfontein Pump Station	Increase pumping capacity from 3 to 4 m <sup>3</sup> /s and install additional standby capacity	4.4			
3	Scour Welbedacht Dam	Scour the dam to increase storage capacity and reduce siltation problems at Tienfontein Pump Station	7	270		2.54
4	Upgrade Welbedacht WTP	Upgrade WTP to deal with high turbidity to maintain output of 145ML/day	7			
5	Secure Welbedacht Pipeline	Relay sections of pipeline which are considered high risk	-			
6	Construction of Welbedacht Pump Station	The construction of a pump station and pipeline between Welbedacht and Knellpoort dams	22.6	374	7.9	1.51
7	MMM to construct additional storage reservoirs	Construct additional storage to ensure network peaks are not transmitted to the bulk supply infrastructure	-			
8	Redesign of Tienfontein Pump Station	Tienfontein should be modified / redesigned to cope with the sedimentation problems	13.7			
9	Reuse of treated effluent from WWTP	Direct or indirect re-use of treated effluent from developments post-2009, from Bloemspruit or Krugersdrift Dam	10.8	179 306	4.9 9.5	1.56 2.83
10	Xhariep Transfer Pipeline	Pipeline from Gariep Dam to Bloemfontein or Knellpoort Dam	20	825	33	6.1

Progress on the implementation of the interventions is limited and it remains critical to the success of the overall GBWSS to continue implementation efforts.

At the time of writing this report, Zutari is aware of the following status of the interventions:

1. Water Conservation / Water Demand Management:

- Little progress has been made to reduce water losses and / or manage demand.
2. Upgrade of Tienfontein Pump Station:  
The installed capacity has been upgraded to 5.7m<sup>3</sup>/s but the maximum operational capacity is limited to 3.8m<sup>3</sup>/s due to siltation issues at the 6<sup>th</sup> pump position. A technical feasibility study to upgrade the pump station to an installed capacity of 7m<sup>3</sup>/s must still be completed.
  3. Scour Welbedacht Dam:  
Upstream scouring of the dam basin is not effective as only two sluice gates are functional. Attempts to scouring the dam resulted in localised scouring at the dam wall toe due to the unbalanced releases of water. The ability to scour the dam is also restricted by the fact that the Welbedacht WTP cannot operate simultaneously and cannot be down for longer than 8 hours at a time due to the high demand to be supplied by the WTP.
  4. Upgrade Welbedacht WTP  
No progress has been made on upgrading the WTP to deal with high turbidity levels.
  5. Secure Welbedacht Pipeline  
Phase 1 of relaying the Welbedacht pipeline is 93% complete. A 33.7km section of the pipeline has been re-laid with a steel pipe. Phase 2 will re-lay the remaining 71.3km section of pipeline and will be implemented subject to availability of funding.
  6. Construction of Welbedacht Pump Station and Pipeline  
Planning for bi-directional pipelines between Welbedacht WTP and Knellpoort Dam was completed in 2019. Lack of funding is preventing construction.
  7. Construction of additional storage reservoirs  
No progress has been made regarding the additional potable water storage capacity within MMM.
  8. Redesign of Tienfontein Pump Station  
It is unclear whether the proposed upgrade to 7m<sup>3</sup>/s installed capacity includes the modification / redesign on the pump station intake to deal with the siltation problems. It is assumed therefore that no progress has been made.
  9. Reuse of treated effluent from Wastewater Treatment Plant (WWTP) - either Bloemspruit or Krugersdrift  
No progress has been made. The WWTP are not in good working condition according to BW.
  10. Xhariep Transfer Pipeline  
Several studies were initiated, and this study is consolidating the previous work done and will be used to progress this recommendation.

While some interventions are in progress it is unclear whether the envisioned yield has in fact been realised, aside from the increase in Tienfontein Pump Station operational capacity to 3.8m<sup>3</sup>/s.

## 4.2 BW, Pre-Feasibility Investigation, 2014

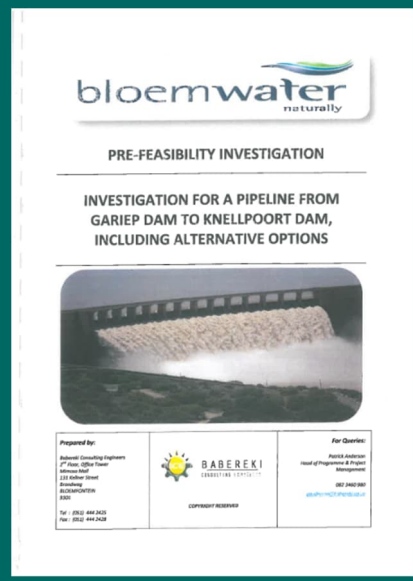
After the 2012 Reconciliation Strategy, BW appointed Babereki Consulting Engineers to conduct a pre-feasibility investigation into a pipeline from Gariep Dam to Knellpoort Dam. The report includes another option; a potable water pipeline directly to Brandkop Reservoir in MMM. The copy of the report provided was missing pages, one of which included a more detailed description of Option 2.



