Mangaung Metropolitan Municipality

10 YEAR WATER CONSERVATION AND DEMAND MANAGEMENT STRATEGY AND IMPLEMENTATION PROGRAMMES

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Revision 3	August 2018	G. Krüger	Bloemfontein	MMM	K. Mokhoabane	Expand Executive Summary to show NRW annual reduction targets. Elaborate on definition statements for the various scenarios. Revise NRW targets based on Client's request.
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Mangaung Metropolitan Municipality

REVISION AND EXPANSION OF 10 YEAR WATER CONSERVATION AND WATER DEMAND MANAGEMENT STRATEGY AND IMPLEMENTATION PROGRAMMES

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LIST OF ACRONYMS

ALC	Active Leakage Control
BAC	Billed Authorised Consumption
BMC	Billed Metered Consumption
BP	Business Process
CARL	Current Annual Real Losses
CMS	Catchment Management Strategy
d	Day
DMA	District Meter Area
DWS	Department of Water and Sanitation
FAVAD	Fixed and Verifiable Area Discharge
FY	Financial Year
GIS	Geographic Information System
H	Hour
kℓ	Kilolitre = 1 m^3
HR	Human Resources
ILI	Infrastructure Leakage Index
IWA	International Water Association
KPI	Key Performance Indicator
ℓ	Litres
LA	Local Authority
m	Metres

m^3	Cubic Metres
mm	Millimetres
MMM	Mangaung Metropolitan Municipality
MNF	Minimum Night Flows
NE	North-Eastern
NRW	Non-Revenue Water
NWCWDMS	National Water Conservation and Water Demand Management Strategy
PAPs	Public Awareness Programmes
PEP	Project Execution Plans
PRV	Pressure Reducing Valve
PRW	Potential Revenue Water
SABS	South Africa Bureau of Standards
SALGA	South African Local Government Association
SIV	System Input Volume
SLA	Service Level Agreement
UAC	Unbilled Authorised Consumption
UARL	Unavoidable Annual Real Losses
VAT	Value Added Tax
WCDM	Water Conservation and Demand Management
WSA	Water Services Authority
WSDP	Water Services Development Plan
WTP	Water Treatment Plant
WTW	Water Treatment Works
WWTP	Wastewater Treatment Plant

REFERENCES

1) **DWS** (2004) The Water Conservation and Water Demand Management Strategy for the Water Service Sector
2) **DWS** (2012) Final Reconciliation Strategy Study for the Larger Bulk Water Supply Systems: Greater Bloemfontein Area
3) **DWS** (2013) Metropolitan Municipality non-revenue water assessment
4) **DWS** (2014) National Water Resources Strategy 2
5) **JOAT** (2011) 5 Year Strategic Management Plan for Non-Revenue Water for Managaung Metropolitan Municipality
6) **JOAT** (2013) Critical assessment of non-revenue water reduction program and recommendations for program enhancement
7) **JOAT (2017)** The latest MMM water balance calculations and data received for the Financial Years 2012/13, 2013/14, 2015/16, and 2016/17.
8) **MMM** (2013/14) Mangaung Metropolitan Municipality Water Services Development Plan
9) **SALGA** (MAY 2008) Framework for Water Conservation and Demand Management, – A model by the Water Service Unit (WSU) of South Africa Local Government Association (SALGA) – Version 1.4
10) **WA Wegelin & HE Jacobs** (2012) The development of a Municipal Water Conservation and Demand Management Strategy and Business Plan as required by the Water Services Act, South Africa,

(Hydraulics and Water Services, Department of Civil Engineering, Stellenbosch University, Matieland 7602, South Africa).

11) **Bigen Africa Services (Pty) Ltd** (2017) Mangaung Gariep Water Augmentation Project Bankable Feasibility Study Report

12) Mangaung Gariep Water Augmentation Project Scenario Analysis Results (2017)

IMPORTANT DEFINITIONS

- **Real losses** can be defined as losses that comprise evaporative and leakage losses from conveyance systems and storage facilities, process losses at treatment plants and overflows from storage tanks.
- **Apparent losses** comprise unauthorised consumption and measurement and administrative inaccuracies.
- **Water conservation** refers to the minimisation of loss or waste, the preservation, care and protection of water resources and efficient and effective use of water. Doing less with less and is particularly applicable in drought scenarios and water restrictions.
- **Demand management** refers to the adaptation and implementation of a strategy by a water institution to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, and environmental protection, sustainability of water supply and services, and political acceptability.
- **Water efficiency** refers to doing the same (or more) with less i.e. fixing leaks; installing hydraulically efficient toilet pans, etc.
- **Water sufficiency** simply means enough is enough i.e. shut-off taps, dual flush toilets, careful gardening, etc.
- **Water substitution** refers to the replacement for water with something else such as air, waterless urinals, vacuum drainage, dry cleaning, etc.
- **Water re-use** refers to water used more than once such as wastewater, grey water re-uses onsite, shared bath water, groundwater abstraction on site.

Mangaung Metropolitan Municipality

10 YEAR WATER CONSERVATION AND WATER DEMAND MANAGEMENT STRATEGY AND IMPLEMENTATION PROGRAMMES

EXECUTIVE SUMMARY

Introduction

Bigen was appointed by Mangaung Metropolitan Municipality (MMM) to complete a 10 Year Water Conservation and Demand Management (WCDM) Strategy for Bloemfontein during 2014/15. Bigen Africa was recently re-appointed on 13 December 2016 to update the current strategy with progress relating to the previous WCDM Strategy recommendations. The report will thus address progress in terms of the WCDM Strategy published in 2014 (forthwith referred to as the Original Strategy) in comparison to the last three (3) years' actual figures. Water balance parameter forecasts were revised based on a revised water balance obtained for the Financial Year (FY) 2013/14.

The re-appointment furthermore includes the expansion of WCDM investigations and recommendations for the inclusion of the additional towns of Soutpan, Dewetsdorp, Wepener, and Van Stadensrus. This follows the Municipal Demarcation Board's decision to re-determine the municipal boundaries of MMM, Xhariep District Municipality (DC 16) and Naledi Local Municipality (FS 164). A status quo overview of the additional towns is analysed and addressed in a separate section of the report as the approach in developing a strategy for these towns will be different (ascribed to the fact that no previous strategies exist for these towns). The key first-order WCDM strategies identified for the additional towns will however be highlighted as part of the main report and the costing of proposed strategies included as part of the holistic WCDM cost estimate.

Background and Status Quo

MMM is one of the largest cities in South Africa. The water supplied to its communities during the FY 2013/14 amounted to about 237 Mℓ/day (86.6 million m^3/a). In comparison to this the water supplied to its communities for the FY 2016/17 amounted to about 189.3 Mℓ/day (69.1 million m^3/a) (JOAT, 2017) which includes supply to the former Naledi and Soutpan. This represents a twenty percent decrease in water supplied which could be ascribed to the recent water restrictions and/or a combination of the implementation of WCDM strategies. This is a significant amount of water that needs to be managed, and it is also a significant business with direct water purchases of about R602 million (Excl. VAT) for FY 2016/17 compared to R385 million (Excl. VAT) for FY 2013/14. Unfortunately like many other cities in the world, old towns, such as Bloemfontein, also suffer from large losses. About 40.3 million m^3/a was lost as Non-Revenue Water in FY 2013/14 compared to 24.3 million m^3/a in FY 2016/17. Non-revenue losses amounted to about 46.6% in FY 2013/14 compared to the current 35.2% in FY 2016/17.

To aggravate matters even further, a number of recent studies have shown that MMM System Input Volume (SIV) would have exceeded the capacity of the bulk water supply systems and the 1:50 year historical firm yield of water resources within the last two years. Water shortages and restrictions recently experienced will occur on a more frequent basis as a result of the fact that the deficit between the greater MMM's water demand and the yield of the current bulk water supply system will continue to increase if additional water supply augmentation options currently planned by MMM aren't implemented timeously. It should also be noted that the recent water restrictions may become a repeat occurrence if the water supply and distribution within Mangaung is not properly managed. The current water restrictions and shortages will be exacerbated by the planned introduction of about 20 000 additional stands in Bloemfontein as well as the planned eradication of VIP's in Botshabelo and Thaba Nchu. It is therefore essential that WCDM initiatives be accelerated as a matter of urgency and that additional long term sources currently being planned by MMM be implemented in parallel to the WCDM initiatives.

Purpose of 10 Year WCDM Strategy

The purpose of this document was to review the 5 year non-revenue Master Plan prepared by JOAT (JOAT, 2011) at the time, identify the areas of opportunities and develop a 10 year strategy for the implementation of WCDM initiatives across the entire WCDM spectrum.

It was found that significant progress has been made during the past number of years since the implementation of the 5 year strategy with regards to metering, system repair and replacement, setting up of a water balance and monthly reporting of the water balance. Some areas identified during the 5 year strategy did not progress adequately and will be emphasised during the 10 year strategy. Another purpose of the 10 year strategy was to expand the WCDM initiatives to include source related WCDM initiatives and identify strategies for the towns of Soutpan, Dewetsdorp, Wepener and Vanstadensrus.

Key Aspects of 10 Year WCDM Strategy

The 10 year strategy has been developed based on a number of integrated pillars:

- Technical and Financial Solutions
- Education, Human Capital Services
- Institutional and Systems Structures

For each of the strategic aspects clear objectives were developed. Strategic objectives were operationalised through the development of an integrated business plan with identified WCDM programmes as detailed in the main text.

WCDM Strategic Programmes, Performance Indicators and Targets

The strategic programmes that were identified during the development of the 10 year strategy focussed on reducing the specific water demand areas of the water balance; SIV reduction, real loss reduction, apparent loss reduction and unbilled authorised consumption (UAC). The WCDM programmes identified are summarised in Table B1 attached as Annexure B.

Key Performance Indicators (KPI's) and targets for each of the above aspects were developed. In addition to the programmes directly related to WCDM it is also recommended that the following projects be implemented to assist MMM in support of WCDM initiatives:

- General awareness and education campaign on water scarcity;
- Integrated MMM water control centre and formalised SCADA and telemetry management systems;

- Integrated Geographic Information System (GIS) based information management system.

The Key 10 year strategic WCDM targets and (KPI's) are listed in Table 1-1 below.

Table 1-1: Key Strategic Targets and KPI's

KPI Description	2013/14	Target (2027/28)
SIV Growth	2%	1%
Real Losses	41%	28%
Apparent Losses	4%	2%
Unbilled Authorised Consumption	2%	2%
Total NRW	47%	30%
ILI	9.5	4.96

Even though this is a ten (10) year strategy it should be noted that the various WCDM parameters targets span a period exceeding ten years as the KPI's for FY 2013/14 are recorded as the status quo WCDM basis and targets formulated for the next ten years from FY 2017/18 to FY 2027/28.

The reason for fixing FY 2013/14 as the base year can be ascribed to the fact that a considerable decline in MMM's SIV was noticed from FY 2013/14 to FY 2016/17. This can be ascribed to water restrictions imposed during FY 2015/16 and the effect thereof on water users' outlook on water consumption. In conjunction with this the current unaffordability of water also limits the consumer's usage, directly influencing the SIV. Should targets thus be formulated on the base year of FY 2016/17, this will result in unrealistic targets as the SIV of the base year (2016/17) represents the effect of the current water restrictions which will have a direct impact on all the other water balance parameters. For this reason it was decided that all WCDM projections will be based on the FY 2013/14 water balance (i.e. before water restrictions were imposed) as this will give a more realistic representation of the state of water management within the MMM and consequently deliver more realistic and achievable targets. ***WCDM Scenario Impact Modelling and Assumptions***

In order to assess the potential impact of the WCDM programmes an Excel based water balance model was developed to model the impact of six (6) different scenarios as broadly defined below:

1. Base Case Scenario: Projections modelled based on the assumption that **no WCDM interventions** are implemented and that all water balance parameters will continue to grow at the current rate.
2. Scenario 1: The assumptions for Scenario 1 are based purely on projections for annual **SIV reduction** and the influence merely SIV reduction has on the water balance as a whole;
3. Scenario 2: The assumptions for Scenario 2 are focused on projected outcomes if only **real loss reduction** strategies are implemented;
4. Scenario 3: The projections for Scenario 3 are focused on projected outcomes if only **apparent loss reduction** strategies are implemented;
5. Scenario 4: The projections for Scenario 4 are focused on projected outcomes if only the **increase of meter consumption** strategies are implemented;
6. Scenario 5 (The Recommended Scenario): Scenario 5 represents the impact of the implementation of a **combination of WCDM strategies**

including SIV reduction, real loss reduction, apparent loss reduction and an increase in metered consumption.

Detailed assumptions for the various scenarios are defined in Section 3.4.2 of the report and attached to the report as Annexure H. The detailed assumptions for Scenario 5 (the recommended scenario) for the various water balance elements are summarised as follows:

Table 1-2: Scenario 5 Summarised Growth/Reduction Assumptions

<table>
<tr><th rowspan="2">Scenario 5 Assumptions</th><th rowspan="2">Annual Continual Growth Assumptions</th><th colspan="4">Gradual Reduction Assumptions</th></tr>
<tr><th>2013/14-2014/15</th><th>2015/16-2018/19</th><th>2019/20-2021/22</th><th>2022/23-2027/28</th></tr>
<tr><td>Population related inputs</td><td></td><td colspan="4"></td></tr>
<tr><td>Population growth</td><td>2%</td><td colspan="4"></td></tr>
<tr><td>System inputs</td><td></td><td colspan="4"></td></tr>
<tr><td>Service connection growth</td><td>2%</td><td colspan="4"></td></tr>
<tr><td>Length of reticulation/trunk increase</td><td>2%</td><td colspan="4"></td></tr>
<tr><td>SIV annual increase (impact SIV)</td><td></td><td>4%</td><td>3%</td><td>2%</td><td>1%</td></tr>
<tr><td>Unbilled consumption inputs</td><td></td><td colspan="4"></td></tr>
<tr><td>Metered consumption increase (impact BMC)</td><td></td><td colspan="3">4%</td><td>3%</td></tr>
<tr><td>Free basic water/informal settlement increase</td><td>2%</td><td colspan="4"></td></tr>
<tr><td>Reduction in unbilled metered consumption</td><td>-1%</td><td colspan="4"></td></tr>
<tr><td>Reduction in unbilled unmetered consumption</td><td>-1%</td><td colspan="4"></td></tr>
<tr><td>Real losses inputs</td><td></td><td colspan="4"></td></tr>
<tr><td>Leakage on mains reduction</td><td>-5%</td><td colspan="4"></td></tr>
<tr><td>Leakage on reservoirs/overflows reduction</td><td>-1%</td><td colspan="4"></td></tr>
<tr><td>Leakage on consumer connections reduction</td><td></td><td colspan="2">-6%</td><td>-5%</td><td>-4%</td></tr>
<tr><td>Apparent losses inputs</td><td></td><td colspan="4"></td></tr>
<tr><td>Illegal consumption reduction</td><td>-2%</td><td colspan="4"></td></tr>
<tr><td>Meter under registration reduction</td><td>-3%</td><td colspan="4"></td></tr>
</table>

The above table illustrates growth/reduction targets which are assumed to increase/decrease by a constant percentage across the WCDM period and also illustrates parameters which are set to gradually decrease across the WCDM period. In addition to the above assumptions applied to Scenario 5, the following assumptions with regards to the SIV are also applied. Refer to Table 1-3 below.

Table 1-3: Scenario 5 Specific SIV Assumptions

	SIV Assumptions		**Mℓ/day**	**m^3/a**
1	Increase Maselspoort WTP from 120 Mℓ/day to 130 Mℓ/day in May 2019	2018/19	10	3 650 000
2	Increase Mockes Dam storage from 3,58 million m^3 to 12,13 million m^3 storage (May 2021). Indirect Re-use 45 Mℓ/day in place by June 2021	2020/21	45	24 975 000
3	Direct potable re-use of 32 Ml/day in place by June 2024 [Date to be finalized based on results from the analysis]	2023/24	32	11 680 000

The assumptions as illustrated in the above table makes provision for the planned increase of the Maselspoort WTP capacity, an increase in the Mockes Dam storage, Indirect Re-Use and Direct Potable Re-Use. The table indicates the desired implementation date and the planned capacity associated with the respective strategic projects. In addition to the above table a 10% reduction in SIV impact is associated with 2018/19 to account for the desired filter wash water recovery at Maselspoort (this SIV impact is only applicable to the volume of raw water abstracted for treatment at the Maselspoort WTP supplied to Bloemfontein).

Water Balance Projections

The latest water balance for 2016/17 was availed for the purposes of the revision of the strategy. However, this water balance represents the effect of current water restrictions imposed on MMM's water demand. As addressed previously, a decision was made to base all further projections on the revised 2013/14 water balance as using 2016/17 as baseline may deliver unrealistic projections and/or targets. The FY 2016/17 water balance is attached as Annexure D as this can be reviewed to determine the actual water balance parameters obtained compared to the FY 2013/14 water balance (attached as Annexure C).

The results of the various scenarios indicate that the base case represents an unsustainable water system with uncontrolled system input volume and unbilled consumption. Scenario 5 demonstrated that real losses can be reduced to 28% and the total NRW can be reduced to 30% within the next 10 years.

It should also be noted that in parallel to the revenue increasing as a result of increased meter recovery levels, the cost of supplying water is also shown to reduce due to the fact that more water is supplied from the local Maselspoort Water Treatment Plant (WTP). The caveat to the above statements is that the Municipality's system is very old and continuous maintenance will be required on old mains and metered connections to contain real losses. Should this not be done the real losses will spiral out of control impacting on the sustainability of MMM water service provision.

Although the current focus of the 10 year strategy is to reduce SIV, increase metered consumption and reduce losses, MMM will also have to address measures to reduce unit consumption through water tariff structuring. Scope therefore exists to improve water use efficiency by consumers and this can be achieved through consumer education, local water re-use and punitive measures such as elevated block tariff rates for high-end residential consumers.

The Original Strategy (Bigen Africa Services (Pty) Ltd, 2014) indicated that the WCDM scenario model predicted that the bulk treatment and supply capacity (and the historical firm yield of the water supply system) will be exceeded. It also warned against more drastic measures such as water restrictions having to be imposed to reduce per capita consumption on especially irrigation of gardens should appropriate action not be taken on time. Water restrictions have indeed been imposed on MMM's water consumers since 2015/16 and the effect thereof is evident in a radical decrease in SIV compared to the Original Strategy's forecast. Refer to Figure 1-1 and Figure 1-2 below for a representation of the Original Strategy's forecast compared to actual values obtained for FY 2013/14; FY 2014/15; FY 2015/16 and FY 2016/17.

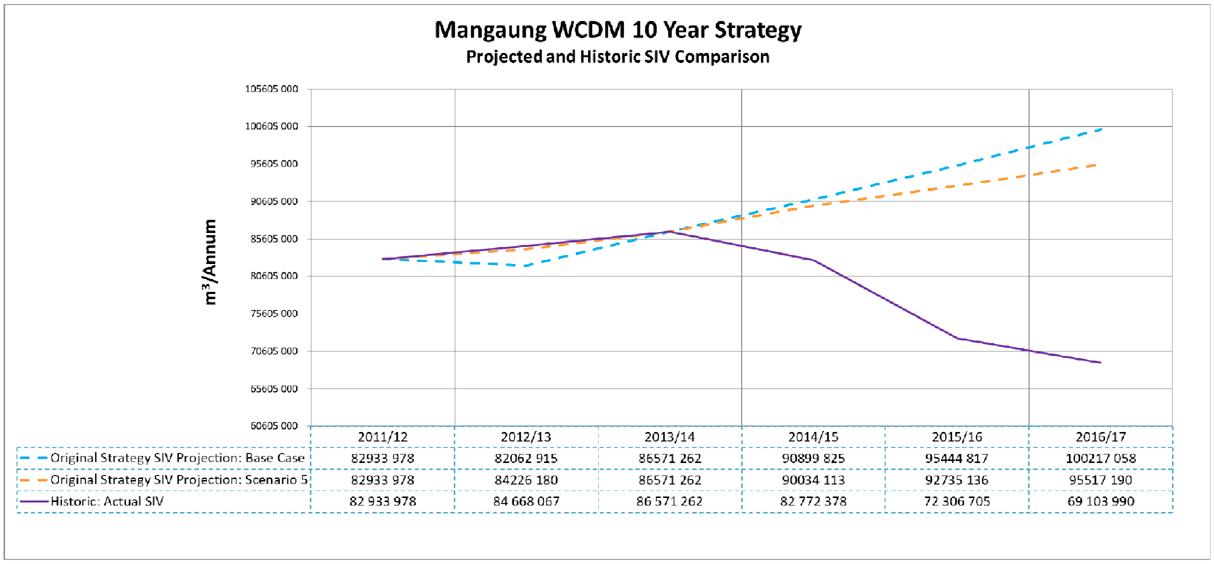


Figure 1-1: Projected SIV compared to Historic SIV for FY 2013/14, FY 2014/15, FY 2015/16 and FY 2016/17.

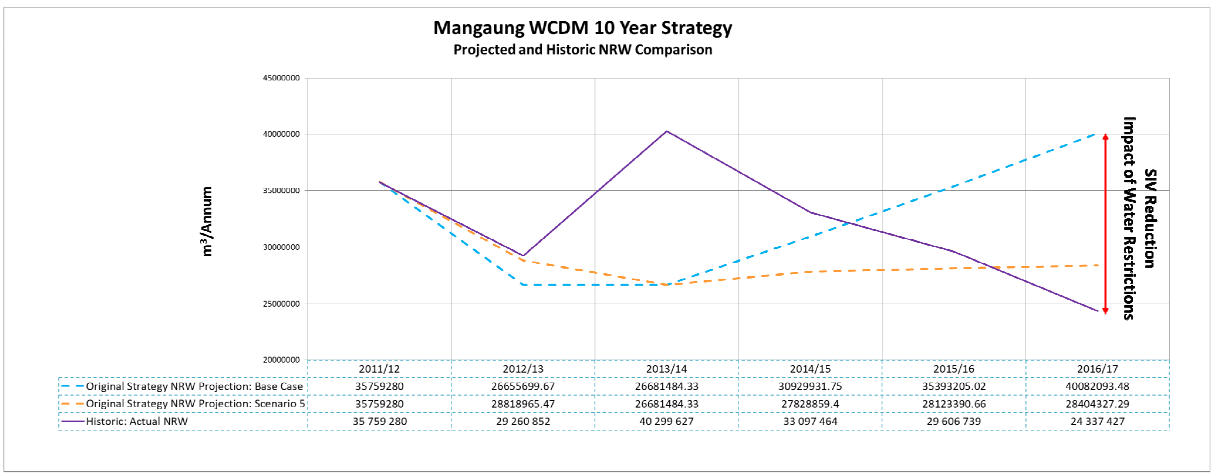


Figure 1-2: Projected NRW compared to Historic NRW for FY 2013/14, FY 2014/15, FY 2015/16 and FY 2016/17.