## 4.2.1 Document Information

Table 4-5 shows the document information of the BW Pre-Feasibility Investigation.

**Table 4-3 Document information of the Pre-Feasibility Investigation report**

	Institution	BloemWater
	Document Name	Pre-Feasibility Investigation, Investigation for a Pipeline from Gariep Dam to Knellpoort Dam, Including Alternative Options
	Date	Undated, assumed June / July 2014
Prepared by	Babereki Consulting Engineers	

## 4.2.2 Augmentation Options

Four options, with two sub options under Option 1, were investigated in the report and are summarised in Table 4-4. Only one of the five options investigated included a different end point other than Knellpoort Dam. The report did not include substantial information regarding the infrastructure assumed to be required for each option (new abstraction works, new WTP, number of high lift pump stations, etc.).

**Table 4-4 Summary of options identified in the BW Pre-Feasibility Investigation**

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2014 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
1A	Xhariep to Knellpoort	A 180km raw water pipeline of 600mm Ø from Xhariep to Knellpoort Dams using an existing connection at the Gariep Dam wall.		1,452		
1B	Xhariep to Knellpoort	A 125km raw water pipeline of 600mm Ø from Xhariep to Knellpoort Dams proposing a new abstraction facility at Bethulie.		1,008		
2	Xhariep to Knellpoort	A 190km raw water pipeline of 900mm Ø from Xhariep to Knellpoort with an additional 10km connection to Welbedacht Dam.		2,660		
3	Xhariep to Knellpoort	A 130km raw water pipeline of 900mm Ø from Bethulie to Knellpoort with an additional 10km connection to Welbedacht Dam.		1,960		
4	Xhariep to Brandkop Reservoir	A 150km potable water pipeline of 600mm Ø from a new treatment works at Bethulie to existing Brandkop Reservoir in Mangaung.		1,650		

The report did not contain information regarding the expected or assumed yield from any of the options, the estimated operating cost, or the URV. Additionally, the report did not reach a conclusion regarding the preferred option as an outcome of the pre-feasibility investigation, although in the subsequent feasibility report it moves forward with Option 1A.


### 4.3 DWS, Accelerated Action Plan, 2014

The Accelerated Action Plan to Augment Bloemfontein’s Water Supply 2014 (hereafter referred to as the 2014 Accelerated Action Plan) was commissioned by the then Minister of Water Affairs in a time of severe water supply problems. At the time, MMM and BW were engaged in progressing the Khariep Pipeline to Feasibility stages: BW had appointed Babereki Consulting Engineers to conduct a Pre-Feasibility Investigation for a pipeline from Gariiep Dam to Knellpoort Dam (one option to Brandkop Reservoir was included in this study). MMM had appointed Bigen Africa to conduct their studies using Gariiep Dam as a source.

#### 4.3.1 Document Information

Table 4-5 shows the document information of the 2014 Accelerated Action Plan.

**Table 4-5 Document information of the 2014 Accelerated Action Plan report**

	Institution	
	Department of Water Affairs	
	Document Name	Accelerated Action Plan to Augment Bloemfontein's Water Supply, draft report
Date	August 2014	
Prepared by	Aurecon South Africa	

#### 4.3.2 Augmentation Options

This report, like the 2012 Reconciliation Strategy, includes interventions that should be implemented prior to constructing a pipeline from Gariiep Dam to the GBWSS. It should be noted that several interventions have had some progress since the publication of this report, these are noted under Section 4.1.2.

**Table 4-6 Summary of options identified in the Accelerated Action Plan**

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2014 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
1	Upgrade Tienfontein Pump Station	Increase pumping capacity from 3 to 4 m <sup>3</sup> /s and install additional standby capacity	5	20		

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2014 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
2	Redesign of Tienfontein Pump Station	Increase pumping capacity from 4 to 7 m <sup>3</sup> /s and install additional standby capacity	12	150		
3	Upgrade Welbedacht WTP	Upgrade WTP to deal with high turbidity to maintain output of 145Ml/day	7			
4	Xhariep Transfer Pipeline - Xhariep to Bloemfontein	A transfer pipeline from Gariep Dam to Bloemfontein (including peak capacity of 90Mm <sup>3</sup> /a) Abstraction pump station, 178km pipeline, 1500Ø, WTP to treat peak demand, second pump station, storage reservoir at Bloemfontein	60	3,980		
5	Xhariep Transfer Pipeline - Xhariep to Bloemfontein	A transfer pipeline from Gariep Dam to Bloemfontein (excluding peak capacity). Abstraction pump station, WTP, 178km pipeline, 1300Ø, second pump station, 22km pipeline and pump station to supply Bloemfontein with 30Mm <sup>3</sup> /a	60	3,120		
6	Xhariep Transfer Pipeline - Xhariep to Novo Outfall	A transfer pipeline from Gariep Dam to Novo Pipeline Outfall (excluding peak capacity). 174km, 1300Ø, 2 pump stations, additional WTP and 22km pipeline and pump station to supply Bloemfontein	60	2,360		
7	Transfer Pipeline - Oranjedraai via Knellpoort and Novo	A transfer pipeline from the Orange River at Oranjedraai. Abstraction pump station, desilting works, high lift pump station, 81km pipeline (22km of 1300Ø, 37km of 1200Ø and 22km of 1000Ø), duplication of Novo scheme, additional WTP and 22km pipeline and pump station to supply Bloemfontein	60	1,810		



Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2014 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
8	Transfer Pipeline - Aliwal North via Knellpoort and Novo	A transfer pipeline from existing irrigation diversion weir on the Orange River. Abstraction pump station on the left bank of the Orange River, desilting works, high lift pump station, 108km (69km of 1200Ø, 24km of 1300Ø and 15km of 1000Ø), duplication of Novo scheme, additional WTP and 22km pipeline to supply Bloemfontein	60	2,380		
9	Welbedacht Bidirectional Pipeline	A bidirectional pipeline between Welbedacht and Knellpoort dams with a pre-treatment option. Options for capacity are 3 or 6m <sup>3</sup> /s, arrangement could be 32km pipeline with pumps at W and gravity flow back, or 17.5km pipelines pumping both ways, duplication of Novo scheme	27 34	980 1,270 (32km) 880 1,090 (17.5km)		
10	Duplication of Novo Scheme	Duplication of Novo Scheme includes a new pump station and 20km 1200Ø pipeline (included in schemes above)	75	270		

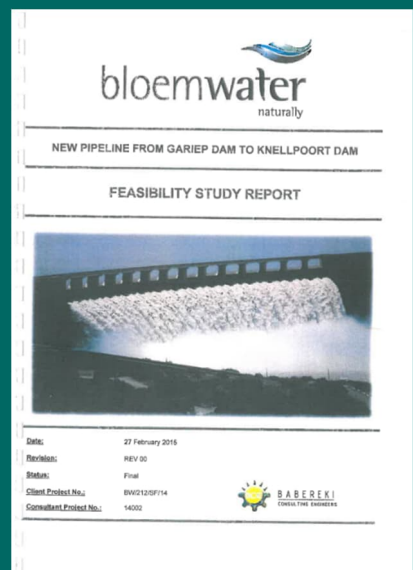
## 4.4 BW, New Pipeline from Gariep Dam to Knellpoort Dam, 2015

The New Pipeline from Gariep to Knellpoort Dam, Feasibility Study Report, 2015 was commissioned by BW and completed by Babereki Consulting Engineers including a preliminary design. It should be noted that there were pages missing from the document provided to Zutari.

### 4.4.1 Document Information

Table 4-7 shows the document information of the 2015 New Pipeline from Gariep Dam to Knellpoort Dam.

**Table 4-7 Document information of the 2015 New Pipeline from Gariep Dam to Knellpoort Dam report**

	<b>Institution</b>	<b>BloemWater</b>
	Document Name	New Pipeline from Gariep Dam to Knellpoort Dam, Feasibility Study Report
	Date	February 2015
	Prepared by	Babereki Consulting Engineers

### 4.4.2 Augmentation Options

Four routing options were considered in this feasibility study, three options considered solely different routes from Gariep to Knellpoort, while the fourth added an offtake to Novo outfall. The study excludes any consideration that the Novo transfer scheme may need upgrading. It also assumes the following:

- ▶ The bidirectional pipeline between Knellpoort Dam and Welbedacht Dam will be implemented by 2017.
- ▶ The upgrade to Tienfontein PS to 4m<sup>3</sup>/s will be operational by 2016.
- ▶ The Rustfontein WTP will be upgraded to 150Ml/d capacity by 2018.
- ▶ The Rustfontein-Leeukop pipeline will be upgraded by 2025.
- ▶ The Leeukop-Brandkop pipeline upgrade will be complete.
- ▶ BW owns and operates sufficient infrastructure to meet the 2035 demands and convey the potable water to the GBWSS.