The total NRW volume for the FY 2013/14 and 2016/17 was 40.3 million m³/a and 24.3 million m³/a respectively. The NRW by volume thus decreased from 46.6% in the FY 2013/14 to 35.2% in the FY 2016/17. It should be noted that the NRW for FY 2013/14 was revised based on revised billing and SIV figures as obtained from MMM. The official Counsel-approved FY 2013/14 water balance was never updated and revised accordingly and this water balance still reflects a NRW by volume of 31.4%. Based on instruction from the Client this water balance was thus revised to incorporate the revised billing figures affecting the NRW considerably. The revised water balance incorporating the revised billing data was forthwith applied to all the projections.

Applying the Scenario 5 model the target is for the NRW by volume to decrease from 46.6% in the FY 2013/14 to 30% in the FY 2027/28. The actual volume of NRW is thus targeted to decrease from 40.3 million m³/a for the FY 2013/14 to 32.5 million m³/a in the FY 2027/28.

WCDM Investment Requirements

The WCDM interventions recommended in this report will require a constant and significant investment over the ten year period of which the largest portion will be to upgrade Maselspoort WTP, pipelines, water networks, valves and meter infrastructure. A large portion of the cost is earmarked for the upgrading of the Maselspoort WTP (including implementation of water re-use from the North-Eastern (NE) Waste Water Treatment Plant (WWTP)) in an effort to reduce the SIV. It is also recommended that the current Bloem Water-MMM Service Level Agreement (SLA) be revised to enable a smaller SIV portion purchased from Bloem Water (the current SLA limits the supply from the Maselspoort WTP to 33% of Bloemfontein's water demand). The balance of the budget is earmarked for real loss reduction (pipe condition assessments, pipeline replacement, fitting and valves replacement, leak detection and -repairs), apparent loss reduction (meter replacement), unmetered authorised consumption (new meter installation) and consumer education and awareness programmes. The total investment required for the revised ten year period (FY 2017/18 to FY 2027/28) including the upgrades required at Maselspoort WTW and water reuse infrastructure is R4 417 000 000 as indicated in the table below. The total cost excluding the upgrades at the Maselspoort WTP and water reuse infrastructure is estimated to be R 3 131 000 000.

Table 1-4: WCDM Investment Requirements per Financial Year.

Cost of WCDM interventions	WCDM Investment Requirements (R x million)										
	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	TOTAL
SIV input reduction cost	**13**	**275**	**388**	**620**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1 296**
Real loss reduction cost	**253**	**254**	**245**	**245**	**246**	**247**	**248**	**249**	**249**	**250**	**251**	**2 736**
Mains & reticulation replacement	*232*	*232*	*223*	*224*	*225*	*226*	*226*	*227*	*228*	*229*	*230*	**2 501**
Valves replacement	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	**228**
Reservoir losses	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	**8**
Apparent loss reduction cost	**17**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**178**
Unbilled consumption reduction cost	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**207**
Total WCDM cost	**302**	**563**	**667**	**900**	**281**	**282**	**283**	**283**	**284**	**285**	**286**	**4 417**

The above summary includes the cost of strategic interventions identified for Bloemfontein, Botshabelo and Thaba Nchu and also includes the cost of WCDM initiatives identified for Dewetdorp, Wepener, Van Stadensrus and Soutpan.

Despite the financial resources required for capital upgrade projects, a significant investment is also required for the appointment of internal resources, services providers and information management systems. The investment required is significant, but the benefits that can be derived from the investments are also significant. The scope includes primarily the cost of SIV as well as the reduced downstream real and apparent losses. A business case exists where funding could be arranged for the planned investments in WCDM in the form of bridging and long-term funding.

The total impact of the implementation of re-use together with the implementation of Scenario 5 results in a total potential saving of **R 4 268 million** for the next ten years (R426 million per annum). This potential saving in SIV reduction alone thus nearly constitutes the total WCDM investment requirements of R 4 417 million over the next ten years. This potential saving excludes the effect of inflation on water purchase rates and also excludes the effect of the potential revenue increase as a result of the proposed increased Billed Metered Consumption as defined in Scenario 5. The total potential saving will thus far outweigh the total investment requirements within the next ten (10) years.

1. INTRODUCTION AND BACKGROUND

It is important to understand the context in which the 10 year Water Conservation Demand Management (WCDM) strategy was prepared and for this purpose a comprehensive background is provided. Section 1.1 of the introduction provides a historic background of the 5 year WCDM strategy that was implemented at the time of the Original Strategy. Section 1.2 of the introduction provides the structure of the proposed 10 year WCDM strategy. It should be noted that WCDM strategies are not once-off events as WCDM will continue for as long as the water systems of MMM are in operation. The current 5 year and new 10 year strategies will, however, form the basis of addressing backlogs, establishing benchmarks and systems and providing structures within which future WCDM initiatives can build upon.

1.1. Current 5 Year WCDM strategy

Mangaung Metropolitan Municipality (MMM) in 2011 recognized the need to focus on the reduction of Non-Revenue Water (NRW) as part of its overall WCDM strategy. It was realised at that stage the initiative will contribute towards the objectives of the National Water Conservation and Water Demand Management programme currently implemented throughout the country in support of the country's scarce water resources. This initiative led to the development of the 5 year Non-Revenue Water Master Plan prepared by JOAT (JOAT, 2011).

The objective of the preparation of the 5 Year Non-Revenue Water Master Plan was to provide both a strategic and operational framework to the Water Services Directorate of MMM to implement its NRW reduction interventions over a 5 year period and beyond. The framework for the preparation and implementation of a NRW master plan for MMM included the following:

- Assess existing areas of supply from bulk conveyance per supply system;
- Review and document of previous NRW reduction activities;
- Recommend infrastructure improvements to be carried out;
- Prepare an International Water Association (IWA) benchmark water balance per supply system/area;
- Prepare a 5-year NRW implementation programme/roll-out plan;
- Development of Key Performance Indicators (KPI's) and Measurement Baselines;
- Assessment of the current in-house capacity of the Engineering Services Department; and
- Review and assessment of funding strategies.

The 5 year strategy time frame has lapsed and MMM decided at the time to commence with the preparation of a 10 year WCDM strategy in order not to lose continuity and momentum gained during the implementation of the 5 year strategy.

1.2. New 10 Year WCDM strategy

The 5 year WCDM strategy spanned the period 2011 to 2015 and therefore expired in June 2015. MMM appointed Bigen to develop a 10 year WCDM strategy. It should be noted that the 10 year WCDM strategy does not aim to 'reinvent the wheel', but rather to build onto the successes and

address the shortcomings of the current WCDM initiatives. Many of the concepts developed in the JOAT 2011 report were therefore retained in the 10 year WCDM strategy.
The development of the 10 year strategy is the subject of this report and will be structured as follows:

- **Part 1:** Describe the Legal-, Institutional-, Technical-, Financial- and Social Framework of WCDM;
- **Part 2:** Conduct a *status quo* assessment of the MMM water balance to identify additional WCDM opportunities;
- **Part 3:** Describe the 10 year WCDM strategy development and strategic elements pertaining to:
    - Solutions:
        - Technical;
        - Financial;
        - Social Requirements; and
        - Operation and Business Development.
    - Services:
        - Consumer awareness & Education.
    - Structures:
        - Legal;
        - Institutional;
        - Information management; and
        - Asset management.
- **Part 4:** Summarise with conclusions and recommendations.

It should be noted that the 10 year WCDM strategy was initially planned as a strategy document, but was later expanded to guide the implementation of the strategy by developing WCDM programmes. The strategic objectives will provide strategic direction whereas the programmes support the strategic objectives and provide operational assistance to achieve WCDM targets. The 10 WCDM strategy report provides a list of WCDM strategic objectives, key performance indicators, targets, programmes, budgets and resource requirements.

It should also be noted that the 5 year Master Plan focussed mainly on NRW and not WCDM in its broader context. Apart from covering a much longer period, the 10 year WCDM strategy aims to address WCDM in a much broader context and include interventions required to reduce the System Input Volume (SIV) in an effort to reduce MMM water input cost and resource conservation. Of particular importance is also the concept of **water re-use** that was introduced in the 10 year WCDM strategy in an effort to improve the water conservation aspect of WCDM. This is in support of the NWRS II (DWS, 2013) as well as Annexure D of the same report that describes the concept of water re-use.

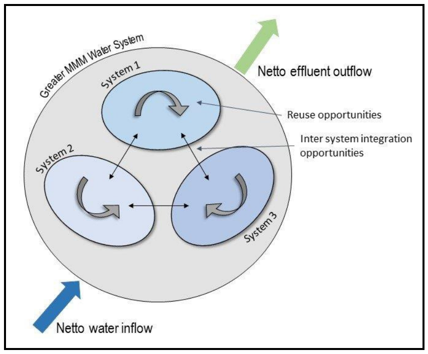


Figure 1-1: MMM Water System Optimisation (Bigen Africa Services (Pty) Ltd, 2017).

2. PART 1 - LEGISLATIVE, INSTITUTIONAL, TECHNICAL, FINANCIAL AND SOCIAL FRAMEWORK

This part of the strategy will consider the legislative-, institutional-, technical-, financial- and social requirements of the WCDM framework. These aspects need to be understood in order to ensure compliance with the legal requirements and ensure a sustainable water system from a technical, institutional, financial and social perspective.

2.1. Legal requirements of WCDM strategy

Any WCDM strategy and implementation programme must take cognizance of both local and national imperatives, regulations and guidelines, such as the Municipal Systems Act (2000) and the Municipal Finance Management Act (2003). This constitutes the overall framework within which the WCDM programme should take place.

The Department of Water and Sanitation (DWS) has developed a multi-sectoral WCDM strategy. One of the sectors that the strategy focusses on is Local Authorities (Domestic Use). South Africa has about 284 Local Authorities (LA's) which were created through the Municipal Demarcation Act (No. 27 of 1998) (DWS, 2007). This includes six (6) metropolitan municipalities, fourty seven (47) District Municipalities and two hundred and thirty one (231) Local Municipalities. All these Municipalities have to formulate WCDM strategies that could assist them in addressing water losses/wastages and also ensure efficient management of their water services infrastructure. The need for WCDM is also based on the economic efficiency objectives due to the significant cost in the provision of water services.

Water Conservation and Water Demand Management are intertwined and complimentary. A potential difference between the principles of Water Conservation and Water Demand Management is that Water Conservation focuses on the efficiency of a combination of resources such as water resources and financial resources. The efficient application of resources through the use of concepts such as

water re-use will lead to reduced water use, extended water system life expectancy and reduced operating costs. In some literature the following distinctions[1] are made regarding the terms 'WCDM':

- Water conservation - 'doing less with less' and is particularly applicable in drought scenarios and water restrictions. This is for instance to take shorter showers or do not irrigate the lawn
- Water efficiency - 'doing the same (or more) with less'. This is for example to fix leaks or use water efficient toilet pan and cistern design
- Water sufficiency - 'enough is enough'. This is for example to use automatic shut-off of taps, dual flush toilets or careful garden watering
- Water substitution - 'replace water with something else by for example air in waterless urinals, vacuum drainage or dry cleaning
- Water reuse – 'doing more with the same'. This for example to use greywater on-site, shared bath water or groundwater abstraction on-site

It is evident that Water Demand Management is no longer considered a possible option, but a necessity that must be implemented within the Mangaung Metropolitan Municipality as a matter of priority in order to meet legal requirements as well as ensure sustainable water service provision. Although not a legislative requirement, the strategic management plan was prepared within a prevailing legislative framework which addresses the provision of water services as well as accountability in terms of managing water resources.

The Water Services Act (No. 108 of 1997) (RSA, 1997) stipulates that all spheres of government must provide water supply services in an efficient, equitable and sustainable manner. This Act also requires municipalities that have been given Water Service Authority (WSA) status to promote water conservation and demand management which should be included in the Water Conservation and Water Demand Management Strategy, Business Plan and Water Services Development Plan (WSDP).

The Water Services sector is expected to play a greater role in water conservation and water demand management in the future. This will be necessary due to the expected growth in water demand in this sector. Water demand is likely to increase comparatively steeply because of a combination of population growth, the increased proportion of the population that will have access to water services (as the current backlog is addressed), the expected improvement in the standard of living that will result in greater per capita water consumption as well as the urbanisation phenomena. The Strategic Framework for Water Services (DWS, 2003) recognises the role of WCDM in ensuring sustainable service delivery.

2.1.1. The National Water Conservation and Water Demand Management Strategy

In order to supplement the legal requirements indicated above, DWS also developed strategic guidelines to assist Water Services Authorities. The strategic outputs of the Water Services are each

[1] Whereas the previous 5 year strategy was purely focussed on 'water efficiency', in terms of the above definitions, the 10 year WCDM strategy expanded its focus on 'water efficiency' and 'water re-use'. Future refinements will also have to consider 'water conservation' aspects especially in the case where the SIV is predicted to exceed the water supply system capacity soon. Refer to later discussion in text on this subject.

linked to at least one of the objectives of the National Water Conservation and Water Demand Management Strategy (NWCWDMS), (DWS, 2004) in order to demonstrate their contribution to the overall WCDM strategy. The generic objectives of the NWCWDMS are shown in Table 2-1

Table 2-1: National Water Conservation and Water Demand Management Strategy Framework Objectives (DWS, 2004).

Objectives	Description of Objective
Objective 1	To facilitate and ensure the role of WCDM in achieving sustainable, efficient and affordable management of water resources and water services
Objective 2	To contribute to the protection of the environment, ecology and water resources
Objective 3	To create a culture of WCDM within all water management and water services institutions
Objective 4	To create a culture of WCDM for all consumers and users
Objective 5	To support water management and water services institutions to implement WCDM
Objective 6	To promote the allocation of adequate capacity and resources by water institutions for WCDM
Objective 7	To enable water management and water services institutions to adopt integrated planning
Objective 8	To promote international co-operation and participate with other Southern African countries, particularly basin-sharing countries, in developing joint WCDM strategies

Not all of the strategies in Table 2-1 are implementable by a Water Services Authority (WSA). The outputs of the WCDM strategies applicable to Water Services Authorities are listed in Table 2-2.

Table 2-2: Strategic Outputs for Water Services Authorities and links to National Water Conservation and Water Demand Management Strategy Framework Objectives (DWS, 2004)

1	**Implement efficient distribution management measures**
1.1	Establish and maintain the integrity of water zones and districts for the entire water supply system
1.2	Monitor the level of UAW continuously for each district and zone
1.3	Reduce and maintain the level of UAW to acceptable standards and benchmarks using best management practises
1.4	Implement a consumer meter management programme
1.5	Implement a pressure management programme
1.6	Implement a pipeline maintenance and replacement programme
1.7	Implement efficient effluent management systems
1.8	Install measuring devices to all existing consumer connections
2	**Ensure adequate information to support decision-making**
2.1	Determine and monitor various future demand scenarios based on water demand trends and WCDM measure
2.2	Produce a monthly water audit and a water balance WSP that can be validated
2.3	Develop an information system to assist with customer care functions and queries
2.4	Develop measurable key performance indicators of various functions and monitor the actual performance against these at appropriate intervals
2.5	Produce monthly deviation reports of water consumption
2.6	Establish and maintain an effective consumer database
3	**Promote the efficient use of water to consumers and customers**
3.1	Develop an appropriate and ongoing marketing communication and education programme
3.2	Implement water tariffs that promote social equity and promote efficient use of water
3.3	Ensure the payment of water services by all consumers
3.4	Identify, prioritise and implement WCDM measures (to be viable through the IP process)
3.5	Reduce unauthorised connections
3.6	Assess the departmental water usage by WSA and establish, achieve and maintain appropriate demand targets
3.7	Prohibit and enforce the wasteful use of water by consumers and users
4	**Adopt integrated planning principles**
4.1	Integrate the planning of bulk water supply infrastructure with the planning of bulk water effluent infrastructure
4.2	Co-ordinate planning and WCDM measures with other water institutions in the water supply chain and in accordance

	with any regional WCDM and catchment management strategies or requirements
4.3	Identify all possible WCDM measures and evaluate their feasibility
4.4	Determine and regularly review the best combination supply-side management and demand-side management options as part of the master plan planning study (to delay capital outlay for infrastructure development)
4.5	Ensure the adequate allocation of funding and resources to WCDM measures
4.6	Determine and review annually 2, 5 and 10-year demand target goals
4.7	Implement measures to monitor the impact of WCDM
5	**Ensure the implementation of WCDM best practices in new developments**
5.1	Ensure the development and implementation of appropriate standards for new developments, which promote efficiency
5.2	Ensure that all new connections have a measuring device
5.3	Where feasible, ensure the removal of invasive alien plants before development takes place
5.4	Implement incentive schemes for developers to adopt WCDM measures and standards
5.5	Ensure that every water services work or consumer installation complies with South Africa Bureau of Standards (SABS) 0252: Water Supply and drainage for buildings and SABS 0254: The installation of fixed electric storage water heating systems
5.6	Ensure that all plumbing fittings comply with SABS WSA standards or the JASWIC list of accepted fittings
6	**Contribute to the Catchment Management Strategy (CMS)**
6.1	Ensure the quality of treated effluent meets required standards
6.2	Minimise leaks of the effluent collection system
6.3	Maximise recycling and reuse of water where it is feasible
6.4	Promote the reduction of pollution by consumers DWS, CMA, WSA
7	**Ensure adequate institutional and financial capacity for WCDM**
7.1	Review and if needed modify the organisation structure and work ethic
7.2	Develop and implement a training programme for all key personnel
7.3	Key personnel to attend relevant conferences and forums
7.4	Identify and investigate both internal and external sources to fund WCDM projects
7.5	Empower by informing, educating and capacitating officials, councillors and other relevant role-players about WC/WDM and IP

2.1.2. International WCDM Framework and Best Practice

With the increasing international trend towards sustainability, economic efficiency and protection of the environment, the problem of losses from water supply systems is of major interest worldwide. Both the technical and financial aspects are receiving increasing attention, especially during water shortages or periods of rapid development. However, particular problems and unnecessary misunderstandings arise because of differences in the definitions used by individual countries for describing and calculating losses. Also, traditional performance indicators also give conflicting impressions of true performance in controlling water losses (for example, the use of percentages).

The best practice in management of water losses consists of a combination of continuous water balance calculations together with night flow measurements on a continuous or “as required” basis. The methodology to be used with the implementation of the program is summarised as follows;

- Understanding the function of the scheme from **source to end-user** with the scheme information available;
- Managing scheme operations to achieve as closely as possible a solution where all consumers can receive **water all day-round** and reservoirs do not have to close down at night;

- Identify water **demand zones** for each scheme and metering and logging points (temporary and permanent) and initiate implementation of the measurement devices as well as measures required to make zones discrete;
- The accurate recording and regular review of flow profiles and **water supply volumes** into each discrete zone, i.e. the metering infrastructure and data logging systems, including the compilation of system water balances;
- The accurate recording and regular review of consumer demand and the sustained implementation of specific tasks (e.g. leak detection surveys, step testing, pressure management reviews, prompt burst repairs, etc.) and **sustained overall maintenance** of all system components;
- The roll out of a **meter testing and meter replacement** programme;
- Consumer **metering and billing**;
- Identify **unmetered consumers** and systematically install meters at all consumer connections
- Accurate and consistent billing of consumers as per the **tariff policy**; and
- Deal with **non-payment** in accordance with the **by-laws** and debt collection policy.

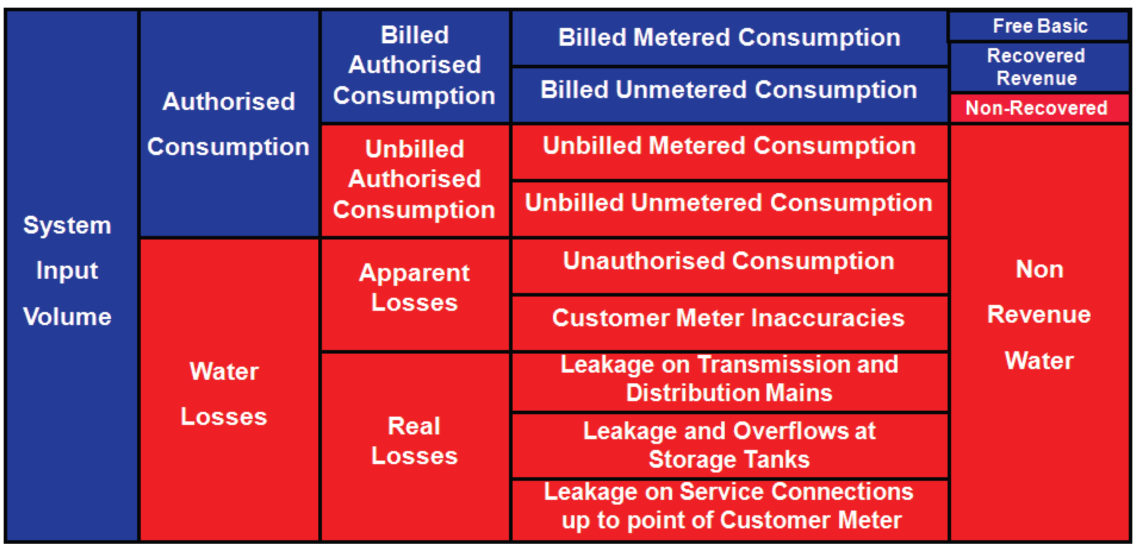


Figure 2-1: IWA water balance model adapted for RSA conditions (McKenzie, Wegelin, 2009)

The International Water Association (IWA) developed a standard format for a water balance. This was adapted for South African conditions as shown in Figure 2-1. The water balance, is usually taken over a 12-month period, and should include:

- A thorough accounting of all water into and out of a distribution system, including inspection of system records;
- An ongoing meter testing and calibration programme; and;
- Due allowance to time lags between bulk meter readings and consumer meter readings.