**Table 4-8 Summary of options considered in the New Pipeline report**

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2015 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
1	Gariep Transfer Pipeline - Gariep to Knellpoort	A 63km pipeline to pump raw water to a high point relatively close to Gariep Dam (Aasvoëlkop or Tafelberg) and allow gravity flow to Knellpoort Dam.	20-60	1,077-2,320		
2	Gariep Transfer Pipeline - Gariep to Knellpoort	A 103 km pipeline to pump raw water to Knellpoort watershed and allow gravity flow over the last few kilometres to Knellpoort Dam	20-60	1,101-2,547		
3	Gariep Transfer Pipeline - Gariep to Knellpoort	A pipeline with two high lift pump stations to pump raw water to Knellpoort watershed	20-60	989-2,508		

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2015 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
4	Gariep Transfer Pipeline - Gariep to Knellpoort & Novo	A pipeline with two high lift pump stations to pump raw water to Knellpoort watershed and will also include a 17km gravity offtake to existing Novo outfall	20-60	1,306-2,953		

This study recommends that the option to be implemented should be Option 3, however the cost for Eskom power supply has not been included in the study and therefore Option 2 is a competitive alternative.

It should be noted that the option to Knellpoort creates redundancies for BW, which will help secure supply to Botshabelo and Thaba Nchu as well as Bloemfontein.

## 4.5 MMM, Water Supply Augmentation, Assessment of Potential Bulk Water Supply Schemes, 2015

### 4.5.1 Document Information

Table 4-9 shows the document information of the 2015 Water Supply Augmentation, Assessment of Potential Bulk Water Supply Schemes.

**Table 4-9 Document information of the 2015 Assessment of Potential Bulk Water Supply Schemes report**

Institution	Mangaung Metropolitan Municipality
Document Name	Water Supply Augmentation to the Greater Bloemfontein Area from the Orange River, Assessment of Potential Bulk Water Supply Schemes
Date	March 2015
Prepared by	Bigen Africa

### 4.5.2 Augmentation Options

The report by Bigen Africa considers three supply options with Gariep Dam as the source. The high-level assessment for the three options considered the end user peak demand plus the estimated pipe losses. Each option included the augmentation or upgrading of the downstream infrastructure in the cost assessment, e.g., pump station upgrades, additional capacity at WTP and pipeline upgrades. Operational costs were not considered.

**Table 4-10 Summary of options considered in the 2015 Assessment of Potential Bulk Water Supply Schemes**

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2015 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
1	Gariep Transfer Pipeline - Gariep to Knellpoort	A raw water pipeline from Gariep to Knellpoort Dam and upgrades of associated infrastructure. Abstraction pump station, 178km 1700Ø pressure pipeline, 11km 1200Ø gravity pipeline, second high lift pump station, additional pump station at Knellpoort Dam, additional pipeline between Knellpoort to Novo, additional Novo outfall, additional pump station and pipeline to Rustfontein WTP, additional WTP, additional high lift pump station from WTP, pipeline to Bloemfontein, new receiving reservoir	80	7,530		
2	Gariep Transfer Pipeline - Gariep to Novo Outfall	A raw water pipeline from Gariep to Novo Outfall and upgrades of associated infrastructure. Abstraction pump station, 179.5km 1500Ø pipeline, second high lift pump station, upgrades to Maselspoort WTP and pump station, additional high lift pump station from WTP, pipeline to Bloemfontein, new receiving reservoir	80	6,120		
3	Gariep Transfer Pipeline - Gariep to Bloemfontein	A raw water pipeline, WTP and potable water pipeline to Bloemfontein. Abstraction pump station, 22km 1500Ø raw water pipeline, second high lift pump station, WTP, 156km 1500Ø potable pipeline to Bloemfontein, new receiving reservoir	101	4,760		

The report recommended that the scheme listed in Option 3 should be developed further.

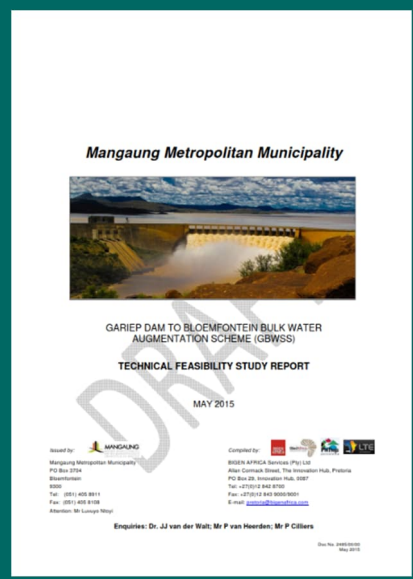
## 4.6 MMM, Water Supply Augmentation, Technical Feasibility Report, 2015

Zutari received a draft version of the Technical Feasibility report which did not include the information regarding the options developed following the recommendation made in the Assessment of Potential Bulk Water Supply Schemes report.

### 4.6.1 Document Information

Table 4-11 shows the document information of the 2015 Water Supply Augmentation, Technical Feasibility report.

**Table 4-11 Document information of the 2015 Technical Feasibility report**

	Institution <b>Mangaung Metropolitan Municipality</b>	
Document Name	Gariiep Dam to Bloemfontein Bulk Water Augmentation Scheme (GBWSS), Technical Feasibility Study Report	
Date	May 2015	
Prepared by	Bigen Africa	


## 4.7 DWS, The Greater Bloemfontein Reconciliation Strategy Support Study, 2015

DWS commissioned Aurecon to complete a support study to try to reconcile the progress made by DWS, BW and MMM up to this point. The report includes a summary of the potential supply augmentation schemes.

### 4.7.1 Document Information

Table 4-12 shows the document information of the 2015 Greater Bloemfontein Bulk Water Supply Augmentation Options, Greater Bloemfontein Reconciliation Strategy Support Study.

**Table 4-12 Document information of the 2015 Greater Bloemfontein Reconciliation Strategy Support Study report**

	Institution <b>Department of Water and Sanitation</b>	
Document Name	Greater Bloemfontein Bulk Water Supply Augmentation Options, Greater Bloemfontein Reconciliation Strategy Support Study	
Date	September 2015	
Prepared by	Aurecon South Africa	

## 4.7.2 Augmentation Options

The study considered multiple versions of the options considered previously by Babereki and Bigen Africa by changing the treatment location of the augmented supply. Throughout the study, it was assumed that raw water pipelines and pump stations would be sized for the average annual daily demand (AADD) while the WTPs and downstream network would supply the peak week demands (PWD). The geographic distribution of future growth is factored into the siting and sizing of the WTPs.

**Table 4-13 Summary of options considered in the 2015 Reconciliation Strategy Support Study**

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2015 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
1	Gariep Transfer Pipeline - Gariep to Bloemfontein	<b>Option 1a1:</b> 210MI/d Gariep Dam Pipeline & new WTP + Upgrades: +86MI/d Rustfontein WTP and Rustfontein-Thaba Nchu pipeline	AADD: 62 PWD: 93	5,685		
2	Gariep Transfer Pipeline - Gariep to Bloemfontein	<b>Option 1a2:</b> 170 MI/d Gariep Dam to Bloemfontein Pipeline & new WTP + Upgrades: + 86 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, + 40 MI/d Maselspoort WTP, Maselspoort-Bloem Pipeline	AADD: 62 PWD: 93	5,236		
3	Gariep Transfer Pipeline - Gariep to Bloemfontein	<b>Option 1a3:</b> 170 MI/d Gariep Dam to Bloemfontein Pipeline & new WTP + Upgrades: + 126 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, Rustfontein-Bloem Pipeline	AADD: 62 PWD: 93	5,521		
4	Gariep Transfer Pipeline - Gariep to Bloemfontein	<b>Option 1a4:</b> 170 MI/d Gariep Dam to Bloemfontein Pipeline & new WTP + Upgrades: + 81 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, + 45 MI/d Welbedacht WTP	AADD: 62 PWD: 93	4,908		
5	Gariep Transfer Pipeline - Gariep to Novo Outfall	<b>Option 2a1:</b> Gariep Dam to Upper Reaches of Modder River Pipeline 170 MI/d + Upgrades: + 86 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, + 210 MI/d Maselspoort WTP, Maselspoort-Bloem Pipeline	AADD: 62 PWD: 93	5,210		
6	Gariep Transfer Pipeline - Gariep to Novo Outfall	<b>Option 2a2:</b> Gariep Dam to Upper Reaches of Modder River Pipeline 170 MI/d + Upgrades: + 296 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, Rustfontein-Bloem Pipeline	AADD: 62 PWD: 93	5,815		