The water balance calculation quantifies volumes of total water into the supply system, authorised consumption (billed and unbilled, metered and unmetered) and water losses (apparent and real). Where continuous leak detection is not being practiced, the process may also include a cost to benefit analysis for recovering excess leakage, leading to a leak detection programme.

Best practice, as recommended by the IWA Performance Indicators Group is to assign confidence grades to each component of the water balance, incorporating both reliability and accuracy grades. An improved understanding of Real Losses can be obtained by classifying components as follows:

- Background losses from very small undetectable leaks – typically low flow rates, long duration, large volumes;
- Losses from leaks and bursts reported to the water supplier – typically high flow rates, short duration, moderate volumes;
- Losses from unreported bursts, found by Active Leakage Control (ALC) – medium flow rates, but duration and volume depends on ALC policy; and;
- Overflows at, and leakage from, service reservoirs.

Methods of assessing Real Losses, other than from the Water Balance include analysing night flows on meter districts, recording numbers and types of leaks and bursts and their average flow rates and durations, modelling calculations for background leakage and pressure.

2.2. Institutional Requirements

The national framework needs to be implemented at a local municipal level. Currently only one MMM directorate is involved in WCDM activities. The Engineering Services Directorate, Water & Sanitation sub-directorate within the Mangaung Metropolitan Municipality is currently responsible for any WCDM or NRW activity. The Section is headed by a General Manager - Water and Sanitation and, in the WCDM Division, by a Manager whose portfolio includes WCDM. These resources are jointly responsible for the monitoring and evaluation of all NRW reduction activities implemented within the MMM. The full support of senior management is essential to deliver a successful program.

The Finance Directorate is responsible for the billing and cost recovery. Finance is also responsible for tariff setting and capital budgeting and funding of WCDM initiatives. The close cooperation between the Finance and Engineering Services directorate is essential. Refer to Annexure E for the proposed organisation structure for WCDM implementation in MMM submitted for Council approval.

It is not clear from the organogram to what extent **contractors** and external **service providers** are required to assist with the executions of WCDM related tasks. This should be shown as contracted services in the future in order to understand the complete WCDM resource pool. Another aspect that is not evident from the organogram is the location of the planned operational **control centre**. It is recommended that this function also be indicated in the organogram as this will form an essential part of the integration of the WCDM related activities and the reporting of performance indicators. MMM intends to have their own GIS office specifically for WCDM. It would appear that this proposed GIS based **information** services is located in a separate functional leg that provides support to the entire Metro.

A key aspect that links to the institutional framework of the MMM to the day-to day operation of the water supply system includes the **business processes**. These business processes supports the institutional structure and are informed by policies, procedures and rules applicable to the water business of MMM. The business processes (BPs) forms an essential step in establishing information collection, sharing and reporting of key WCDM information. It is absolutely essential that these business processes be mapped in order to streamline the water service delivery model.

MMM needs to build institutional capacity that would ensure successful implementation of aspects of WCDM. That buy-in is essential for such staff having the **authority** to make necessary changes to the department, section and individual job responsibilities, then set about ensuring that all the tasks that were not performed in the past that are now recognized to be necessary, are actually carried out.

WCDM must be promoted as a vital component of water service delivery and must be integrated into the organization in its various parts. To this effect a **structured training** and internal information programme is required for WCDM personnel is required to keep them up to date with the latest technology and sharing experience with other Water Services Authorities.

2.3. Technical Requirements

The key technical requirements span a wide range and include various types of information that is required to setup the water balance and ensure accurate billing. It is essential that this information is captured on a central GIS/Metering data base in order to ensure data integrity and security;

- Infrastructure information and system condition
- Information systems used to capture, store and report on WCDM aspects
- Understanding of the Water / Waste water infrastructure systems with respect to:
  - Raw water sources and infrastructure
  - Potable water treatment plants
  - Bulk water purchases / imports
  - Treated water storage facilities
  - Treated water transmission mains
  - Bulk water system metering
  - Water and sewerage networks
  - Pumping networks
  - Meter districts and zoning
  - Consumer metering and billing
  - Water mass balance and performance indicators

The ultimate aim of the water balance and performance indicators is to determine the areas where interventions are required in order to reduce NRW and to ensure sustainable water services.

2.4. Financial Requirements

The cost recovered from the provision of water services can be utilized to improve the status of the existing infrastructure in terms of operation and maintenance and/or even replacing the old/non-functional infrastructure. Water use charges can be used as a means of encouraging reduction in water wastages (losses) and/or inefficient water use. Both real and apparent water losses, as well as conveyance of ground water and surface water inflows to sewer systems represent a financial loss to the municipality. The recovery of these losses within a WCDM programme can provide a significant contribution to its funding.

It is important that the **tariff** determination be developed in conjunction with the WCDM Manager with due consideration of the future capital and operational expenses required. The financial aspects will include WCDM capital budget and cash flow forecasts and sources of funding for WCDM initiatives. These funding sources could be in the form of external funding (loans or grants) or internal capital reserves.

Significant opportunities not only in terms of structure water tariffs, and losses on the main and consumers connections and fittings, but also in this particular case on the cost associated with the SIV. This will be expanded upon later in the text.

2.5. Social Requirements

Municipalities need to develop appropriate WCDM **awareness and education** material. MMM should also needs to implement various educational and awareness programmes to promote water use efficiency and also encourage water saving practices. This practice requires an understanding of consumer profiles and behaviour/practices. In many cases water efficiency is involuntary or punitive if the SIV cannot be met by water system capacity.

3. PART 2 - REVIEW OF CURRENT WCDM WATER ACTIVITIES

Mangaung Metropolitan Municipality has since the development of the 5 year WCDM strategy implemented a number of Water Loss Reduction initiatives. In this section the lessons learned from the WCDM implementation will be highlighted as input to the 10 year strategy.

3.1. Review of the Methodology

The development of a long term 10 year WCDM strategy is influenced to some extent by the successes and failures of the past 5 year strategy. The section will identify key challenges and areas of opportunity as follows:

- Key focus areas and critical success factors of the 5 year WCDM strategy
- Detailed water balance assessment and key challenges from current water balance
- Recommended areas of opportunity for 10 year strategy

3.2. Current 5 Year WCDM Focus Areas and Success Factors

In broad terms the 5 year WCDM strategy focussed on the reduction of non-revenue water (NRW) and in particular real losses. The critical success factors developed in order to meet the proposed WCDM targets included the following:

- Recognition of Water Conservation/Water Demand Management and **NRW** reduction as a **major focus area** of the Water Service Provider and Water Service Authority by **all Client Directorates**, including and especially the Finance Directorate.
- Recognition of the need to have **sufficient** motivated **internal resources** available to be focused on ensuring the implementation, sustaining, monitoring and evaluation of WCDM interventions.
- **Embracing the principles** and objectives of Water Conservation/Water Demand Management.
- Securing the requested **funding** of approximately R47 million (excluding VAT) over the five financial years of the 5 year strategy. (Capital Cost and Maintenance, not including mains replacement)
- **Implementing accepted best practice** in all aspects of WCDM, including **data/information** management.
- Not falling into the trap of treating the WCDM interventions proposed in this Master plan as a once-off capital investment – any intervention has to be sustained and the **ongoing operations and maintenance** must be budgeted for and carried out.
- Focussing on **high impact interventions** irrespective of any external (political) influence that could be brought to bear on the proposed roll-out strategy.

Based on a study conducted by DWS it can be seen in Figure 3-1 that the MMM NRW water has improved over time and that the 5-year NRW strategy most definitely had a significant impact on the water use efficiency in MMM. Figure 3-2 also indicates a gradual decline in UARL, apparent and total water losses.

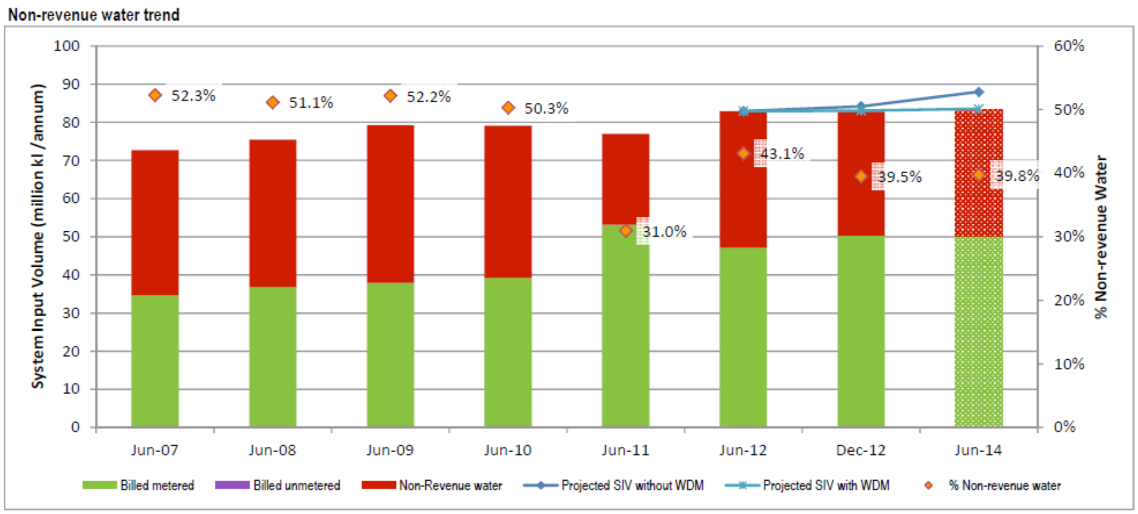


Figure 3-1: Historic trend of MMM SIV and percentage NRW (DWS, 2013).

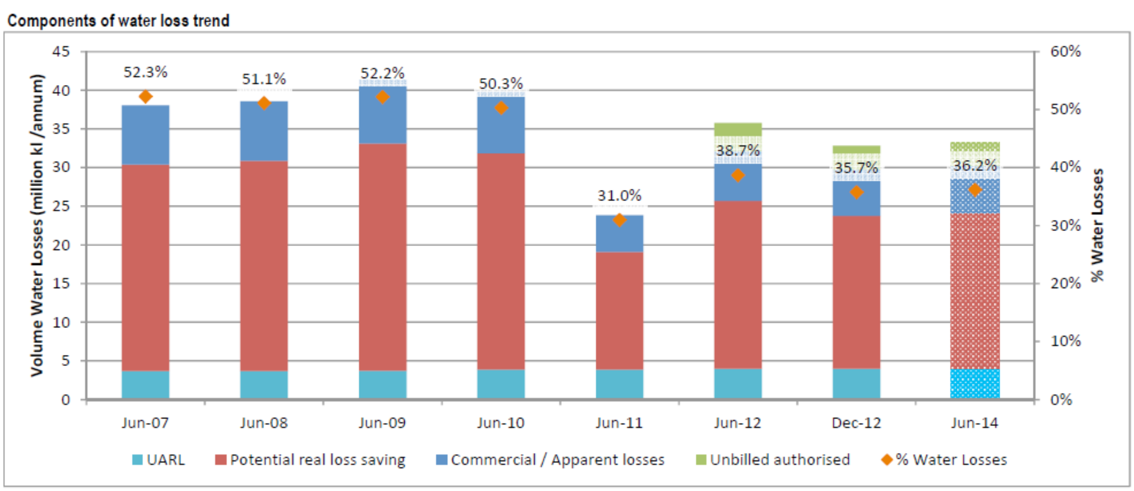


Figure 3-2: Historic trend of MMM UARL, Apparent and Total Water Losses (DWS, 2013).

3.2.1. Key Challenges experienced during execution of 5 year WCDM strategy

The most prominent challenges identified both during the preparation of the 5-year WCDM strategy as well as the implementation of the WCDM interventions are summarized as follows:

- **Inaccurate Billing Database**: Information consistency needs to be improved as consumption figures bounced from month to month. The overall percentages of registered and read meters to number of connections have increased during the past number of year, but still need to be increased. The billing data base accuracy still needs to be improved.

- **Inadequate GIS information**: Google Earth was used to break down the billing into the respective supply zones. Billing data should be geographically referenced on a GIS system for more accurate supply zone analysis.
    - Small inconsistencies were found in each supply zone when the number of connections was compared to the number of cadastral units counted in GIS/Google Earth.
    - The inability to reconcile the billing database with the GIS database is a cause for concern and needs to be addressed.
- **Inadequate background data/Water Information Management** on individual supply schemes/systems. MMM does not have an integrated management information system to monitor supply and demand.
- **Valve operation** and associated valve status were not recorded through a proper management system. This led to numerous challenges pertaining to zone and water loss identification.
- **Limited funding** was available to implement the recommended WCDM interventions. It is essential that some of the revenue collected from water sales be ring fenced for WCDM programmes in order to avoid the scenario where MMM becomes dependent on grant funding from National Government. MMM should budget to fund all WCDM initiatives from internal tariff based revenue sources.
- A large percentage of MMM water supply system (especially in the Bloemfontein portion) is quite old and have been experiencing extensive leaks. This results in **significant real losses** as indicated in the water balance. A focused programme is required to systematically replace old and leaking infrastructure.

3.2.2. Recommended areas of opportunity for proposed 10 year WCDM strategy

A number of areas have been identified where the 10 year strategy can be enhanced and these include:

- Documentation of business processes;
- Development of integrated information management systems;
- Integrated GIS data base for infrastructure and meters;
- Improved meter management;
- Increased meter coverage;
- Complete zoning of systems, pressure management of zones and management of meter zones;
- Increased funding for WCDM related activities;
- Integrate WCDM and water resource management initiatives;
- Enhance water re-use as a recognized WCDM technique;
- Consumer education and awareness raising;
- Review meter installation and replacement procedures;
- Review water supply agreements and water tariff structures.

3.3. Detailed Water Balance Assessment

3.3.1. General Approach to Water Balance assessment

The implementation of any water loss management programme is multi-phased. The ultimate objective of any such initiative must be to reduce unnecessary distribution losses to an economical minimum while maximising revenues from customers. One such way of monitoring any water utility's success in this regard is by compiling a monthly or annual water balance. A number of performance indicators can be determined from this water balance to identify progress in minimizing water loss in its various components.
The water balance can be prepared in either a "top-down" or "bottom-up" approach. The "top-down" approach is largely a desktop exercise whereby generally, high-level information from readily available documentation is collected and reviewed to prepare a water balance. Typical data included in this approach is bulk water volume (treated and/or purchased), customer billing volumes, leak repair summaries, meter calibration tests, fire hydrant use etc. The "top-down" approach, while approximate in its reliability, can be compiled relatively quickly and is usually advisable for utilities preparing their first water balance.

The "bottom-up" approach involves taking field measurements and conducting audits, investigations and research into the policy and practices of the water utility. This is necessary to extract the explicit knowledge on the total variety of water use and losses. The use of night flow analysis to obtain inferred measurements of leakage is an example of using actual field measurements in the "bottom-up" approach to replace estimates of distribution losses used in a "top-down" approach.

The "bottom-up" approach improves the accuracy of the water balance in reflecting the true water delivery and billing process. However, it requires more time and resources to conduct field measurements and research to gain the greater level of information required to improve the water balance. The "bottom-up" approach was used to compile the water balance for during the 5 year NRW strategy.

3.3.2. Methodology Used for the Municipality Water Balance

The water balance for the MMM was completed using the "bottom-up" approach. The following steps were followed for completing the water balance:

- **Step 1:** The System Input Volume was measured and included in the water balance
- **Step 2:** The components of the Billed Authorised Consumption (BAC) were calculated and summed up. These included the Billed Metered Consumption (BMC), Free Basic Water (consumption $\leq$ 10kl/month, within the allocated consumer quota, majority being consumption of $\leq$ 1kl/day on average) and Metered Municipal Consumption. The BAC is the Revenue Water in the water balance
- **Step 3:** The volume of Non-Revenue Water is calculated by subtracting the Revenue Water from the System Input Volume
- **Step 4:** The components of the Unbilled Authorised Consumption (UAC) were calculated and summed up. These included Unmetered Municipal Use (firefighting, scouring etc.)

- **Step 5:** The volumes of the Billed Authorised Consumption and Unbilled Authorised Consumption are summed up to obtain the Authorised Consumption value.
- **Step 6:** Water Losses are then calculated as the difference between System Input Volume and Authorised Consumption
- **Step 7:** The Metering Inaccuracies and Illegal Consumptions determined and summed to determine the total Apparent Losses.
- **Step 8:** The Real Losses are calculated by using IWA best practice as the difference in total Water Losses and Apparent Losses.

The above approach is applied in the subsequent section. It should however be noted that historic water balances obtained from FY 2011/12 to FY 2016/17 were formulated based on a combination of different approaches (not necessarily coherent with the above approach) which could result in the various water balance parameters not representing the same outcomes across the available years' data necessarily. As the previous years' water balances have already been submitted and approved these water balances were not amended to conform to this approach, however, all the projected water balances from FY 2017/18 to FY 2027/28 were calculated based on this approach.

3.3.3. Water Balance Setup and Calculations

The MMM water balance was developed as part of the 5 year WCDM Master Plan by JOAT and is currently updated on a monthly basis.

System Input Volume

The System Input Volume (SIV) is defined as the total volume of water entering a discrete consumption zone. Mangaung Metro Municipality SIV was obtained by recording the raw water purchases at Maselspoort and the Bloem Water purchases at bulk water sales meters. The SIV comprises own sources (Maselspoort) and external sources (Bloem Water). Of particular importance is the observation that approximately 10% water is lost at Maselspoort WTW due to filter backwash and desludging. The peculiar metering and supply agreement results in MMM paying nearly three times for the 'lost water'. Reducing this loss through the recovery of filter wash water will reduce the SIV and cost of treatment as Maselspoort WTW. Maximising the production of MMM own sources and reducing treatment losses will not only reduce the SIV, but will also reduce the cost of water purchases significantly. It is recommended that this aspect be addressed as a priority WCDM activity.

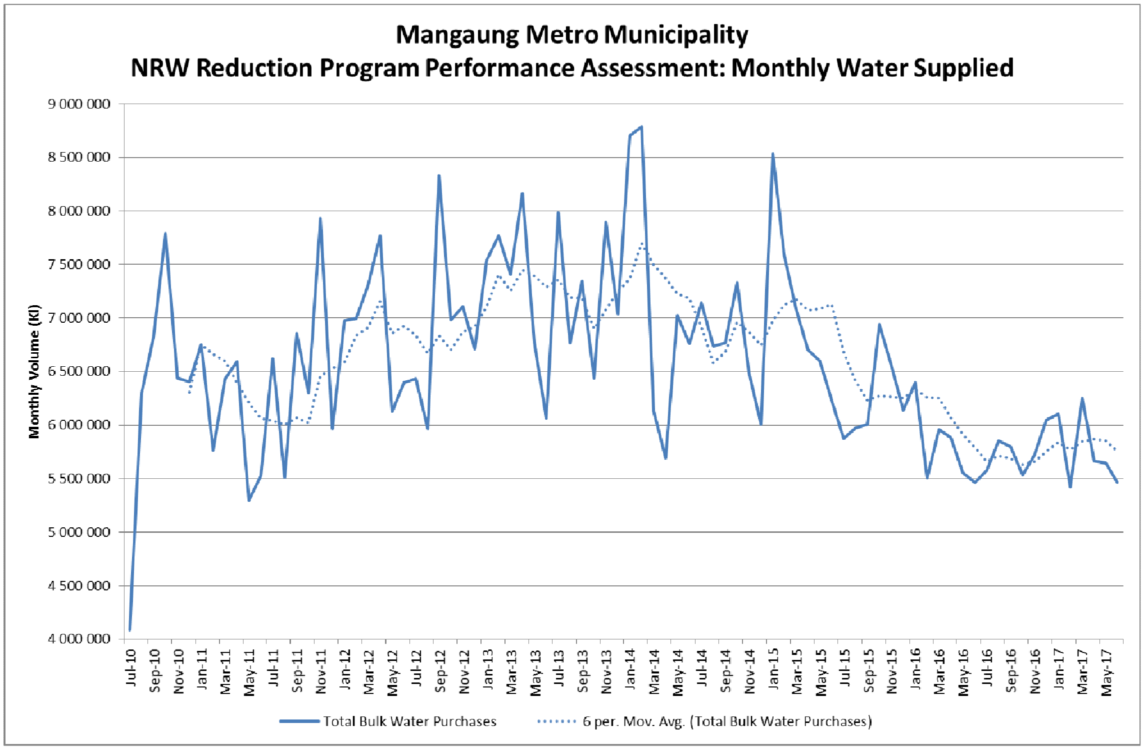


Figure 3-3: Historic Trend of SIV (JOAT, 2017)

From Figure 3-3 it would appear that the general rise of SIV has been curtailed since the introduction of the 5 Year NRW Strategy.

Billed Authorised Consumption

Billed Authorised Consumption (BAC) constitutes the water balance components from which revenue could be generated and was divided into four components:

- Metered customer consumption
- Consumption within Free Basic Water Allocation – In the case of MMM this amounts to 10 kl/month/household
- Metered municipal consumption
- Metered standpipes consumption

The first two components were derived from individual meter connection data. For the purposes of the water balance, Billed Metered Consumption (BMC) was taken to be the total sales to consumers as contained in the billing database. Billed Unmetered Consumption and Potential Unbilled Unmetered Consumption, in the interests of simplicity, were taken as zero in the water balance. Billed meter consumption can be easily improved by metering all consumer off-takes from the system and this was one of the key drivers in the 10 year strategy.

Potential Revenue Water (PRW) and Savings

The overall water savings are made up of a combination of the lower consumption by users that are limited to the free basic use and the savings from a reduction in physical losses. The savings will reduce the non-revenue water by turning it into revenue water or reduce the total consumption. The free basic use is inclined to increase with increase population growth, but in the case of MMM the free basic use is 10 kl/month/household instead of the recommended 6 kℓ/month/household (66% higher than the national benchmark).