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2015 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
7	<b>Gariep Transfer Pipeline - Gariep to Novo Outfall</b>	<b>Option 2a3:</b> Gariep Dam to Upper Reaches of Modder River Pipeline 170 MI/d + Upgrades: + 251 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, Rustfontein-Bloem Pipeline, + 45 MI/d Welbedacht WTP	AADD: 62 PWD: 93	5,376		
8	<b>Gariep Transfer Pipeline - Gariep to Knellpoort</b>	<b>Option 3a1:</b> 170 MI/d Gariep Dam to Knellpoort Dam Pipeline + Upgrades: Knellpoort-Modder River Pipeline + 86 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, + 210 MI/d Maselspoort WTP, Maselspoort-Bloem Pipeline	AADD: 62 PWD: 93	5,672		
9	<b>Gariep Transfer Pipeline - Gariep to Knellpoort</b>	<b>Option 3a2:</b> 170 MI/d Gariep Dam to Knellpoort Dam Pipeline + Upgrades: Knellpoort-Modder River Pipeline + 296 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline	AADD: 62 PWD: 93	6,276		
10	<b>Gariep Transfer Pipeline - Gariep to Knellpoort</b>	<b>Option 3a3:</b> 170 MI/d Gariep Dam to Knellpoort Dam Pipeline + Upgrades: Knellpoort-Modder River Pipeline, + 251 MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, + 45 MI/d Welbedacht WTP	AADD: 62 PWD: 93	5,838		
11	<b>Integration with Planned Future Infrastructure</b>	<b>Option 4a1:</b> Bi-directional Pipeline, + 86 MI/d Rustfontein WTP, Knellpoort-Welbedacht Pipeline, + 45MI/d Welbedacht WTP, Tienfontein	AADD: 62 PWD: 93	3,038		
12	<b>Integration with Planned Future Infrastructure</b>	<b>Option 4a2:</b> Bi-directional Pipeline, + 189MI/d Rustfontein WTP, Rustfontein-Botshabelo/Thaba Nchu Pipeline, + 62 MI/d Maselspoort WTP, Knellpoort-Welbedacht Pipeline, + 45MI/d Welbedacht WTP	AADD: 62 PWD: 93	3,643		

No recommendation regarding the preferred option to take forward was made.

## 4.8 MMM, Mangaung Xhariep Water Augmentation Project, High Level Transfer Option Analyses, 2017

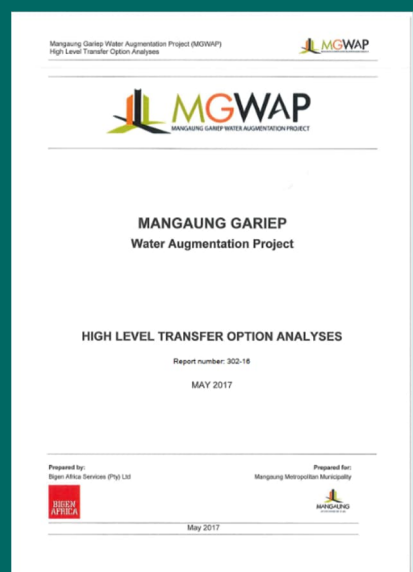
This desktop study was completed after DWS completed the Support Study and introduces additional sources for the augmentation of water supply to the GBWSS.



### 4.8.1 Document Information

Table 4-14 shows the document information of the 2017 Water Augmentation Project, High Level Transfer Option Analysis.

**Table 4-14 Document information of the 2017 High Level Transfer Option Analysis report**

	Institution		Mangaung Metropolitan Municipality			
	Document Name	Water Augmentation Project, High Level Transfer Option Analysis				
	Date	May 2017				
Prepared by	Bigen Africa					

### 4.8.2 Augmentation Options

The 16 options compared were sized for peak demand except for the options from the Lesotho Highlands Water Project (LHWP) and the option of upgrading existing infrastructure which were sized for average demands. Table 4-15 contains a summary of the options investigated.