Unbilled Authorised Consumption

Unbilled Authorised Consumption consists of Mangaung Metro Municipality's sanctioned devices that provide predominantly rural settlements with some form of water supply. The physical devices included:

- Unmetered municipal use
- Unmetered standpipes

Other UAC components that were also identified included firefighting, emergency drought relief, scouring and sewerage pump station and treatment works usage as well as operational and maintenance functions on sewer systems (flushing).

Apparent Losses

Apparent Losses are comprised of Unauthorised Consumption and Metering Inaccuracies. Unauthorised consumptions are perceived to be from illegal connections while metering inaccuracies are perceived losses arising from the deterioration of average meter accuracy due to normal wear and tear that either under-reads, or in exceptional cases over-reads the volume of water used by the customer. This factor is greatly reliant on supply water quality as well as appropriate sizing and type of meter. A meter replacement policy and programme will ensure that old meters are replaced timeously. A draft meter replacement policy is attached as Annexure I.

Real Losses

Real Losses are determined/estimated from leaks/losses from mains and service connections as well as reservoir overflows. Mains leaks and service connection leaks are calculated from analysing minimum night flows (MNF) from storage reservoirs. The two can be separated into individual components by using freely available software (such as SANFLOW developed by the South African Water Research Commission). Not all MNF consists exclusively of losses and/or leaks – in some cases there are legitimate night-time consumers and intermittent night usage from users which form part of the recorded night flow rates. Leaks on private property which passes through a customer meter are also regarded as being part of consumption. It is therefore necessary to "unbundle" MNF rates into different components to fully understand the quantity of real losses.

Real losses need to be contained by preventing reservoir overflows, losses from bulk and reticulation mains, valves and consumer connections. A system also need to be implemented that records and analyse burst frequency and leak repairs in order to better estimate real losses.

3.3.4. Confidence Grading of Water Balance Information

The results and analysis of the approaches will always be dependent on the quality of information and data used. In this regard a Confidence Grading Scheme was used to assess the adequacy, reliability and accuracy of the existing data in determining the relevant performance indicators. The system used for this purpose was the recommended standard contained in the International Water Association's *Manual of Best Practice: Performance Indicators for Water Supply Services*.

3.3.5. Technical Key Performance Indicators (KPIs)

The water balance components can be interpreted and related to standardised key performance indicators developed by IWA. A selection of the most important KPIs are discussed in more detail below.

Unavoidable Annual Real Losses (UARL)

This volume of water is calculated from the standard UARL equation and is a function of length of mains, number of service connections and average operating pressures in supply zones. The 2013/14 financial year's UARL for the entire MMM was 77 ℓ/connection/day.

Current Annual Real Losses (CARL)

The Technical Indicator for Real Losses should be the annual volume of Real Losses divided by the number of service connections.

Infrastructure Leakage Index (ILI)

The difference between the CARL and the UARL represents the maximum potential for further savings in Real Losses, when the system is pressurized. Also, the ratio of CARL to UARL is a useful non-dimensional index of the overall condition and management of infrastructure, under the current operating regime of average pressure and continuity of supply, and is recommended as an additional step in interpreting the calculated value of the CARL for a wide range of international situations. The ILI for FY 2013/14 was 9.5 and it will be feasible to achieve an ILI of 5 by 2027/28. This will have to be achieved by reducing both the UARL (through pressure management) and CARL (reducing real losses).

Non-Revenue Water by Volume (NRW)

The NRW for 2013/14 is 46.6% and increased significantly from the previous (2012/13) NRW of 34.6%. The current annual NRW quantum is 40.3 million m^3/annum (or 110 Mℓ/day) in FY 2013/14. From Figure 3-5 it can be seen that MMM reported one of the highest NRW levels during the comparative NRW study performed by DWS (2013).

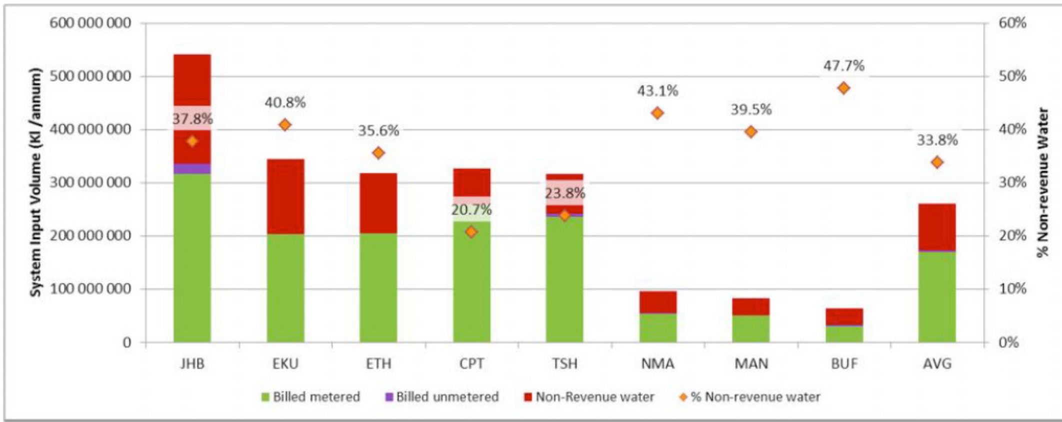


Figure 3-5: NRW Comparison Between MMM and Other Metros

It would therefore appear feasible to reduce the NRW to a percentage as low as 30% from the current 46.6%, by reducing real water losses, increased metered consumptions and reduced SIV. This will be discussed in more detail later in the text.

3.4. Modelling impact of WCDM Interventions on Water Balance

3.4.1. Water Balance Modelling Approach

A number of interventions/projects/programmes have been identified for inclusion in the 10 year WCDM strategy. In order to assess the impact of these interventions it was decided to develop a water balance model that is able to calculate the various water balance components and KPIs based on a set of user defined inputs. The inputs can be varied until the model output has reached the target water balance component/KPI value.

A larger historic database was available for the Revised Strategy and thus figures for the FY 2011/12, 2012/13, 2013/14, 2014/15, 2015/16 and 2016/17 could be applied as reference points. A decision was however made to continue applying FY 2013/14 as base year as the SIV for FY 2016/17 represents the effect of water restrictions and basing projections on the current situation may likely deliver unrealistic targets/projections. However, the water balance for FY 2013/14 has since been amended and this revised water balance is forthwith applied as base year for the Revised Strategy.

The same scenarios as tested for the Original Strategy was also tested for the Revised Strategy in order to determine the relative impact of the water balance component over which MMM has some degree of control.

The base case was developed first and then scenarios 1 to 5 were introduced with the interventions described. Only scenario 5 can achieve the required 10 year WCDM targets and will require a wide range of interventions. Only the Base Case and scenario 5 will be discussed in the remainder of the text.

For each scenario a set of planning input parameters were determined based on the type of interventions implemented.

Table 3-6 and Table 3-8 show the planning parameters for the Base Case and Scenario 5 respectively. The planning input parameters were then used to calculate the basic elements of the water balance and the rows highlighted in light green indicate the water balance elements that were adjusted using the planning input parameters. Table 3-2 and Table 3-4 show the projected water balance elements until 2027/28 for the Base Case and Scenario 5 respectively. Based on the water balance projections, key performance indicators were calculated and these are shown in Table 3-7 and Table 3-9 respectively for the Base Case and Scenario 5.

3.4.2. Water Balance Model Assumptions

The water balance model, like any other model, is only an approximation of reality and are therefore based on a number of assumptions that need to be explained in order to put the model results in contexts. The following assumption were made pertaining to the demographic factors that influences the water demand and water balance components:

- Population and population growth as best estimated from the Census figures and growth rate between Census 2001 and Census 2011;
- Number of indigent connections as obtained from the 2016 Human Settlement information;
- Quantum of free basic water supply (10 kl/month).

Previous WCDM studies did not consider the physical limits of the bulk water supply system on the ability of MMM to meet SIV. This is an essential consideration and was included in the water balance model as a key consideration as the treatment capacity determines the maximum SIV. It should be noted that there is currently a difference between the actual and rated treatment capacity at both the Maselspoort and Welbedacht WTWs. In both cases process upgrades are required to treat raw water to the required quality throughout the year. Table 3-1 shows the treatment capacities for the various WTWs and it is clear that about 90 Mℓ/day cannot be utilised throughout the year. The current physical limit of supply into MMM water supply network is estimated at 270Mℓ/day.

Rated Treatment Capacity	**Mℓ/day**	**m^3/a**
Rustfontein WTW	100	36 500 000
Maselspoort WTW	108	39 420 000
Welbedacht WTW	140	51 100 000
Total		**127 020 000**
Current Capacity during rainy season	**Mℓ/day**	**m^3/a**
Rustfontein WTW	100	36 500 000
Maselspoort WTW (constraint iro agreement)	70	25 550 000
Welbedacht WTW	100	36 500 000
Total		**98 550 000**

Table 3-1: Current rated and actual treatment capacity

The model is currently limited and have not included the following aspects:

- As a first point of departure the water balance model treated MMM as **a whole** and did not allow the seven sub-systems (Bloemfontein, Botshabelo, Thaba Nchu, Wepener, Dewetsdorp, Wepener, Vanstadensrus and Soutpan) to be modelled individually. This is a refinement that can be developed at a later stage to improve model accuracy and assess the impact of interventions on each sub-system. Al though the water balances have recently been sub-divided to show the various sub-systems, targets are set for Mangaung as a holistic entity and once the smaller sub-systems also gain momentum in WCDM initiatives, the targets can be re-evaluated in order to set specific targets per sub-entity.
- The impact of water **restrictions** have not been modelled explicitly, but have been implicitly included via the SIV reductions.
- The impact of **water tariffs** especially punitive tariffs and water restriction on water demand have not been included in the model at this stage. This can be a future enhancement to the model and should be developed in collaboration with the Directorate: Finance.

The following interventions have been considered and modelled in the water balance in the final Scenario 5:

- Water treated and supplied from Maselspoort WTW[2]
  - As the filter wash water recovery hasn't been implemented to date the 10% reduction previously applied for 2014/15 in the Original Strategy was moved forward and applied to 2018/19 in the Revised Strategy.
  - The increased production from Maselspoort has not been implemented and thus this stepped increase is applied as follows:
    - Increase Maselspoort WTP from 120 Mℓ/day to 130 Mℓ/day in 2018/19;
    - Increase Mockes Dam storage from 3,58 million m^3 to 12,13 million m^3 storage (May 2021).
- Implement water re-use initiatives to reduce water treatment losses
  - The DWS Reconcilliation Strategy (2012) will be revised, considering the utilisation and prioritisation of water re-use as per DWS legislation and recent discussions.
    - Assume indirect re-use of 45 Mℓ/day will be in place by 2020/21;
    - Assume direct potable re-use of 32 Ml/day in place by June 2024.
- Water treated and supplied from Welbedacht and Rustfontein WTW
  - The supply from Bloem Water will be reduced proportionally from Welbedacht WTW to account for the increased production at Maselspoort from 2018/19.
- System input volume
  - System input volume was constrained to a growth rate commensurate with population growth (plus an additional factor to account for the influence of VIP eradication). The SIV will have to be determined in more detail when VIP project plans are known.
  - The ratio of supply from Maselspoort and Welbedacht was determined by the revised Maselspoort WTW production.

[2] *The Maselspoort WTW production is currently constrained by the Bloem Water-MMM WSA Supply Agreement to 31% of total water supplied*

- Service connection growth and length of pipelines
  - Both these aspects were increased to the same level as the population growth of 2% in 2017/18 across the ten year prediction.
- Number of metered consumers and free basic consumption
  - The Billed Metered Consumption growth of 4% per annum in 2017/18 was gradually reduced to 3% per annum at the end of the period (2027/28).
  - Free basic consumption was linked to the population growth rate.
- Meter replacement and accuracy
  - The meter errors and under-registration was reduced by 3% per annum for the entire period.
- Illegal consumption reduction
  - The illegal consumption was reduced by 2% per annum for the entire period.
- Real loss leakage reduction
  - The leakage on mains was reduced by 5% per annum for the entire period and the leakage on reservoir overflows was reduced by 1% for the entire period.
  - The leakage on consumer connections was reduced from 6% in 2017/18 with a gradual decrease to 4% in 2027/28.

Refer to Annexure H for a complete table of the listed assumptions for the various defined scenarios across the 10 year period.

3.4.3. Model Results

As addressed previously a considerable decline in MMM's SIV from FY 2013/14 to the FY 2016/17 has been noticed which may be as a result of the strict water restrictions imposed by MMM on consumers together with the recent drought situation which may affect the user's outlook on water consumption. A decision was thus made to continue applying FY 2013/14 as base year as the SIV for FY 2016/17 represents the effect of water restrictions and basing projections on the current situation may likely deliver unrealistic targets/projections.

The option to base all other projections other than the SIV on the FY 2016/17 water balance was also considered but this will yield inaccurate outcomes as other water balance elements such as the Billed Metered Consumption will also be influenced by the impact of water restrictions. In order to maintain conformity it was thus decided to apply the entire effect of the FY 2013/14 water balance as base year. The water balance for FY 2013/14 has since been amended and this revised water balance was forthwith applied as base year for the Revised Strategy. The data of the FY 2016/17 water balance will thus merely be applied to compare projections from the Original Strategy to actual figures obtained.

In the case of the Base Case using the revised water balance of 2013/14 as the base year to apply projected SIV growths the SIV exceeds the actual capacity in 2019/20 and the rated treatment capacity by 2024/25. This is indicated by the red shaded area at the top of Table 3-2. This projection disregards the effects of water restrictions on the SIV as the actual SIV for 2016/17 is merely 69.1 million m^3/a. The Base Case SIV is predicted to increase to 148 million m^3/a in 2027/28. The SIV of Scenario 5 is contained to 103 million m^3/a in 2027/28. Non-revenue water can be contained to 30%

(32.5 million m³/annum) in 2027/28 if Scenario 5 is implemented compared to the Base Case prediction of 65% (96.7 million m³/annum). Real losses can be reduced to 28.4 million m³/annum if Scenario 5 is executed compared to 91.9 million m³/annum for the Base Case.

The relevant KPI's from each of scenarios compared to the baseline is shown in Figure 3-6**.** This shows the projected progression for the 10 year WCDM strategy without any intervention (base case) and with the recommended interventions (Scenario 5). This is discussed in more detail later in the section. The source related KPIs are shown in Figure 3-7. It is evident from these graphs that a significant improvement can be achieved should the interventions be implemented.

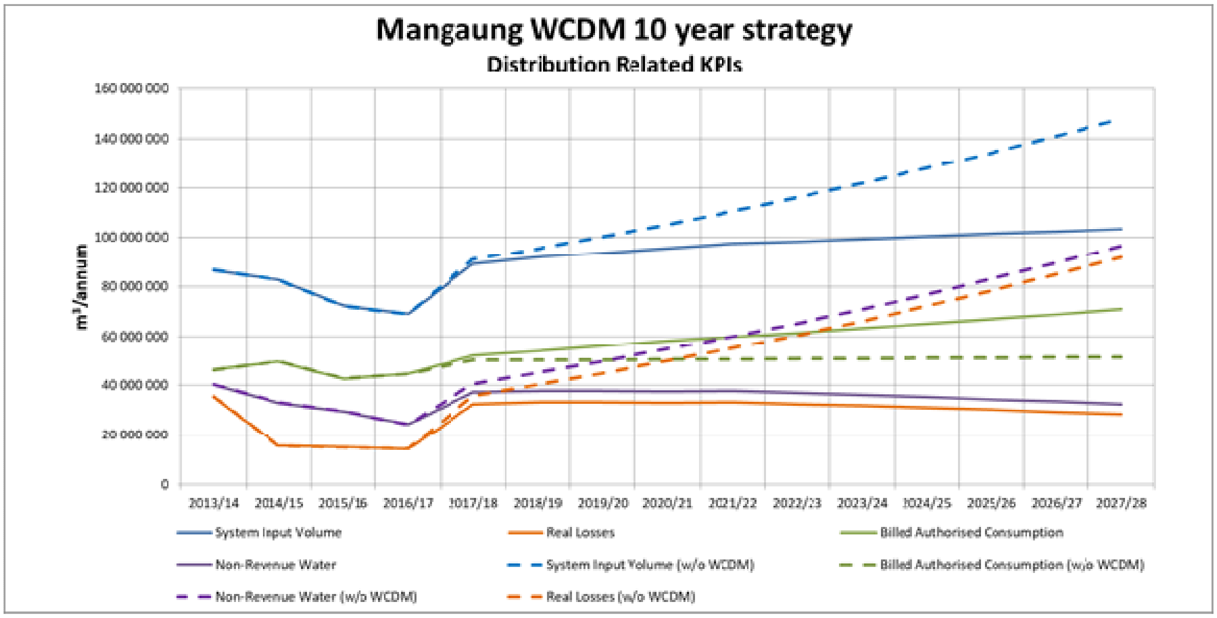


Figure 3-6: Key distribution KPI's for Base Case and recommended Scenario 5

As MMM should strive not only to reduce NRW, but also the total input cost of the potable water supplied a significant effort is required to reduce SIV through the use of underutilised internal resources such as Maselspoort. Two key consideration need to be highlighted:

- Urgent refurbishment and process upgrades are required at both the Welbedacht and Maselspoort WTWs. The current capacity of these WTWs is in the order of 260 Mℓ/d compared to the design capacity of 370 Mℓ/d. It should also be noted that during certain times of the year both Maselspoort and Welbedacht WTWs are constrained i.t.o treatment capaity due to raw water quality issues putting further constraints on the reliable supply of the WTWs.
- The current MMM-Bloem Water Service Level Agreement (SLA) puts constraints on the amount of water that can be treated at Maselspoort. System constraints can therefore be experienced for commercial reasons even though the treatment systems are not constrained. This will influence the SIV, the ratio of internal and external water and the cost of water.

Figure 3-7 indicates the proposed maximising of the own sources by upgrading the Maselspoort WTW (red solid line). The upgrade is planned in phases which results in the stepped increase of own source utilisation (red line) and the stepped reduction of relying on external sources (green line). The solid blue line indicates the combined SIV for Scenario 5. The MMM system is constrained by the water treatment capacity above 98.55 million m³/a before the process upgrades. This figure increases to 127.02 million m³/a after completion of the process upgrades at the Maselspoort and Welbedacht WTWs.

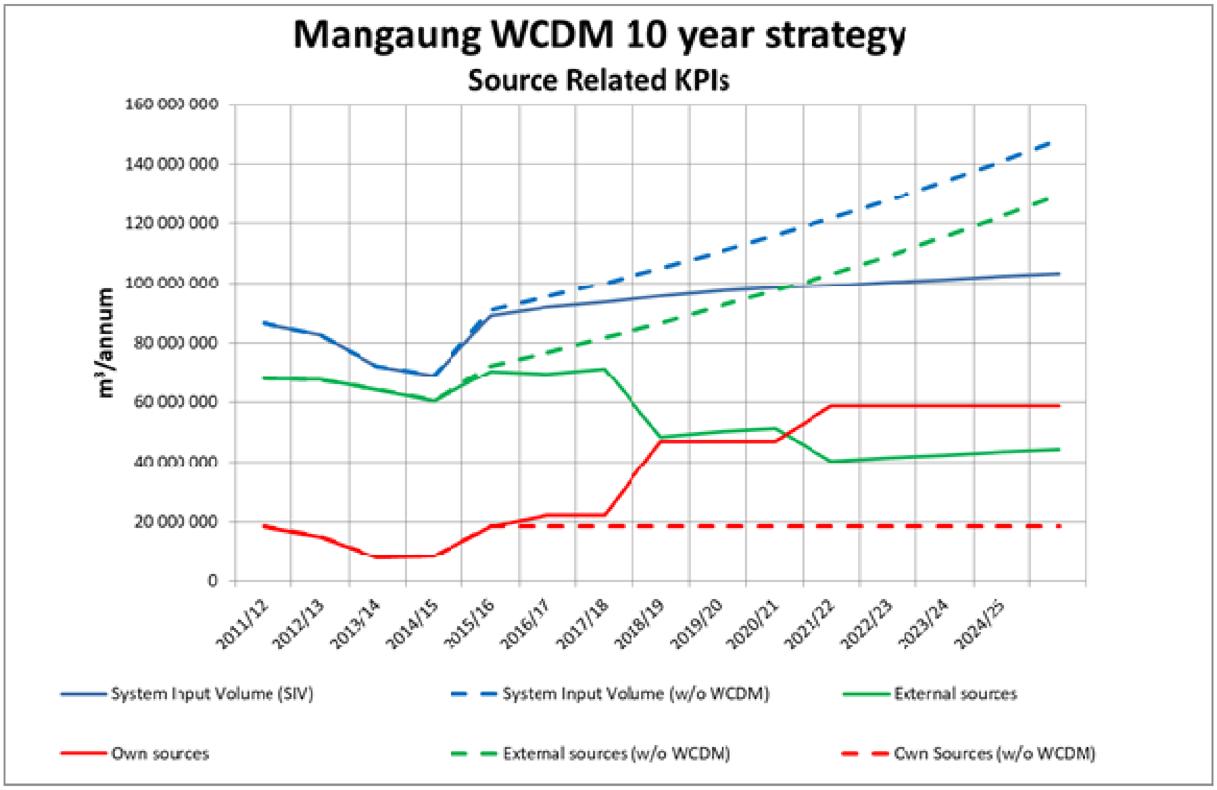


Figure 3-7: Key source related KPI's for Base Case and recommended Scenario 5.

Containing the SIV will reduce the cost of water by reducing treatment losses and also by increasing the supply of water from internal (Maselspoort) sources in relation to the Bloem Water sources.

It is absolutely essential that the SIV be contained and that the billed consumption be increased as the SIV increases in order to maintain the NRW levels. If this is not done the unbilled water use will spiral out of control and MMM will find it difficult to deliver a sustainable water service. The unbilled authorised consumption is currently about 6.1 million m³/a in FY 2016/17. It is therefore important to keep in mind when the VIP eradication projects are launched that these projects be complemented with the installation of metered connections and that cost recovery mechanisms be put in place for the billed amounts to be recovered. Illegal consumption should not be tolerated.

In parallel to increasing the meter coverage to increase revenue, it is also essential that the losses of the increased amount of water supplied into the system be reduced. The easiest losses to reduce are overflowing reservoirs. This is recommended as an essential strategy which will yield the quickest results. Loss reduction should also be implemented through replacement of under-registering meters, active leak detection on trunk mains and consumer installations. The need for a thorough pressure management system is also highlighted as one of the key strategies to reduce Real Losses.

Refer to Table 3-2 and Table 3-3 below illustrating the **Base Case** projections for water balance parameters and water supply system information respectively. Refer to Table 3-3 and Table 3-4 below illustrating the **Scenario 5** projections for water balance parameters and water supply system information respectively. Also refer to
Table 3-6 and Table 3-7 for the assumptions applied to the **Base Case** and the corresponding distribution system KPI's respectively. Refer to Table 3-8 and Table 3-9 for the assumptions applied to **Scenario 5** and the corresponding distribution system KPI's respectively.

Water Balance Component	Historic Information						Ten Year Projections (Based on FY 2013/14)										
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
														Exceeds Rated Treatment Capacity	Exceeds Rated Treatment Capacity	Exceeds Rated Treatment Capacity	Exceeds Rated Treatment Capacity
									Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity
Own Sources (OS)	19 627 318	17 346 160	18 533 429	15 176 615	8 059 441	8 545 570	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429
Water Imported (WI)	63 306 660	67 321 906	68 037 833	67 595 763	64 247 264	60 558 420	72 366 396	76 911 387	81 683 628	86 694 481	91 955 877	97 480 342	103 281 030	109 371 753	115 767 013	122 482 035	129 532 808
System Input Volume (SIV)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Water Exported (WE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Supplied (WS)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Authorised Consumption (AC)	47 174 698	55 407 215	48 027 823	62 804 514	52 698 581	50 884 501	51 922 144	52 033 978	52 148 049	52 264 401	52 383 080	52 504 132	52 627 606	52 753 549	52 882 011	53 013 043	53 146 695
Billed Authorised Consumption (BAC)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	50 165 956	50 277 790	50 391 861	50 508 213	50 626 892	50 747 945	50 871 418	50 997 362	51 125 824	51 256 855	51 390 507
Billed Water Exported to Other Systems (BWEOS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billed Metered Consumption (BMC)	44 763 274	51 479 975	44 574 259	42 595 034	36 501 846	37 440 085	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259
Free Basic Water/Indigent Consumption (FBW)	2 411 424	3 927 240	1 697 376	3 295 200	2 654 040	3 525 138	1 731 324	1 765 950	1 801 269	1 837 294	1 874 040	1 911 521	1 949 751	1 988 747	2 028 521	2 069 092	2 110 474
Billed Unmetered Consumption (BUC)	0	0	0	3 784 680	3 544 080	3 801 340	3 860 374	3 937 581	4 016 333	4 096 659	4 178 593	4 262 164	4 347 408	4 434 356	4 523 043	4 613 504	4 705 774
Potential Revenue Water (PRW)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	50 165 956	50 277 790	50 391 861	50 508 213	50 626 892	50 747 945	50 871 418	50 997 362	51 125 824	51 256 855	51 390 507
Unbilled Authorised Consumption (UAC)	3 655 002	9 313 488	1 756 188	13 129 600	9 998 615	6 117 938	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188
Unbilled Metered Consumption (UMC)	3 655 002	9 313 488	1 231 572	12 301 877	8 819 068	5 431 254	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572
Unbilled Unmetered Consumption (UUC)	0	0	524 615	827 724	1 179 547	686 683	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615
Total Water Losses (WL)	32 104 278	19 947 364	38 543 439	19 967 864	19 608 124	17 896 255	38 977 681	43 410 839	48 069 009	52 963 510	58 106 226	63 509 639	69 186 854	75 151 633	81 418 431	88 002 421	94 919 543
Apparent Losses (AL)	3 403 932	1 939 253	3 041 152	4 470 742	4 665 025	3 514 188	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152
Illegal Consumption (IC)	1 941 516	221 629	2 292 847	1 986 995	2 537 101	1 988 180	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847
Meter Under-Registration (MUR)	1 462 416	1 717 624	748 306	2 483 747	2 127 924	1 526 007	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306
Real Losses (RL)	28 700 346	18 008 112	35 502 287	15 497 122	14 943 099	14 382 068	35 936 529	40 369 686	45 027 857	49 922 357	55 065 074	60 468 486	66 145 701	72 110 481	78 377 278	84 961 269	91 878 390
Leakage on Mains (LM)	6 276 206	5 157 815	1 188 264	3 052 065	2 941 260	2 827 187	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264
Leakage and Overflows on Reservoirs (LOR)	621 230	246 482	686 511	236 799	236 799	246 130	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511
Leakage on Service Connections (LSC)	21 802 910	12 603 815	20 523 501	12 208 258	11 765 040	11 308 750	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501
Non-Revenue Water (NRW)	35 759 280	29 260 852	40 299 627	33 097 464	29 606 739	24 337 427	40 733 869	45 167 026	49 825 197	54 719 697	59 862 414	65 265 827	70 943 041	76 907 821	83 174 618	89 758 609	96 675 730

Table 3-2: Ten year water balance model for WCDM Base Case

Static Information	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Number of service connections	126 582	126 582	132 689	131 054	142 565	193 591	197 463	201 412	205 440	209 549	213 740	218 015	222 375	226 823	231 359	235 986	240 706
Length of trunk mains (km)	696	696	696	696	696	710	725	739	754	769	784	800	816	832	849	866	883
Length of reticulation (km)	2 962	2 962	2 962	2 962	2 989	3 106	3 168	3 231	3 296	3 362	3 429	3 498	3 568	3 639	3 712	3 786	3 862
Average Zone Operating Pressure (m)	54	62	64	62	61	60	60	60	60	60	60	60	60	60	60	60	60
UARL (ℓ/conn/day)	8 360	9 274	77	3 452 683	3 619 197	4 387 716	65	65	65	65	65	65	65	65	65	65	65
Population	721 157	721 367	721 157	788 881	836 711	825 686	842 200	859 044	876 225	893 749	911 624	929 857	948 454	967 423	986 771	1 006 507	1 026 637
CARL (ℓ/conn/day)							499	549	600	653	706	760	815	871	928	986	1 046

Table 3-3: Water supply system information for WCDM Base Case

Water Balance Component	Historic Information						Ten Year Projections (Based on FY 2013/14)										
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
													Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity
Own Sources (OS)	19 627 318	17 346 160	18 533 429	15 176 615	8 059 441	8 545 570	18 533 429	22 183 429	22 183 429	47 158 429	47 158 429	47 158 429	58 838 429	58 838 429	58 838 429	58 838 429	58 838 429
Water Imported (WI)	63 306 660	67 321 906	68 037 833	67 595 763	64 247 264	60 558 420	70 634 971	69 660 023	71 496 892	48 395 498	50 306 577	51 281 227	40 585 624	41 579 864	42 584 047	43 598 272	44 622 639
System Input Volume (SIV)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	89 168 400	91 843 452	93 680 321	95 553 928	97 465 006	98 439 656	99 424 053	100 418 293	101 422 476	102 436 701	103 461 068
Water Exported (WE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Supplied (WS)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	89 168 400	91 843 452	93 680 321	95 553 928	97 465 006	98 439 656	99 424 053	100 418 293	101 422 476	102 436 701	103 461 068
Authorised Consumption (AC)	47 174 698	55 407 215	48 027 823	62 804 514	52 698 581	50 884 501	53 696 334	55 653 720	57 687 558	59 800 859	61 475 299	63 199 086	64 973 677	66 800 568	68 681 304	70 617 472	72 610 708
Billed Authorised Consumption (BAC)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	51 948 927	53 915 050	55 957 581	58 079 533	59 762 579	61 494 930	63 278 041	65 113 411	67 002 582	68 947 144	70 948 732
Billed Water Exported to Other Systems (BWEOS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billed Metered Consumption (BMC)	44 763 274	51 479 975	44 574 259	42 595 034	36 501 846	37 440 085	46 357 230	48 211 519	50 139 980	52 145 579	53 709 946	55 321 245	56 980 882	58 690 308	60 451 018	62 264 548	64 132 485
Free Basic Water/Indigent Consumption (FBW)	2 411 424	3 927 240	1 697 376	3 295 200	2 654 040	3 525 138	1 731 324	1 765 950	1 801 269	1 837 294	1 874 040	1 911 521	1 949 751	1 988 747	2 028 521	2 069 092	2 110 474
Billed Unmetered Consumption (BUC)	0	0	0	3 784 680	3 544 080	3 801 340	3 860 374	3 937 581	4 016 333	4 096 659	4 178 593	4 262 164	4 347 408	4 434 356	4 523 043	4 613 504	4 705 774
Potential Revenue Water (PRW)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	51 948 927	53 915 050	55 957 581	58 079 533	59 762 579	61 494 930	63 278 041	65 113 411	67 002 582	68 947 144	70 948 732
Unbilled Authorised Consumption (UAC)	3 655 002	9 313 488	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Unbilled Metered Consumption (UMC)	3 655 002	9 313 488	1 231 572	12 301 877	8 819 068	5 431 254	1 225 415	1 219 287	1 213 191	1 207 125	1 201 089	1 195 084	1 189 109	1 183 163	1 177 247	1 171 361	1 165 504
Unbilled Unmetered Consumption (UUC)	0	0	524 615	827 724	1 179 547	686 683	521 992	519 382	516 785	514 201	511 630	509 072	506 527	503 994	501 474	498 967	496 472
Total Water Losses (WL)	32 104 278	19 947 364	38 543 439	19 967 864	19 608 124	17 896 255	35 472 067	36 189 733	35 992 764	35 753 069	35 989 707	35 240 570	34 450 376	33 617 725	32 741 173	31 819 229	30 850 360
Apparent Losses (AL)	3 403 932	1 939 253	3 041 152	4 470 742	4 665 025	3 514 188	2 972 846	2 906 131	2 840 967	2 777 318	2 715 147	2 654 418	2 595 097	2 537 149	2 480 541	2 425 241	2 371 218
Illegal Consumption (IC)	1 941 516	221 629	2 292 847	1 986 995	2 537 101	1 988 180	2 246 990	2 202 050	2 158 009	2 114 849	2 072 552	2 031 101	1 990 479	1 950 669	1 911 656	1 873 423	1 835 954
Meter Under-Registration (MUR)	1 462 416	1 717 624	748 306	2 483 747	2 127 924	1 526 007	725 857	704 081	682 958	662 470	642 596	623 318	604 618	586 480	568 885	551 819	535 264
Real Losses (RL)	28 700 346	18 008 112	35 502 287	15 497 122	14 943 099	14 382 068	32 499 220	33 283 602	33 151 796	32 975 750	33 274 560	32 586 152	31 855 279	31 080 577	30 260 632	29 393 988	28 479 141
Leakage on Mains (LM)	6 276 206	5 157 815	1 188 264	3 052 065	2 941 260	2 827 187	1 128 851	1 072 408	1 018 788	967 848	919 456	873 483	829 809	788 319	748 903	711 458	675 885
Leakage and Overflows on Reservoirs (LOR)	621 230	246 482	686 511	236 799	236 799	246 130	679 646	672 850	666 121	659 460	652 866	646 337	639 874	633 475	627 140	620 869	614 660
Leakage on Service Connections (LSC)	21 802 910	12 603 815	20 523 501	12 208 258	11 765 040	11 308 750	19 497 326	18 522 460	17 596 337	16 716 520	15 880 694	15 245 466	14 635 647	14 050 221	13 488 213	12 948 684	12 430 737
Non-Revenue Water (NRW)	35 759 280	29 260 852	40 299 627	33 097 464	29 606 739	24 337 427	37 219 473	37 928 402	37 722 740	37 474 395	37 702 427	36 944 726	36 146 012	35 304 883	34 419 894	33 489 557	32 512 336

Table 3-4: Ten year water balance model for WCDM Scenario 5

Static Information	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Number of service connections	126 582	126 582	132 689	131 054	142 565	193 591	197 463	201 412	205 440	209 549	213 740	218 015	222 375	226 823	231 359	235 986	240 706
Length of trunk mains (km)	696	696	696	696	696	710	725	739	754	769	784	800	816	832	849	866	883
Length of reticulation (km)	2 962	2 962	2 962	2 962	2 989	3 106	3 168	3 231	3 296	3 362	3 429	3 498	3 568	3 639	3 712	3 786	3 862
Average Zone Operating Pressure (m)	54	62	64	62	61	60	60	60	60	60	60	60	60	60	60	60	60
UARL (ℓ/conn/day)	8 360	9 274	77	3 452 683	3 619 197	4 387 716	65	65	65	65	65	65	65	65	65	65	65
Population	721 157	721 367	721 157	788 881	836 711	825 686	842 200	859 044	876 225	893 749	911 624	929 857	948 454	967 423	986 771	1 006 507	1 026 637
CARL (ℓ/conn/day)							451	453	442	431	427	410	392	375	358	341	324

Table 3-5: Water supply system information for WCDM Scenario 5

BASE CASE ASSUMPTIONS															
Annual percentage increase															
Population related inputs	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Population growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
System inputs															
Service connection growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Length of reticulation/trunk increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
SIV related inputs															
SIV annual increase (impact SIV)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Maselspoort WTW increased production and re-use implementation (m^3/a Stepped Increase)															
Unbilled consumption inputs															
Metered consumption increase (impact BMC)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Free basic water/informal settlement increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Reduction in unbilled metered consumption	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Reduction in unbilled unmetered consumption	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Real losses inputs															
Leakage on mains reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Leakage on reservoirs/overflows reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Leakage on consumer connections reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Filter washwater recovery at Maselspoort (impact SIV, imported sources)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Apparent losses inputs															
Illegal consumption reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Meter under registration reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 3-6: Planning assumptions for WCDM Base Case

Key Performance Indicators	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
WR1 Inefficiency of Use of Water Resources	34.6%	21.3%	41.0%	18.7%	20.7%	20.8%	40%	42%	45%	47%	50%	52%	54%	56%	58%	60%	62%
Op23 Water Losses per Connection	695	432	796	417	377	253	541	590	641	692	745	798	852	908	964	1 022	1 080
Op27 Real Losses per Connection	621	390	733	324	287	204	499	549	600	653	706	760	815	871	928	986	1 046
Op29 Infrastructure Leakage Index	9.4	5.3	9.5	4.5	4.1	3.3	7.6	8.4	9.2	10.0	10.8	11.6	12.5	13.3	14.2	15.1	16.0
Fi46 Non-Revenue Water by Volume	43.1%	34.6%	46.6%	40.0%	40.9%	35.2%	45%	47%	50%	52%	54%	56%	58%	60%	62%	64%	65%
Consumption per capita (l/per/day)	179	210	176	173	140	149	163	160	158	155	152	150	147	144	142	140	137
Consumption per connection (l/conn/day)	1021	1199	955	1038	821	634	696	684	672	660	649	638	627	616	605	595	585
% Apparent Losses:Total Water Losses	10.6%	9.7%	7.9%	22.4%	23.8%	19.6%	8%	7%	6%	6%	5%	5%	4%	4%	4%	3%	3%

Table 3-7: Distribution system KPI's for Base Case

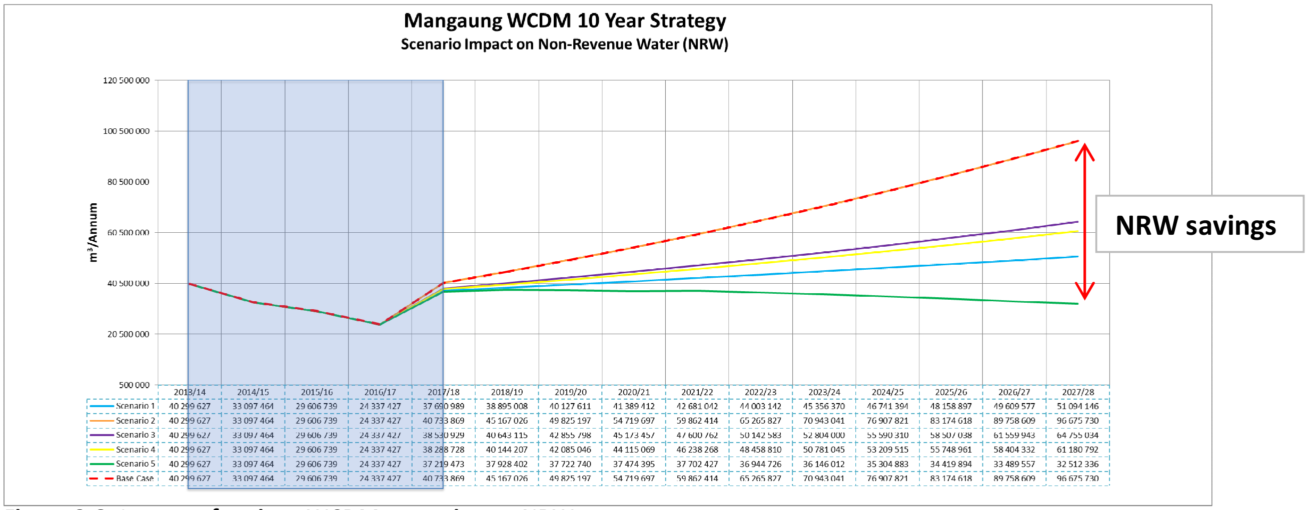
SCENARIO 5 ASSUMPTIONS - COMBINATION															
Annual percentage increase															
Population related inputs	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Population growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
System inputs															
Service connection growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Length of reticulation/trunk increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
SIV related inputs															
SIV annual increase (impact SIV)	4%	4%	3%	3%	3%	3%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Maselspoort WTW increased production and re-use implementation (m^3/a Stepped Increase)						3 650 000		24 975 000			11 680 000				
Unbilled consumption inputs															
Metered consumption increase (impact BMC)	4%	4%	4%	4%	4%	4%	4%	4%	3%	3%	3%	3%	3%	3%	3%
Free basic water/informal settlement increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Reduction in unbilled metered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Reduction in unbilled unmetered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Real losses inputs															
Leakage on mains reduction	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%
Leakage on reservoirs/overflows reduction	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Leakage on consumer connections reduction	-6%	-6%	-6%	-6%	-5%	-5%	-5%	-5%	-5%	-4%	-4%	-4%	-4%	-4%	-4%
Filter washwater recovery at Maselspoort (impact SIV, imported sources)	0%	0%	0%	0%	0%	-10%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Apparent losses inputs															
Illegal consumption reduction	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Meter under registration reduction	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%

Table 3-8: Planning Assumptions for WCDM Scenario 5

Key Performance Indicators	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
WR1 Inefficiency of Use of Water Resources	34.6%	21.3%	41.0%	18.7%	20.7%	20.8%	36%	36%	35%	35%	34%	33%	32%	31%	30%	29%	28%
Op23 Water Losses per Connection	695	432	796	417	377	253	492	492	480	467	461	443	424	406	388	369	351
Op27 Real Losses per Connection	621	390	733	324	287	204	451	453	442	431	427	410	392	375	358	341	324
Op29 Infrastructure Leakage Index	9.4	5.3	9.5	4.5	4.1	3.3	6.9	6.9	6.8	6.6	6.5	6.3	6.0	5.7	5.5	5.2	5.0
Fi46 Non-Revenue Water by Volume	43.1%	34.6%	46.6%	40.0%	40.9%	35.2%	42%	41%	40%	39%	39%	38%	36%	35%	34%	33%	31%
Consumption per capita (l/per/day)	179	210	176	173	140	149	169	172	175	178	180	181	183	184	186	188	189
Consumption per connection (l/conn/day)	1021	1199	955	1038	821	634	721	733	746	759	766	773	780	786	793	800	808
% Apparent Losses:Total Water Losses	10.6%	9.7%	7.9%	22.4%	23.8%	19.6%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%

Table 3-9: Distribution System KPI's for Scenario 5

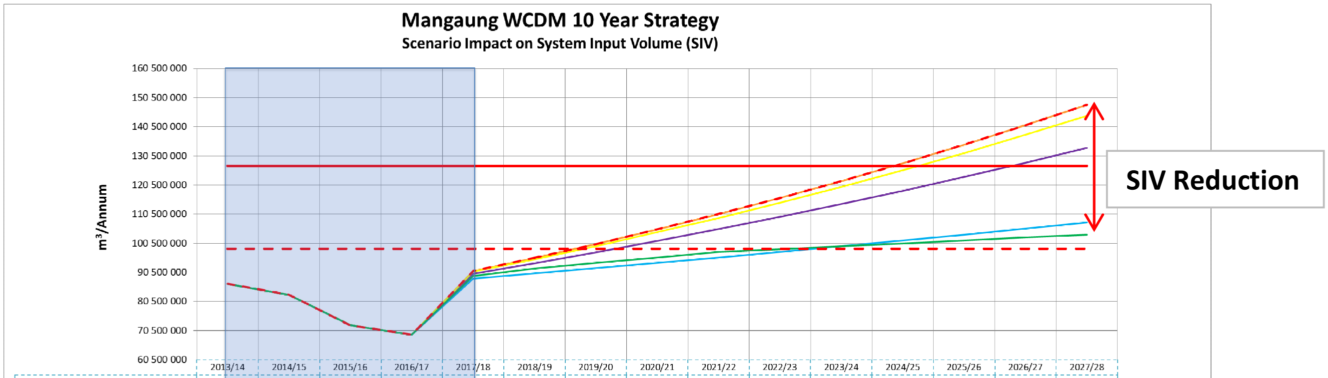
The impact of the various WCDM scenarios are graphically shown in Figure 3-8 to Figure 3-12. Figure 3-8 shows that NRW can be reduced significantly during the next 10 years with suitable WCDM interventions and can be reduced from a projected 96.7 million m^3/annum in 2027/28 if no WCDM is implemented to about 32.5 million m^3/annum in 2027/28 if a combination of interventions are implemented. This is a potential saving of 64.2 million m^3/a. By analysing the NRW contributions it becomes evident that the largest contribution to the improvement on NRW is as a result of reduction of unbilled authorised consumption. This combined with the real and apparent loss reduction could result in total NRW levels of 30% by 2027/28 under Scenario 5.