**Table 4-15 Summary of options considered in the 2017 High Level Transfer Option Analysis**

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2017 Rand value)			URV (R/m <sup>3</sup> )
				Capital (R million)	Operating (R million/a)		
1	Muela Transfer Pipeline - Muela to Bloemfontein	<b>Option 1A:</b> a gravity transfer pipeline from Muela Dam to Bloemfontein. Abstraction pump station, 40.6km 3m tunnel, 129.3km 1200Ø pipeline, 82.2km 1300Ø, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	7,433	427	20.33	
2	Muela Transfer Pipeline - Muela to Bloemfontein	<b>Option 1A (alternative):</b> a pressured pipeline from Muela Dam to Bloemfontein. Abstraction pump station, 40.6km 3m tunnel, 211.5km 1100Ø pipeline, 2 pump stations, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	7,249	450	19.99	

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2017 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
3	Muela Transfer Pipeline - Muela to Bloemfontein	<b>Option 1B:</b> a pressured pipeline from Muela Dam to Bloemfontein. Abstraction pump station, 18.6km 1100Ø pipeline, 129.3km 1200Ø pipeline, 121.2km 1350Ø pipeline, pump station, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	4,791	386	14.52
4	Muela Transfer Pipeline - Muela to Bloemfontein	<b>Option 1B (alternative):</b> a pressured pipeline from Muela Dam to Bloemfontein. Abstraction pump station, 269.1km 1100Ø pipeline, three pump stations, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	4,477	415	13.95
5	Muela Transfer Pipeline - Muela to Bloemfontein	<b>Option 1C:</b> a gravity pipeline from Muela Dam to Bloemfontein. Abstraction pump station, 129.3km 1200Ø pipeline, 63.7km 1450Ø pipeline, 80.8km 1500Ø pipeline, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	5,088	393	15.1
6	Muela Transfer Pipeline - Muela to Bloemfontein	<b>Option 1C (alternative):</b> a pressure pipeline from Muela Dam to Bloemfontein. Abstraction pump station, 273.8km 1100Ø pipeline, three pump stations, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	4,541	425	14.14
7	Ash River Transfer Pipeline - Ash River Outfall to Bloemfontein	<b>Option 2A:</b> a pressured pipeline from Ash River Outfall to Bloemfontein. Abstraction pump station, 29.6km 3m tunnel, 105.3km 1100Ø pipeline, 129.3km 1200Ø pipeline, pump station, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	6,699	451	18.93
8	Ash River Transfer Pipeline - Ash River Outfall to Bloemfontein	<b>Option 2A (alternative):</b> a pressured pipeline from Ash River Outfall to Bloemfontein. Abstraction pump station, 290km 1100Ø pipeline, three pump stations, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	4,816	458	15.24

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2017 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
9	Ash River Transfer Pipeline - Ash River Outfall to Bloemfontein	<b>Option 2B:</b> a gravity pipeline from Ash River Outfall to Bloemfontein. Abstraction pump station, 31km 3m tunnel, 239.1km 1300Ø pipeline, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	7,168	438	19.78
10	Ash River Transfer Pipeline - Ash River Outfall to Bloemfontein	<b>Option 2B (alternative):</b> a pressured pipeline from Ash River Outfall to Bloemfontein. Abstraction pump station, 114.7km 1000Ø pipeline, 170.1km 1100Ø pipeline, three pump stations, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	4,669	478	14.76
11	LHWP Release - Caledon to Bloemfontein	<b>Option 3A:</b> a pressured pipeline from upstream of Welbedacht Dam to Modder River for treatment at Rustfontein WTP before being pumped to Bloemfontein. Weir in Caledon River, abstraction pump station, primary treatment, 39km 3m tunnel, 59.2km 1100Ø pipeline, two pump stations, WTP, storage reservoir at WTP	31	5,673	407	20.98
12	LHWP Release - Caledon to Bloemfontein	<b>Option 3B:</b> a pressured pipeline from upstream of Welbedacht Dam to Modder River for treatment at Rustfontein WTP before being pumped to Bloemfontein. Weir in Caledon River, abstraction pump station, primary treatment, 46.2km 3m tunnel, 12.4km 1100Ø pipeline, 59.5km 1100Ø pipeline, two pump stations, WTP, storage reservoir at WTP	31	6,491	441	22.14
13	Integration with Planned Future Infrastructure	<b>Knellpoort:</b> a pressured pipeline/channels/river from upstream of Welbedacht Dam to Modder River. Weir in Caledon River, abstraction pump station, sand traps, 61.4km 1100Ø pipeline, 20.3km 1300Ø pipeline, 0.5km 1350Ø pipeline, two pump stations, WTP, storage reservoir at WTP	31	2,544	356	15.67