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	40 299 627	33 097 464	29 606 739	24 337 427	37 690 989	38 895 008	40 127 611	41 389 412	42 681 042	44 003 142	45 356 370	46 741 394	48 158 897	49 609 577	51 094 146
Scenario 2	40 299 627	33 097 464	29 606 739	24 337 427	40 733 869	45 167 026	49 825 197	54 719 697	59 862 414	65 265 827	70 943 041	76 907 821	83 174 618	89 758 609	96 675 730
Scenario 3	40 299 627	33 097 464	29 606 739	24 337 427	38 530 929	40 643 115	42 855 798	45 173 457	47 600 762	50 142 583	52 804 000	55 590 310	58 507 038	61 559 943	64 755 034
Scenario 4	40 299 627	33 097 464	29 606 739	24 337 427	38 288 728	40 144 207	42 085 046	44 115 069	46 238 268	48 458 810	50 781 045	53 209 515	55 748 961	58 404 332	61 180 792
Scenario 5	40 299 627	33 097 464	29 606 739	24 337 427	37 219 473	37 928 402	37 722 740	37 474 395	37 702 427	36 944 726	36 146 012	35 304 883	34 419 894	33 489 557	32 512 336
Base Case	40 299 627	33 097 464	29 606 739	24 337 427	40 733 869	45 167 026	49 825 197	54 719 697	59 862 414	65 265 827	70 943 041	76 907 821	83 174 618	89 758 609	96 675 730

Figure 3-8: Impact of various WCDM scenarios on NRW

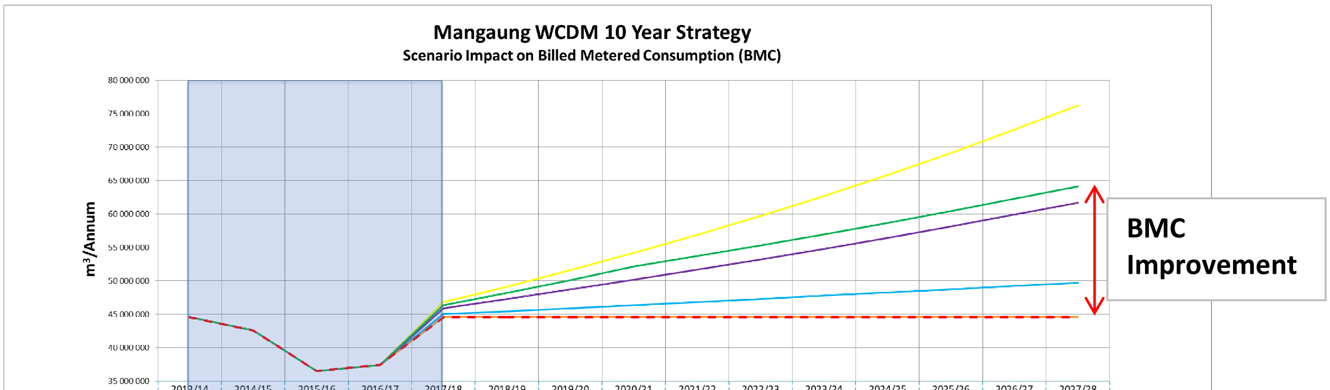
Figure 3-9 shows the impact of the same WCDM scenarios on the SIV and that the SIV can be reduced by about 44.6 million m^3/annum during the next ten years compared to the Base Case where no WCDM is implemented. The SIV growth is predominantly as a result of the population growth and improvement of level of service from basic water supply to **full water borne water services**. As previously mentioned it should be noted that the SIV is **resource constrained** and will reach the maximum system capacity before the end of the 10 year period if no WCDM is implemented. The red solid and dotted lines indicate the water supply system's rated and actual capacity respectively. It is evident that the actual annual average daily demand (AADD) system capacity will theoretically be reached within the next year in the case of the Scenario 5 and the nominal capacity will not be reached in the 10 year period. In the Base Case scenario SIV will rapidly increase and will exceed the nominal capacity before the end of the 10 year period. This treatment capacity refers to AADD and not the peak week demand. If the peak week demand is considered this horizon is reduced significantly. It is essential to **upgrade** the Maselspoort WTP and continue with planning and implementation of additional bulk water supply augmentation options in order to sustain the projected SIV growth.



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	86 571 262	82 772 378	72 306 705	69 103 990	88 302 688	90 068 741	91 870 116	93 707 518	95 581 669	97 493 302	99 443 168	101 432 032	103 460 672	105 529 886	107 640 483
Scenario 2	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Scenario 3	86 571 262	82 772 378	72 306 705	69 103 990	90 034 113	93 635 477	97 380 896	101 276 132	105 327 178	109 540 265	113 921 875	118 478 750	123 217 900	128 146 616	133 272 481
Scenario 4	86 571 262	82 772 378	72 306 705	69 103 990	90 683 397	94 990 859	99 502 924	104 229 313	109 180 206	114 366 266	119 798 663	125 489 100	131 449 832	137 693 699	144 234 150
Scenario 5	86 571 262	82 772 378	72 306 705	69 103 990	89 168 400	91 843 452	93 680 321	95 553 928	97 465 006	98 439 656	99 424 053	100 418 293	101 422 476	102 436 701	103 461 068
Base Case	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Rated Treatment Capacity	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000
Current Capacity during rainy season	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000

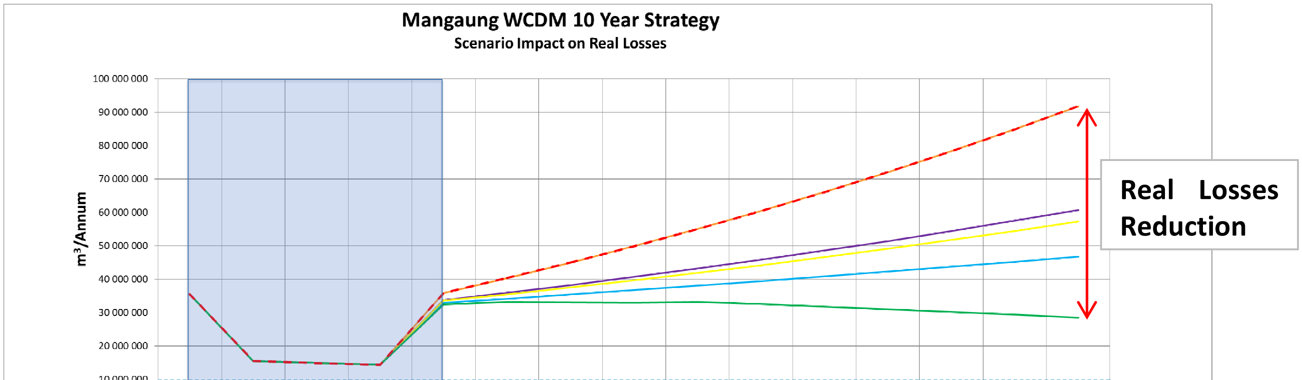
Figure 3-9: Impact of Various WCDM Scenarios on SIV

Similar improvements are shown in Figure 3-10 and Figure 3-12. (Please note that each of the graphs is attached separately as Annexures F should the text be too small to read in the main report.)



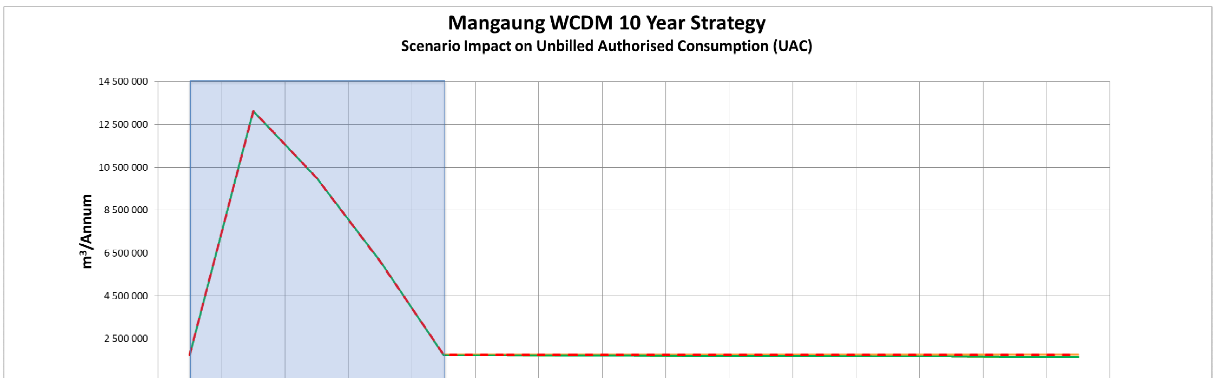
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	44 574 259	42 595 034	36 501 846	37 440 085	45 020 002	45 470 202	45 924 904	46 384 153	46 847 995	47 316 474	47 789 639	48 267 536	48 750 211	49 237 713	49 730 090
Scenario 2	44 574 259	42 595 034	36 501 846	37 440 085	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259
Scenario 3	44 574 259	42 595 034	36 501 846	37 440 085	45 911 487	47 288 832	48 707 497	50 168 722	51 673 783	53 223 997	54 820 717	56 465 338	58 159 298	59 904 077	61 701 199
Scenario 4	44 574 259	42 595 034	36 501 846	37 440 085	46 802 972	49 143 121	51 600 277	54 180 291	56 889 305	59 733 771	62 720 459	65 856 482	69 149 306	72 606 771	76 237 110
Scenario 5	44 574 259	42 595 034	36 501 846	37 440 085	46 357 230	48 211 519	50 139 980	52 145 579	53 709 946	55 321 245	56 980 882	58 690 308	60 451 018	62 264 548	64 132 485
Base Case	44 574 259	42 595 034	36 501 846	37 440 085	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259

Figure 3-10: Impact of various WCDM scenarios on Billed Metered Consumption (BMC)



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	35 502 287	15 497 122	14 943 099	14 382 068	32 940 324	34 190 447	35 468 588	36 775 373	38 111 438	39 477 436	40 874 028	42 301 893	43 761 722	45 254 219	46 780 104
Scenario 2	35 502 287	15 497 122	14 943 099	14 382 068	35 936 529	40 369 686	45 027 857	49 922 357	55 065 074	60 468 486	66 145 701	72 110 481	78 377 278	84 961 269	91 878 390
Scenario 3	35 502 287	15 497 122	14 943 099	14 382 068	33 825 642	36 027 049	38 326 234	40 727 782	43 236 465	45 857 252	48 595 316	51 456 042	54 445 041	57 568 155	60 831 467
Scenario 4	35 502 287	15 497 122	14 943 099	14 382 068	33 591 403	35 544 117	37 579 492	39 701 432	41 914 007	44 221 458	46 628 210	49 138 875	51 758 261	54 491 385	57 343 475
Scenario 5	35 502 287	15 497 122	14 943 099	14 382 068	32 499 220	33 283 602	33 151 796	32 975 750	33 274 560	32 586 152	31 855 279	31 080 577	30 260 632	29 393 988	28 479 141
Base Case	35 502 287	15 497 122	14 943 099	14 382 068	35 936 529	40 369 686	45 027 857	49 922 357	55 065 074	60 468 486	66 145 701	72 110 481	78 377 278	84 961 269	91 878 390

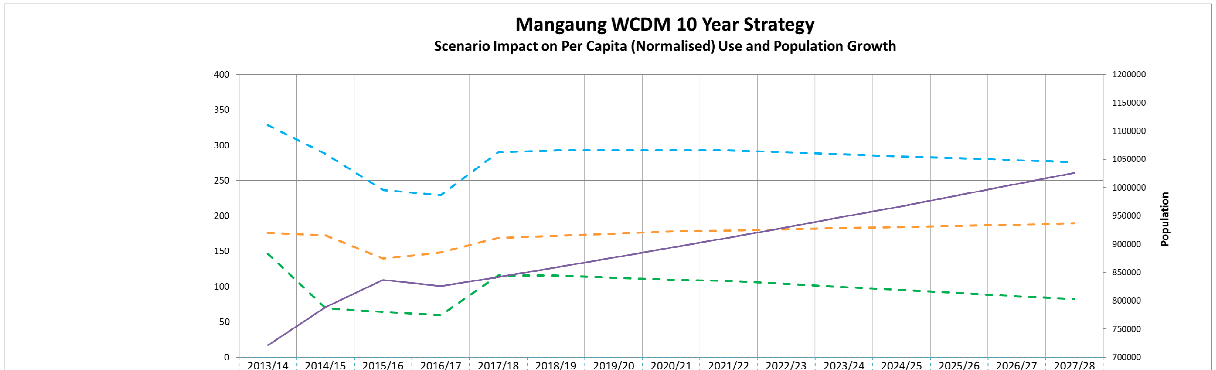
Figure 3-11: Impact of various WCDM scenarios on Real Losses



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Scenario 2	1 756 188	13 129 600	9 998 615	6 117 938	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188
Scenario 3	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Scenario 4	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Scenario 5	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Base Case	1 756 188	13 129 600	9 998 615	6 117 938	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188

Figure 3-12: Impact of various WCDM scenarios on Unbilled Authorised Consumption (UAC)

In order to perform a sanity check the normalised (per capita) consumption for key KPIs were also calculated. The result for the Scenario 5 interventions are indicated in Figure 3-13. It is evident that a marginal reduction in SIV and real losses is observed. The per capita consumption showed a marginal increase. This appears to be counter intuitive, but it should be kept in mind that MMM plans to develop approximately 20 000 additional stands and also to replace all VIP systems with water borne sanitation. Despite the other WCDM interventions this will lead to the per capita water use increasing in especially the Botshabelo and Thaba Nchu areas.



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
SIV Per Capita (ℓ/person/day)	329	287	237	229	290	293	293	293	293	290	287	284	282	279	276
Consumption Per Capita (ℓ/person/day)	176	173	140	149	169	172	175	178	180	181	183	184	186	188	189
Losses Per Capita (ℓ/person/day)	146	69	64	59	115	115	113	110	108	104	100	95	91	87	82
Population	721157	788881	836711	825686	842200	859044	876225	893749	911624	929857	948454	967423	986771	1006507	1026637

Figure 3-13: Unit water consumption KPIs vs population growth

4. PART 3 - THE 10 YEAR WCDM STRATEGY

4.1. Methodology

The development of a 10 Year WCDM strategy for Mangaung Metropolitan Municipality is a requirement that will address the limitations identified in the 5 year strategy in order to meet the objectives of economic efficiency, social development, social equity, environmental protection and sustainable use of available water resources. A number of supporting strategic elements have been identified that will support the overall 10 year WCDM strategy. These supporting strategic elements are discussed in more detail in Section 4.2, and include:

- Solutions: technical strategy (Section 4.2.1) and financial strategy (Section 4.2.2);
- Services: consumer awareness and educational strategy (Section 4.2.3) and human capital strategy (Section 4.2.4); and
- Structures: institutional strategy (Section 4.2.5) and systems strategy (Section 4.2.6).

The 10 year WCDM strategy also summarised the process to be followed for development of the WCDM Business Plan (Section 4.3) and listed Key Performance Indicators and Targets to be used to measure the effectiveness of future WCDM efforts by the municipality (Section 4.4). Lastly, the 10 year WCDM strategy compared the estimated cost of proposed WCDM activities to the benefits of successful implementation of WCDM activities (Section 4.5).

4.2. 10 Year WCDM Strategic Aspects

4.2.1. Technical Strategy

It is estimated that by implementing effective distribution management measures, NRW can be reduced significantly. This can be achieved through adequate and proper operating and maintenance measures of the reticulation system by implementing the following:

- **Zoning** of supply schemes
- **Real loss** reduction
  - Leak detection and repair programme
  - Pressure management
  - Repair of visible and reported leaks
  - Mains replacement/management programme
  - Reticulation/consumer connection replacement/management programme
  - Cathodic protection of pipelines (steel and ductile iron pipe material)
- **Apparent loss** reduction
  - Meter management programme
  - Illegal connection programme

The above items will be discussed in more detail in the following paragraphs; some of these have been extracted from the 5 year strategy (JOAT,2011).

To control real or physical losses, it is important to restate the components that make up real losses. In the IWA water balance, real losses are made up of mains leaks, service connection leaks and reservoir overflows, with the first two typically making up the greatest volume of losses. Losses from these elements are the basis for determining the UARL, and the minimization of these loss components form the basis for determining the economic level of leakage for a water distribution system.

A significant amount of capital is required to address the real losses specifically in the old Bloemfontein water network. There should be a continuous focus on replacing leaking fittings.

Zoning is a device of land-use planning used by Municipalities. In this context zoning refers to the concept of regulating water use through pressure management activities, meter management, etc.

Establishing the practice of discrete zoning or sectorisation in large water distribution systems has been an important factor in implementing ongoing active leakage control. By creating district metered areas (DMA's) that range in size from several hundred to several thousand properties each, water usage patterns can be monitored closely to infer leakage rates based upon minimal night flow rates. Establishing DMA's and utilizing leakage modelling techniques effectively provides a quantitative measure of leakage to the water utility manager. This information is available as the "bottom-up" contribution to the water balance.

Such measurements also form the basis for leakage reduction targets in a DMA. Flexibility exists in the manner in which DMA's are configured such that possible concerns for fire flow limitations, closed valves and customer usage variations can be safely and cost-effectively managed. Significant progress was made in this regard since the initiation of the 5 year strategy.

Another major innovation of efficient loss control is **pressure management**. It is common engineering design of water supply systems that adequate pressure be provided to ensure that a specified minimal level of service is met. However, it is now understood that certain types of leaks are very sensitive to pressure. Excess pressure – which is not always carefully assessed by water system operators – has a cost in terms of higher leakage and unnecessary energy usage. Better understanding of high and low pressure variations gives suppliers more control in preventing surging ruptures and backflow conditions, thereby extending the life of infrastructure and safeguarding distribution system water quality. Pressure control has proven to be effective in reducing leakage from "background" leaks, or those leaks that are so small that they are not easily located or repaired through conventional means. The installation of pressure reducing valves (PRV's) and use of selective pressure reduction during minimum usage night-time hours is a technique that is effective in economically reducing background leakage. This technique has greatly challenged the traditional concepts of what is regarded as "unavoidable" leakage, and assisted the development of the Unavoidable Annual Real Losses (UARL) calculation.

Since the implementation of the 5 year strategy MMM has also implemented pressure management with success.

Pressure related interventions include:

- Pressure modelling via innovative methods such as the Fixed and Variable Area Discharge Paths (FAVAD) model;
- Controlling pressure close to, but greater than, the minimum standard of service;
- Operation of discrete pressure zones configured based upon topography or service supply standards;
- Limiting pressure levels above or close to the maximum standards of service and limiting surges in pressure;
- Off-peak pressure reduction where feasible to reduce losses from small “background” leaks;
- Conducting extensive pressure logging, monitoring and zoning for the entire MMM;
- Adoption of new design standards/pressure zones. In this regard, it is recommended that all existing and future supply zones be designed so as not to exceed 50m static pressure;
- Installation of intelligent PRVs and flow meters on larger PRV’s so that 7-day yearly peak demand (summer peak) conditions combined with instantaneous daily peak conditions can be accommodated in terms of minimum standards of service while simultaneously reducing off-peak system pressures;
- A PRV maintenance schedule be created and adhered to;
- 100% inspection (and sounding when needed) of all water mains, reticulation and connections on a twice-yearly basis;
- Metering of individual pressure zones and online monitoring of the same, with alarm levels pre-set;
- Continuous and intermittent night flow analysis;
- Identification of how all systems operate;
- Temporary placement of leakage detection equipment and/or loggers;
- Installation of two-point controllers on all clusters of standpipes. The controllers will reduce pressure in the distribution lines to standpipes at times of minimal usage, and increase this pressure during times of high demand, on a daily basis.

Active leakage control consists of the following activities:

- regular inspection and sounding of all water main fittings and connections (leakage surveys);
- leakage modelling via innovative methods such as minimum night flow analysis;
- metering of individual pressure zones;
- District Metered Area (DMA) metering (measuring total inflow per day, week or month);
- continuous or intermittent night flow measurements;
- short-period measurements at any time of day;
- temporary placing of leak noise detectors and loggers.

The effect of burst and leak run time has been exposed and incorporated as an active leakage control strategy. Leaks left to run long periods of time create large annual loss volumes. In any distribution system, the greatest annual volume of real losses occur from long-running, small-to-medium sized leaks on customer service connections, except at very low densities of service connections. To achieve successful leakage control, water utilities must be effective and efficient in providing routine surveillance to identify leaks and in executing timely, lasting repairs.

It is estimated that by **repairing plumbing leaks** within the domestic consumers the total consumption can be reduced by between 7% to 25% of the domestic household usage. Plumbing leaks include any leaks past the consumer connection, and include leaks within the connection pipe, leaking taps, leaking toilets and leaking hot water geysers. Repairs of plumbing leaks can be achieved by the following related activities:

- Leak repair projects in formerly disadvantaged areas where relatively low household income doesn't accommodate expenditure on maintenance of waterborne sanitation systems, sponsored by the water institutions;
- Communication and education campaigns;
- Ensuring payment of services through credit control measures.

By **replacing existing plumbing fittings** with more efficient fittings the total consumption can be reduced by roughly 14% or 50% of the domestic household and commercial water use. Opportunities in retrofitting of plumbing fittings include fitting dual-flush or interruptible toilets, user-activated urinals, low flow shower heads and tap controllers and aerators. Retrofitting can be achieved by implementing the following:

- Retrofit projects in the formerly disadvantaged areas sponsored by the water institutions (combined with leak repair projects described above);
- Communication and education campaigns;
- Grant incentives schemes where water institutions will pay part of the costs to retrofit to the consumer;
- Regulation and by-laws;
- Marketing and research of new technology;
- Schools audits.

Projections estimate that by increasing the efficiency of **gardening water usage** the total consumption can be reduced by 5% to 25% of the total gardening water use. Opportunities in reducing water used for gardening include water wise plants, mulching, efficient irrigation systems, irrigation scheduling, and rain harvesting and recycling of household grey water. Reduction in gardening usage can be achieved by the instituting the following:

- Communication and education campaigns;
- Water-wise demonstration exhibits;
- Block rate tariffs;
- Regulation and by-laws;
- Marketing and research of new technology;
- Grant incentives scheme for lawn replacement and zero-scaping where water institutions can pay part of the costs to change existing gardens.