Option Number	Option Name	Description	Yield (Million m <sup>3</sup> /a)	Costs (at 2017 Rand value)		
				Capital (R million)	Operating (R million/a)	URV (R/m <sup>3</sup> )
14	<b>Makhaleng Transfer Pipeline - Makhaleng River to Bloemfontein</b>	<b>Option 4A:</b> a pressured pipeline from new dam on Makhaleng River in Lesotho to Bloemfontein. Dam on Makhaleng River, 122.7km 1100Ø pipeline, 95km 1350Ø pipeline, pump station, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	5,461	442	14.9
15	<b>Makhaleng Transfer Pipeline - Makhaleng River to Bloemfontein</b>	<b>Option 4A (alternative):</b> a pressured pipeline from new dam on Makhaleng River in Lesotho to Bloemfontein. Dam on Makhaleng River, 217.7km 1100Ø pipeline, two pump stations, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	5,302	465	14.67
16	<b>Gariep Transfer Pipeline - Gariep to Bloemfontein</b>	<b>Gariep:</b> a pressured pipeline from Gariep to Bloemfontein. Abstraction pump station, 188.1km 1100Ø pipeline, three pump stations, WTP, storage reservoir at WTP and another along pipeline route to Bloemfontein	44	3,687	461	10.51

The study assumed raw water tariffs are 282 c/kl for water sourced from the Caledon River as well as the TCTA Lesotho Highlands Water Project (LHWP), 106 c/kl for water sourced from the Makhaleng River (Lesotho) and 21 c/kl from Gariep Dam. The raw water cost from Option 13 (Knellpoort) is stated as R 3.246 billion while Option 16 (Gariep) had a raw water cost of R 90 million. The raw water cost to Option 13 (Knellpoort) assumed water would be released from the LHWP (at 282 c/kl) and that only 35% of the released amount would reach Bloemfontein.

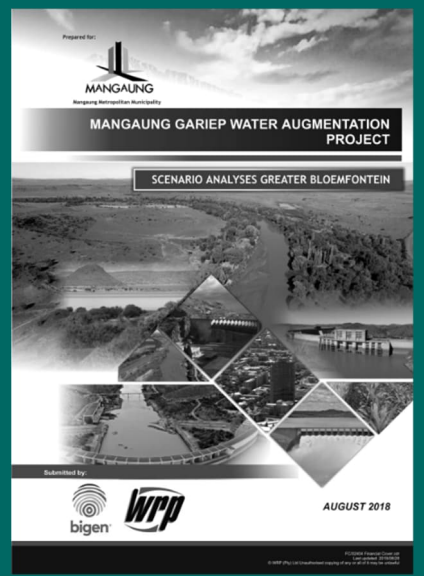
## 4.9 MMM, Mangaung Gariep Water Augmentation Project, Scenario Analyses for the Bloemfontein Water Supply System, 2018

This analysis, commissioned by MMM and completed by Bigen Africa, was a continuation on the Technical Feasibility study completed in 2015. As such, no new augmentation options were identified or analysed.

### 4.9.1 Document Information

Table 4-16 shows the document information of the 2018 Mangaung Gariep Water Augmentation Project, Scenario Analysis Greater Bloemfontein.

**Table 4-16 Document information of the 2018 Mangaung Gariep Water Augmentation Project, Scenario Analysis Greater Bloemfontein report**

	<b>Institution</b>	
Document Name	Mangaung Gariep Water Augmentation Project, Scenario Analysis Greater Bloemfontein	
Date	August 2018	
Prepared by	Bigen Africa	

## 5 Comparison of Identified Options

At this stage it is not possible to compare all the options identified since 2012. This is due to the differing assumptions in the high-level design and resultant cost comparison. Additional complexities are introduced when trying to compare capital cost, operational cost, and URV as these have not been worked out and included in all reports. It should also be noted that some reports are missing pages and others are only the draft versions of the report.

Some of the studies assume that the interventions proposed by the 2012 Reconciliation Strategy will be implemented before the Xhariep Pipeline and therefore exclude the cost for upgrading pipelines, pump stations, WTPs and power supply. Others assume that the status quo will remain until the Xhariep Pipeline project is implemented and therefore include the costs for upgrading existing infrastructure.

In addition to the technical differences, the studies listed do not all include the operational costs or otherwise leave out the electrical costs of the operational budget. A number of studies were also silent on the yields assumed for various interventions, making it impossible to determine NPVs or URVs.



## 6 Conclusion

This report contains a list of directly related and indirectly related studies. The bulk of the report contains a summary of the options/interventions identified in previous studies for the Greater Bloemfontein Water Supply System (GBWSS) commissioned by DWS, BW and MMM.

Due to the widely varying assumptions, and varying levels of detail, it is not possible to accurately compare the options. The studies, however, generally concluded that the transfer of water from Gariep Dam was consider the most feasible augmentation option once the interventions, as identified in the 2012 Reconciliation Strategy, have been implemented. As such, a comparison of options associated with the transfer of water from Gariep Dam will be undertaken as part of the pre-feasibility phase of this project.