By increasing the efficiency of all new consumers it is possible **to reduce the growth** in water demand significantly. Opportunities in reducing water demand of new consumers include selecting appropriate level of services for different communities, efficient plumbing fittings, efficient reticulation design practices and pre-payment meters by introducing the following:

- Installation of pre-payment meters;
- Communication and education campaigns;
- Regulation and by-laws;
- Negotiations and incentives to developers;
- Improved reticulation design and plumbing standards.

Apparent losses typically don't carry the tangible impact that is experienced with real losses. Rather, they wield a significant financial effect on both water suppliers as well as customers. Apparent losses also compromise efforts to reliably distinguish actual water consumption from real loss volumes.

In the IWA water balance, apparent losses are represented by **metering inaccuracies** and illegal, unauthorised consumption. Typically, in South African water supply systems, the latter (unauthorised consumption) constitutes the largest volume.

Financially, apparent losses represent service rendered without payment recovered. The short-term economic impact of apparent losses may be much greater than real losses since they occur at the consumer tariff charged to customers, while short-term real losses occur at the marginal or unit cost of water. It is evident that both real and apparent losses have a significant impact on infrastructure development: high real losses result in oversized pipelines and storage facilities, while high apparent losses sacrifice a portion of utility revenue that could be invested in infrastructure needs. Recovering apparent loss can be attractive since it usually offers a speedy payback; controlling apparent losses also improves equity in revenue collection since a portion of apparent losses occur when some active customers are inadvertently left out of the billing system.

All non-paying consumers are effectively subsidized by paying customers, resulting in pressures that exacerbate the need for higher water rates. Many water operators perceive customer meter inaccuracy is the sole "administrative" loss that occurs in water supply systems. While numerous utilities have documented accountability improvements by replacing old, worn residential meters, or "right-sizing" large commercial or industrial meters, it should be recognized that apparent losses have a number of components, including:

- Customer meter inaccuracy; usually occurring due to meter wear, malfunction or inappropriate size or type of meter;
- Data transfer error in transferring customer metered usage data into a database or billing system;
- Data analysis error, including poor estimating procedures used for unmetered or unread accounts;
- Poor accounting, including lack of controls that ensure accounts exist for **all** water users and bills are issued or tabulated (even if water is supplied at no cost). This also includes procedural gaps that allow legitimate water users to exist in "non-billed" status;
- All forms of unauthorised use, including tampering with metering equipment, water taken illegally from fire hydrants, unauthorised taps into service mains or unauthorised restoration of water service connection valves after violation discontinuance by the water supplier;
- Weak or non-existent policy, including the often-used practice of not billing/metering municipal-owned or other public buildings, allowing unrestricted use of fire hydrants, lack of enforcement of existing statutes, lack of promotion of the value of water, etc.;

- Upgrade the Billing System and Database, ensuring there are sufficient, responsible personnel who are qualified and trained to manage the billing system;
- All existing connections need to be registered and bills forwarded regularly;
- Conduct a pilot project on consumer meters that were installed more than 20 years ago to determine accuracy levels;
- Ensure billing other government departments is conducted efficiently and that the meters are regularly read;
- All data from new connections need to be registered;
- Ensure that flow limiters are effective in limiting quotas allocated to individual consumers;
- Investigate cases of replaced meters still existing in the billing database and clean the same by removal;
- Investigate all consumers/properties that have zero, or close to zero, consumption;
- Investigate alternative consumer metering strategies such as prepayment meters;
- Investigate, as a matter of urgency, Top Consumers per Local Municipality, ensure that connection meters are properly installed and correctly sized, that the consumer is registered in the Billing System and meter is read monthly;
- All municipal consumptions must be accurately metered and consumption assigned to the relevant votes;
- All unmetered standpipes within the municipality must either be individually metered or clustered, the meters should be regularly read and bills posted to relevant Departments;
- Investigate all properties that have not been registered/legally connected – these are probably illegally connected. If found, formalise the meter connection, ensure due legal recourse, register meter on Billing System and bill;
- Monitor zone meters frequently to determine any illegal connection volumes and increased water leaks;
- Conduct a pilot project on consumer meters that are 5 year old, 10 years old, 15 years old and older to determine their accuracy levels;
- Preparation of a schedule to replace all faulty and old inaccurate meters;
- Develop meter replacement strategy.

An aspect of WCDM that was not addressed in the 5 year WCDM strategy, but forms an integral part of the National Water Resources Strategy is the concept of **water re-use**. MMM is ideally positioned to implement water re-use in a number of instances. The re-use opportunities will result in a reduced SIV and will also reduce the total cost of water supply. The water reuse opportunities have been modelled as Scenario 5 in Part 2 of this document and reduces the SIV significantly and also the system input cost. Two of the most prominent water re-use opportunities include:

- Supernatant Water Reuse at Maselspoort WTW;
- Planned capacity and treatment process upgrading of Maselspoort WTW to treat additional water to a better quality;
- Further water re-use opportunities exist by transferring effluent, currently discharged into the Renosterspruit from the NE WWTW to the Mockes/Maselspoort Dam for treatment to potable standards at Maselspoort WTW. In order to use more raw water from Maseslpoort WTW the current Bloem Water Service Level Agreement will have to be revised. This will allow MMM utilising more of the locally available water resources and purchasing less from Bloem Water.

The **Zoning and water balance** strategy should therefore include the following aspects:

- GIS based zoning plan with clearly delineated metering and pressure zones;
- Live water balance model for each water zone to determine: input volume, metered use, non-revenue water, average zone pressure;
- Meter installation and replacement programme;
- Pipe replacement programme;
- Consumer fitting replacement programme;
- Identify high burst areas and high real loss areas to start a pressure management programme;
- A clear water re-use action plan to reduce system input volume and total water supply cost;
- Active telemetry system controlling water supply into system, transferring water across system through booster pumps, controlling reservoir levels and reducing pressure into pressure zones.

4.2.2. Financial Strategy

An appropriate **revenue management** strategy that maximises income and revenue collection needs to be developed and implemented. An appropriate **tariff setting plan** forms the basis for the amount of revenue that would be collected from the water sales. It is appropriate that all points of entry and outlets should be installed with meters in order to ascertain the volumes of water passing through and also to ensure cost recovery. This includes both authorised and unauthorised consumptions. Authorised consumption forms an integral part of the water balance calculations. However, the confirmation of the integrity of the data in the **billing database** did highlight certain shortcomings of the existing billing database. Unauthorised consumption could contribute significantly to the water balance and potentially forms the largest component of apparent loss. Unauthorised consumption comprises of both consumers who have registered connections but have bypassed these illegally, as well as those consumers who do not have registered connections.

In the “top-down” approach of compiling the IWA water balance, the quantification of unauthorised consumption is very subjective and depends entirely on the operator’s feel for the system. The simplest way of determining the quantity of unauthorised consumption is to apply a factor to the entire water losses volume (determined from the water balance by subtracting authorised consumption from the system input volume).

Revenue generation is the one side of the financial strategy. The other side of the strategy has to deal with the short and long term expenses. The **short term expenses** needs to be provided for in the annual expense budget whereas **the long term expenses** need to be funded through internal or external loans or grants. Annual **budgets** need to be developed to establish annual budget deficit/surplus with tariffs adjusted to ensure sufficient income for short and long term liquidity.

Long term WCDM operational and capital budgets need to be prepared in order to project tariff increases, capital and funding requirements.

A **funding strategy** is a written and agreed plan that determines the financial requirements of an organisation. MMM should develop a practical funding strategy on how to raise funds for its operations. It should be understood by all trustees, staff and stakeholders.

By reviewing the water balance in the context of water re-use as part of the 10 year strategy, the achievable NRW can be reduced to 30%. It has also now become possible to fund WCDM initiatives through national grant funding. Ideally the funding for WCDM should be generated from long term savings accrued from WCDM initiatives.

Key aspects of the financial strategy should therefore include:

- **Tariff** setting;
- **Metering, billing and cost** recovery;
- Short term annual **operational budget;**
- Long term **funding** requirements and prioritisation of WCDM capital investment.

In the case of water scarcity where the SIV cannot be met by the water supply system, **water restrictions** and punitive measures will have to be put in place. Both these actions will reduce the water demand and will impact negatively on the water sales and revenue to MMM. It is essential that the impact of water restrictions (both the financial effect of water restrictions and the effect on water demand) be modelled and that the water tariffs be adjusted to account for the loss of revenue as a result of lower water sales.

4.2.3. Consumer awareness and education strategy

Part of the successful implementation of a WCDM programme would be the implementation of a comprehensive communications strategy that is focused on the following role-players both inside and outside MMM:

- MMM – Area Managers and Operations staff;
- MMM – Senior management;
- MMM – Exco and Councilors (including various standing committees);
- MMM – Marketing and public relations;
- Consumers;
- Water Service Authorities;
- Water Service Providers.

Consumer awareness and education would include the following, among other things;

- An extensive schools programme which might also include annual competitions between schools (e.g. with a prize for the lowest water consumption, the lowest per capita consumption and for the best WCDM Strategy poster design, etc.);
- Public awareness programmes (PAP's) conducted in conjunction with the media to inform the public of what the Municipality is doing (and has done) to save water. The PAP's should focus on a 'lead-by

example' approach whereby the municipality reveals their own successes instead of informing end-users what they should do to save water;
- Explain opportunities for local water re-use to consumers;
- Addressing issues regarding non-payment of water;
- Large water consumers' one-on-one custom methods to reduce demand.

The consumer awareness and education strategy should therefore include the development of a clear WCDM stakeholder awareness and education programme.

4.2.4. Human Capital Strategy

Based on the current WCDM structure that still needs to be approved by MMM it would appear that sufficient internal resources have been allocated. What is not clear is to what extent **external service providers** are used, internal support services are available for use by the WCDM function and when the vacancies will be filled.

MMM must be aware of the fact that any WCDM intervention is not just a "once off" programme that can be left aside once the targets have been achieved. System attrition is a real problem and just as much effort must be focused on sustaining lowered NRW levels as achieving them in the first place. Linked to the business process mapping activity the following Human Capital related activities are required:

- Determine if the current **WCDM structure** is suitably integrated within current MMM structures;
- Develop a **resourcing strategy** informed by WCDM structure with a balance between internal resources and outsourced resources;
- Develop appropriate **training programmes** for internal resources;
- Develop **cross functional awareness** between Finance and Engineering Directorates
- Identify and develop key **policies and procedures** required to guide WCDM operations.

It is foreseen that MMM will have to outsource a significant portion of the WCDM functions until sufficient momentum has been gained in savings realised from WCDM activities in order to justify the appointment of full time internal resources.

It is imperative that any resource/official that forms part of the WCDM section be actively involved in a comprehensive and sustainable **skills development** programme. Ideally this should form part of the Workplace Skills Development Plan of MMM. The following activities will benefit all internal staff:

- Interactive visits and proactive engagement with other National WSAs and WSPs;
- Interaction with international public sector water utilities;
- Attendance at relevant training courses as and when held (e.g. through WISA, WRC or IWA);
- Development of a Standards and Procedures Manual that can serve both as a Quality Management System and induction training material;
- Development of customized accreditation criteria, such as for leak detection, that allows for Client assurance in a quality product.

4.2.5. Institutional Strategy

The institutional strategy support all the programmes and projects that will be implemented under this strategy. Without the institutional structures, **business processes** and programmes, very little progress will be made. The key aspects that need to be included in the institutional and human capital strategy include the following;

In order to translate the WCDM strategy into executable programmes and plans it is essential that an integrated **WCDM programme and project management** function be established within MMM. Without this integrated planning function, the WCDM objectives will not be achieved. An impact, influence and dependency model could be developed from an institutional perspective.

It is also important that all Directorates of MMM are informed by the impact, influence and dependency of WCDM as an MMM wide accepted strategy.

Currently, MMM does not have adequate **policies and procedures** in place to guide internal resources in terms of WCDM best practises. These policies and procedures are required to standardise WCDM related activities. A relevant policy should be instated in order to provide a technical foundation for the responsible technical departments within the Municipality.

Some of the policies that impact on WCDM that need to be considered are listed below. MMM has developed strategies for some of these items:

- Metering policy for meter selection, installation and replacement;
- Meter reading policy;
- Billing and cost recovery policy;
- Water tariff policy;
- Water restrictions and punitive measure policy;
- Asset management policy;
- Financial and funding policy;
- Human resource policy;
- Consumer awareness and education policy;
- Information management policy.

4.2.6. Systems Strategy

The strategic objectives of the WCDM programme will guide the functions that need to be performed which in turn will inform the **business process** requirements. The development of the business processes will inform the correct structure of the WCDM function. This methodology follows the old maxim of “form follows function”. It is necessary that the WCDM related business processes be mapped. Based on the most effective business processes, the current WCDM structure should be reviewed and adjusted where required. Once the structure has been developed the most suitable resourcing of the structure can be determined.

All too often MMM has a fragmented approach to information management, data is duplicated in many places or alternatively data is completely missing. Developing an information system is the foundation that should be in place before an attempt is made to justify or implement WCDM initiatives.

Location of water related infrastructure and equipment is a critical problem in MMM. It is cardinal that a systematic approach to location methods such as tracking are adopted and institutionalised. The **GIS based information system** can be used for a number of operational and planning based activities such as:

- Water system age;
- Payment history;
- High consumption areas;
- Areas in which frequent pipe breaks occur.

Apart from generating intelligent queries, the GIS system can also be a depository for all as-built information of infrastructure as well as serving as a host for a dynamic water network model.

An **integrated GIS based meter data base** forms the basis of any WCDM program. The meter data base should be configured not only for purposes of meter data collection, but also for purposes of maintenance asset management and GIS interrogation. The meter database should be setup in meter zones with the ability to establish a water balance for each meter zone. The meter database should be intelligent to identify meter anomalies such as reverse flow, high consumption, trends, meter stoppages and meter replacement. The meter databases should form part of a MMM wide asset database containing information required for all aspects of asset management.

WCDM **system performance measurement** is a means to monitor the effectiveness of the interventions so that corrective measures may be applied, if necessary. This forms part of the Integrated **Information Management System** and interrogates the meter data based and calculates the key WCDM performance indicators. As part of the Information Management System a rigid monthly reporting system will need to be implemented in order for progress to be recorded. The monthly reports will need to communicate progress to various role-players and will need to include the following items:

- Water balances for month and year-to-date;
- Physical progress on WCDM activities;
- Progress against targets;
- Key Performance Indicators – actual and trend;
- Budget and expenditure;
- Identification of challenges;
- Success stories;
- Recommended changes to intervention strategy.

Quality Assurance plays an important role in the implementation of any WCDM programme and without a Quality Management System in place which is actively monitored by the Client; the desired impact of WCDM may not be achieved. Quality assurance applies just as much to the Client organisation as it does to any external service provider. Quality Assurance plays an important part in the Work Plan, which serves as a detailed breakdown of activities, roles and responsibilities; although this can only be addressed with the required attention to detail once the actual work packages have been determined.

All the system information management must be stored or operated from a central point within MMM. The establishment of a control centre from where all the complaints and water supply related activities are managed has for some time been contemplated. The **MMM Control Centre** will be able to orchestrate all aspects of the WCDM strategy, provided the information management strategy is implemented. It is essential that information management strategy be implemented before the control centre can function.

The information management strategy should therefore include:

- Identify information that needs to collected for effective WCDM programme;
- Identify GIS system suitable for encapsulating WCDM information;
- Populate GIS system with meter information and functionality to perform meter queries and WCDM performance indicators;
- Link GIS with financial, budget and tariff systems;
- Establish control centre with suitable information management tools to monitor actual WCDM and financial performance, quality of repairs and many other performance measures.

An **Asset Management Strategy** is a high level but very important strategy that guides the overall asset management activities within an organisation. Being a strategy it is meant to explore long term issues and ensure that the overall plan is linked to key "strategic" issues of the organisation. The Asset Management Strategy should give an outlook on, at least, the next 20 years. The strategy will start with the "vision, the goals and objectives" and will describe how, in practical terms, these corporate objectives can be achieved (generally in the longer term). The strategy covers macro items (and activities) and leaves the detailed (micro) environment to the more specific plans. Asset management systems include the following;

- Asset information system;
- Asset maintenance system;
- Asset replacement system.

Finally the overall systems strategy should address the following objectives:

- Establish a dedicated WCDM **program management function** that assumes overall responsibility for the WCDM strategy;
- Develop clear and detailed WCDM **programmes and projects** support the WCDM strategic objectives;
- Develop and map **WCDM business processes**.

4.3. Business Plan Development

Operations management is an area of management concerned with overseeing, designing, and controlling the process of production and redesigning business operations in the production of goods or services. It involves the responsibility of ensuring that business operations are efficient in terms of using as few resources as needed, and effective in terms of meeting customer requirements. It is concerned with managing the process that converts inputs (in the forms of raw materials, labour and energy) into outputs (in the form of goods and/or services).

The highest-level officers shape the strategy and revise it over time, while the line officers make tactical decisions in support of carrying out the strategy.

The 5 year strategy developed some of the building blocks required for the development of the 10 year strategy. In order to operationalise the WCDM business strategy it is essential to develop an integrated **WCDM business plan**. This is an iterative process as depicted in Figure 4-1.

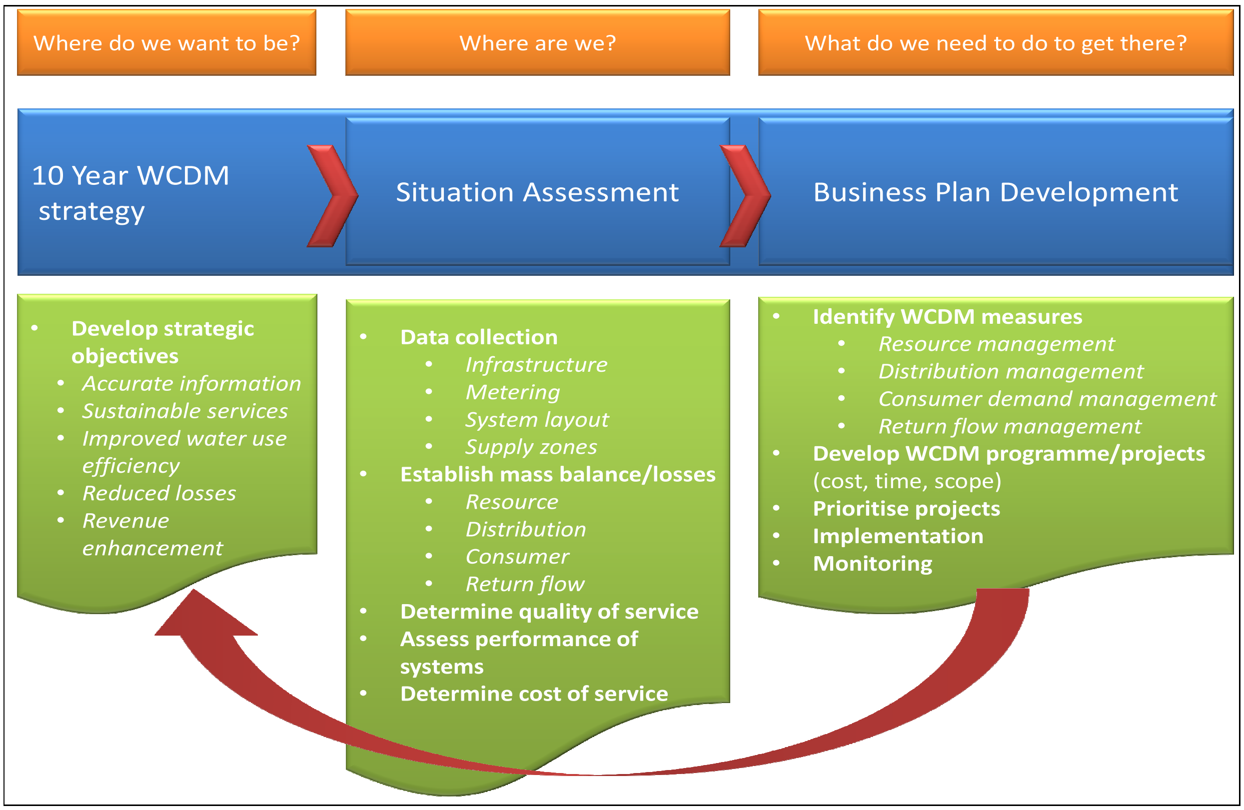


Figure 4-1: WCDM Business Planning Process

This business plan needs to define and prioritize detailed project execution plans (PEPs) and allocate financial and human resources (HR) in order to drive execution. The PEPs should be prioritized based on return on investment and strategic importance. In this regard the meter replacement PEP will show a much higher return on investment compared to the pipe replacement PEP, but in the long term the water supply system will fail if pipes are not replaced in time. The return on investment decisions should therefore be made based on an integrated suite of PEPs required for a sustainable water supply system.

The central WCDM program management function needs to develop project schedules for each of the PEPs and monitor and report performance. A critical bottleneck in any municipal system is the procurement of products and services. The requirements of the MFMA and other applicable legislation put onerous administrative responsibility on the WSA to ensure transparent and value for money procurement processes. This is time consuming and needs to be planned in advance and included in the schedule developed for all PEPs.

The operations strategy should therefore include aspects such as;

- WCDM Business plan development with detailed and prioritised project execution plans, schedules and return on investment information and adequate financial and human resource allocation;
- Detailed WCDM business plan operational and capital budget;
- WCDM Master plan with frequent reporting on progress, costs and risks;
- WCDM procurement schedule for products and services.

4.4. Key Performance Indicators and Targets

The combined MMM current key performance indicators and associated targets for 2027/2028 are summarised in Table 4-1. KPIs for individual sub-systems (Bloemfontein, Botshabelo, Thaba Nchu, Dewetsdorp, Wepener, Vanstadensrus and Soutpan) will have to be developed during the execution of the 10 year strategy.

Table 4-1: Key WCDM Performance Indicator Targets.

KPI Description	2013/14	Target (2027/28)
SIV Growth	2%	1%
Real Losses	41%	28%
Apparent Losses	4%	2%
Unbilled Authorised Consumption	2%	2%
Total NRW	47%	30%
ILI	9.5	4.96

Careful analysis will be required to identify cost effective improvements and this needs to be continuously assessed depending on monthly water balances and changes to the water supply system condition.

4.5. Cost and Benefits of WCDM Interventions

4.5.1. Investment Requirements

The WCDM interventions recommended in this report will require a constant and significant investment over the ten year period of which the largest portion will be to upgrade Maselspoort WTP, pipelines, water networks, valves and meter infrastructure. A large portion of the cost is earmarked for the upgrading of the Maselspoort WTP (including implementation of water re-use from the North-Eastern (NE) Waste Water Treatment Plant (WWTP)) in an effort to reduce the SIV. It is also recommended that the current Bloem Water-MMM Service Level Agreement (SLA) be revised to enable a smaller SIV portion purchased from Bloem Water (the current SLA limits the supply from the Maselspoort WTP to 33% of Bloemfontein's water demand).

The balance of the budget is earmarked for real loss reduction (pipe condition assessments, pipeline replacement, fitting and valves replacement, leak detection and -repairs), apparent loss reduction (meter replacement), unmetered authorised consumption (new meter installation) and consumer education and awareness programmes. The total investment required for the revised ten year period (FY 2017/18 to FY 2027/28) including the upgrades required at Maselspoort WTW and water reuse infrastructure is R4 417 000 000 as indicated in Table 4-2 below. The total cost excluding the upgrades at the Maselspoort WTP and water reuse infrastructure is estimated to be R 3 131 000 000.

Cost of WCDM interventions	WCDM Investment Requirements (R x million)- Excl. VAT											
	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	TOTAL
SIV I nput reduction cost	**13**	**275**	**388**	**620**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1 296**
Real loss reduction cost	**253**	**254**	**245**	**245**	**246**	**247**	**248**	**249**	**249**	**250**	**251**	**2 737**
Mains & reticulation replacement	*232*	*232*	*223*	*224*	*225*	*226*	*226*	*227*	*228*	*229*	*230*	**2 501**
Valves replacement	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	*21*	**228**
Reservoir losses	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	**8**
Apparent loss reduction cost	**17**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**16**	**178**
Unbilled consumption reduction cost	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**19**	**207**
Total WCDM cost	**302**	**563**	**667**	**900**	**281**	**282**	**283**	**283**	**284**	**285**	**286**	**4 417**

Table 4-2: Summary of Revised WCDM Capital Investment Cash Flow Requirements

Table 4-2 summarises the cost of interventions in each successive year until 2027/28. The investments is estimated to peak at about R900 million per annum and stabilises at about R280 million per annum as shown in Table 4-2. Details of the investment requirements is shown in Table 4-3 and includes the cost of strategic interventions identified for Bloemfontein, Botshabelo, Thaba Nchu, Dewetsdorp, Wepener, Vanstadensrus and Soutpan.

4.5.2. Cost-Benefit Analysis

In order to place the potential water savings and the return on investment into perspective the effect of the implementation of the proposed WCDM initiatives on the SIV alone is emphasised. The implementation of the proposed water re-use by 2020/21 will reduce raw water abstraction by 45Mℓ/day (16 425Mℓ per annum). At the current Bloem Water tariff of R7.23 per Kℓ raw water abstraction the implementation of re-use alone will enable a saving of R 1 118 million over ten years (R 118.8 million per annum). Furthermore, with the implementation of the proposed Scenario 5 (implementing a combination of WCDM initiatives), the potential potable SIV reduction for the projected ten (10) years is 310 725 Mℓ which translates to a direct saving of R 3 088 million (R308 million per annum) at the current Bloem Water tariff of R9.94 per Kℓ.

The total impact of the implementation of re-use together with the implementation of Scenario 5 results in a total potential saving of R 4 268 million for the next ten years (R426 million per annum). This potential saving in SIV reduction alone thus nearly constitutes the total WCDM investment requirements of R 4 417 million over the next ten years. This potential saving excludes the effect of inflation on water purchase rates and also excludes the effect of the potential revenue increase as a result of the proposed increased Billed Metered Consumption as defined in Scenario 5. The total potential saving will thus far outweigh the total investment requirements within the next ten (10) years.

Despite the financial resources required for capital upgrade projects, a significant investment is also required for the appointment of internal resources, services provider and information management systems. The investment required is thus significant, but the benefits that can be derived from the investments will ensure a sustainable water supply for MMM in the long-term.

The 10 year strategy aims at using water more efficiently (reducing losses) and increasing the revenue earning ability (increase authorised billed water use) of MMM. If the recommended WCDM strategies are implemented and the planning assumptions for Scenario 5 is achieved the following figures are applicable for the time frame 2017/18 to 2027/28:

- SIV - System Input Volume would increase from **86.6 million m^3/annum** in FY 2013/14 to **103.5 million m^3/annum** in FY 2026/27, recording a rise of only **16% (16.9 million m^3/annum)** over the next 10 year period (from FY 2017/18 to FY 2027/28) considering the increase in stands and service level improvement. The SIV is projected to be contained within the population increase despite the planned improvement in level of service.
- Billed Metered Consumption would rise from **44.6 million m^3/annum** in FY 2013/14 to **64.1 million m^3/annum** in FY 2027/28 recording a rise of **38% (19.5 million m^3/annum)** over the next 10 years (from FY 2017/18 to FY 2027/28).
- NRW volumes would decrease from **40.3 million m^3/annum** in FY 2013/14 to **32.5 million m^3/annum** in FY 2027/28 recording a reduction of **13% (7.8 million m^3/annum)** over the next 10 years (from FY 2017/18 to FY 2027/28).
- To achieve this the total cost of the interventions would be in excess of **R4 417 million**. This includes the cost for Maselspoort WTW upgrade and construction of infrastructure to enable water reuse totalling **R1 285.5 million.**

Refer to Figure 4-2 for a visual illustration of the distribution of WCDM capital investments required over the next ten years.

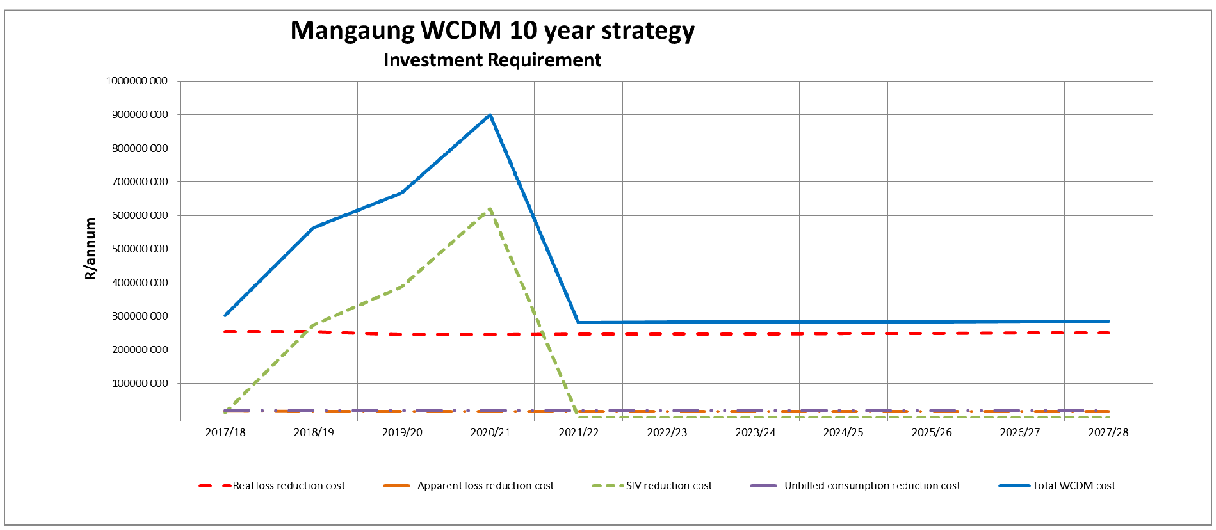


Figure 4-2: WCDM Investment Requirements.

The cost/benefit ratios are shown in Table 4-4. The ratios were normalised by the SIV and it is evident that apart from the necessary upgrades at Maselspoort the most expensive NRW activity is the reduction of real losses.

Cost of WCDM interventions	WCDM Investment Requirements (R x million)											
	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	TOTAL
SIV input reduction cost	**13 000 000**	**274 500 000**	**388 000 000**	**620 000 000**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1 295 500 000**
Maselspoort WTW Treatment and Re-Use Pipelines	5 500 000	272 000 000	388 000 000	620 000 000								
Maselspoort WTW filter wash water recovery	5 000 000											
SIV Measurement and Metering Positions Reconciliation and Bulk Meter Accuracy Verifications	2 500 000	2 500 000										
Real loss reduction cost	**253 163 883**	**253 851 915**	**244 553 708**	**245 269 537**	**246 254 682**	**246 999 430**	**247 759 073**	**248 533 909**	**249 324 242**	**250 130 382**	**250 952 644**	**2 736 793 405**
Mains & reticulation replacement	*231 763 883*	*232 451 915*	*223 153 708*	*223 869 537*	*224 854 682*	*225 599 430*	*226 359 073*	*227 133 909*	*227 924 242*	*228 730 382*	*229 552 644*	***2 501 393 405***
Replace midblocks												
Pipe Condition Assessments	10 000 000	10 000 000										
Pipe replacement (replace over 50 years)	108 895 451	108 895 451	108 895 451	108 895 451	108 895 451	108 895 451	108 895 451	108 895 451	108 895 451	108 895 451	108 895 451	
Pro-active Leak detection	3 600 000	3 600 000	3 600 000	3 600 000	3 600 000	3 600 000	3 600 000	3 600 000	3 600 000	3 600 000	3 600 000	
Nework zoning and zoning meters	777 273	777 273	777 273	777 273	777 273	777 273	777 273	777 273	777 273	777 273	777 273	
Management of meter zones	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	
Pressure management (licensing)	4 335 000	4 335 000	4 335 000	4 335 000	4 590 000	4 590 000	4 590 000	4 590 000	4 590 000	4 590 000	4 590 000	
Pressure management (control valves)	1 554 545	1 554 545	1 554 545	1 554 545	1 554 545	1 554 545	1 554 545	1 554 545	1 554 545	1 554 545	1 554 545	
Pressure management (locating valves)	40 000 000	40 000 000	40 000 000	40 000 000	40 000 000	40 000 000	40 000 000	40 000 000	40 000 000	40 000 000	40 000 000	
Replacement of fittings (5 year replacement freq)	28 003 818	28 563 894	29 135 172	29 717 876	30 312 233	30 918 478	31 536 848	32 167 585	32 810 936	33 467 155	34 136 498	
Pipeline upgrading												
Leak repairs	27 000 000	27 000 000	27 000 000	27 000 000	27 000 000	27 000 000	27 000 000	27 000 000	27 000 000	27 000 000	27 000 000	
Leakage on Service Connections	6 397 795	6 525 751	6 656 266	6 789 392	6 925 179	7 063 683	7 204 957	7 349 056	7 496 037	7 645 958	7 798 877	
Valves replacement	*20 700 000*	*20 700 000*	*20 700 000*	*20 700 000*	*20 700 000*	*20 700 000*	*20 700 000*	*20 700 000*	*20 700 000*	*20 700 000*	*20 700 000*	***227 700 000***
Valve audit	1 800 000	1 800 000	1 800 000	1 800 000	1 800 000	1 800 000	1 800 000	1 800 000	1 800 000	1 800 000	1 800 000	
Valve maintenance & replacement (15 years)	18 900 000	18 900 000	18 900 000	18 900 000	18 900 000	18 900 000	18 900 000	18 900 000	18 900 000	18 900 000	18 900 000	
Reservoir losses	*700 000*	*700 000*	*700 000*	*700 000*	*700 000*	*700 000*	*700 000*	*700 000*	*700 000*	*700 000*	*700 000*	***7 700 000***
Cathodic protection (of steel pipes)	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000	
Telemetry system (level control) (PC to confirm)	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	600 000	
Apparent loss reduction cost	**17 015 600**	**16 115 600**	**16 115 600**	**16 115 600**	**16 115 600**	**16 115 600**	**16 115 600**	**16 115 600**	**16 115 600**	**16 115 600**	**16 115 600**	**178 171 600**
Domestic meter replacement (very old, older than 7 years, faulty meters)	1 692 000	1 692 000	1 692 000	1 692 000	1 692 000	1 692 000	1 692 000	1 692 000	1 692 000	1 692 000	1 692 000	
Domestic meter unmetered and relocations (Thaba Nchu & Botshabelo)	3 024 000	3 024 000	3 024 000	3 024 000	3 024 000	3 024 000	3 024 000	3 024 000	3 024 000	3 024 000	3 024 000	
Large replacement (very old, older than 5 years, faulty>40 mm)	1 080 000	1 080 000	1 080 000	1 080 000	1 080 000	1 080 000	1 080 000	1 080 000	1 080 000	1 080 000	1 080 000	
Communical stand meters installation (very old, 7 years and faulty)	507 600	507 600	507 600	507 600	507 600	507 600	507 600	507 600	507 600	507 600	507 600	
Government meter installation (7 years and faulty)	252 000	252 000	252 000	252 000	252 000	252 000	252 000	252 000	252 000	252 000	252 000	
Lifting of bulk meter to above ground	1 260 000	1 260 000	1 260 000	1 260 000	1 260 000	1 260 000	1 260 000	1 260 000	1 260 000	1 260 000	1 260 000	
Consumer Awareness & Education Programmes	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	5 000 000	
Top 500 consumers ID and meter monitoring	2 400 000	2 400 000	2 400 000	2 400 000	2 400 000	2 400 000	2 400 000	2 400 000	2 400 000	2 400 000	2 400 000	
Illegal consumption (assume 1% off stands illegal)	1 800 000	900 000	900 000	900 000	900 000	900 000	900 000	900 000	900 000	900 000	900 000	
Unbilled consumption reduction cost	**18 803 156**	**18 803 156**	**18 803 156**	**18 803 156**	**18 803 156**	**18 803 156**	**18 803 156**	**18 803 156**	**18 803 156**	**18 803 156**	**18 803 156**	**206 834 711**
Installation of meters on unmetered connections	3 988 145.45	3 988 145.45	3 988 145.45	3 988 145.45	3 988 145.45	3 988 145.45	3 988 145.45	3 988 145.45	3 988 145.45	3 988 145.45	3 988 145.45	
New connection (meter installation)	7 862 410.13	7 862 410.13	7 862 410.13	7 862 410.13	7 862 410.13	7 862 410.13	7 862 410.13	7 862 410.13	7 862 410.13	7 862 410.13	7 862 410.13	
Metering of informal settlements	6 952 600	6 952 600	6 952 600	6 952 600	6 952 600	6 952 600	6 952 600	6 952 600	6 952 600	6 952 600	6 952 600	
Total WCDM cost	**301 982 638**	**563 270 670**	**667 472 463**	**900 188 292**	**281 173 438**	**281 918 186**	**282 677 829**	**283 452 665**	**284 242 998**	**285 049 137**	**285 871 400**	**4 417 299 716**

Table 4-3: Capital Cost Requirements for Scenario 5.

Normalised Unit Cost of Interventions (R/m^3)	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Real Loss Cost/SIV	2.84	2.76	2.61	2.57	2.53	2.51	2.49	2.47	2.46	2.44	2.43
Apparent Loss Cost/SIV	0.19	0.18	0.17	0.17	0.17	0.16	0.16	0.16	0.16	0.16	0.16
Unbilled Loss Reduction Cost/SIV	0.21	0.20	0.20	0.20	0.19	0.19	0.19	0.19	0.19	0.18	0.18
SIV cost/SIV	0.15	2.99	4.14	6.49	-	-	-	-	-	-	-
Total Cost of Interventions	301 982 638	563 270 670	667 472 463	900 188 292	281 173 438	281 918 186	282 677 829	283 452 665	284 242 998	285 049 137	285 871 400

Table 4-4: Cost/Benefit Ratios for Real Losses, Apparent Losses, Unbilled Loss Reduction and SIV Reduction for Scenario 5.

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5. PART 4 – SMALLER TOWNS (Dewetsdorp, Wepener, Van Stadensrus and Soutpan)

The ambit of this report includes the expansion of WCDM investigations and recommendations for the inclusion of the additional towns of Soutpan, Dewetsdorp, Wepener, and Van Stadensrus. This follows the Municipal Demarcation Board's decision to re-determine the municipal boundaries of Mangaung Metropolitan Municipality (MMM), Xhariep District Municipality (DC 16) and Naledi Local Municipality (FS 164).

5.1. Status Quo Bulk Supply Overview of the Smaller Towns

The following section includes a status quo assessment of each town including a desktop analysis of existing information in order to determine infrastructure and strategic development plans shortfalls. From the status quo analyses critical shortfalls affecting the financial and operational management of WCDM in MMM as a holistic entity have been identified. In order to ensure that MMM continues to build on the strong momentum created over the past few years in the implementation of WCDM strategies; high-level commitment from stakeholders and investment is required for the successful first-order implementation of the proposed Water Conservation Demand Management (WCDM) Strategies for the smaller towns.

5.1.1. Dewetsdorp

The town of Dewetsdorp, consisting of Dewetsdorp and Morojaneng, is situated approximately 80km south east of Bloemfontein on the R702 to Wepener in the Free State Province. The district is renowned as a prime sheep and cattle farming area. Dewetsdorp has no large commercial or industrial sector and water users consist mainly of domestic type users (Phethogo Consulting, 2016).

Dewetsdorp receives bulk water via a pipeline from Bloem Water's Welbedacht – Bloemfontein Pipeline, and from local boreholes when they are operational. Dewetsdorp Town Area receives it potable water supply wholly from Bloem Water. The town does not have its own surface water sources (Phethogo Consulting, 2016).

Dewetsdorp and Morojaneng are provided with potable water from the Welbedacht Purification Works via a take-off on the De Hoek-Bloemfontein pipeline (WorleyParsons RSA (Pty) Ltd, 2012). Dewetsdorp is provided with water via the Caledon-Bloemfontein works which supplies in 69% (per agreement) of the needs of Bloemfontein (Phethogo Consulting, 2016). Refer to Figure 5.1 below for an illustration of the bulk water distribution network supplying Dewetsdorp and surrounding areas with water.

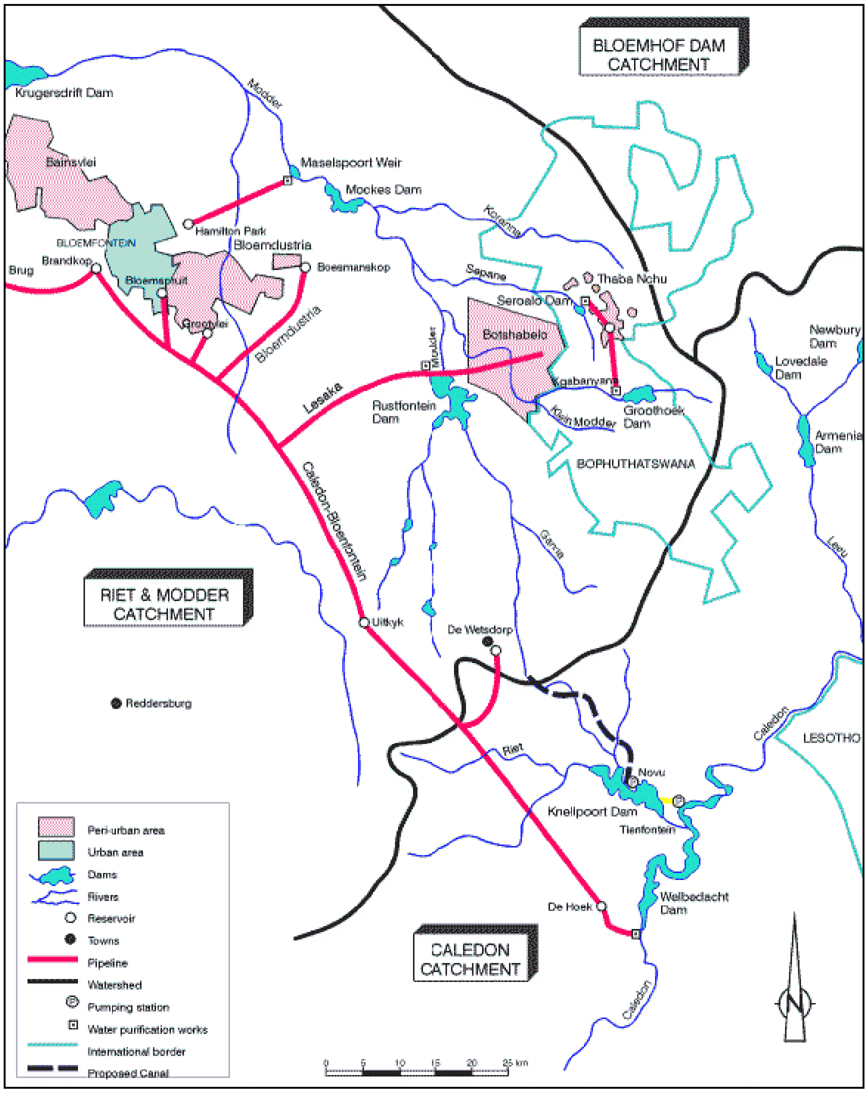


Figure 5.1: Overview of Bulk Distribution Network

Water Supply System

The details of the bulk water supply pipeline are:

- Pumped pipeline from the Welbedacht Water Treatment Works;
- 200mm Ø, 13.2km pipeline, capacity of 25.5ℓ/s or 2.2 Mℓ/day.

Storage

Dewetsdorp has existing reservoirs which comprise two (2) 1.5Mℓ municipal reservoirs and a 1Mℓ Bloem Water reservoir. The existing reservoirs are situated at an elevation of 1576m and the Bloemwater reservoir is situated an elevation 1580m (WorleyParsons RSA (Pty) Ltd, 2012).

Both the Dewetsdorp- and Wepener pipelines were initially gravity pipelines which were both subsequently upgraded with a booster pump station. The indicated capacity for Dewetsdorp is with a booster in operation (Phethogo Consulting, 2016).

5.1.2. Wepener

Wepener is located in the south-eastern part of the Free State, close to the border of Lesotho, next to the Caledon River (Phethogo Consulting, 2016).

Predominantly mixed farming is practiced in the Wepener area with farming activities including cattle-; sheep-; and dairy farming; and wheat and maize cultivation. Wepener has no large commercial or industrial sector and water users consist mainly of domestic type users (Phethogo Consulting, 2016).

Wepener receives bulk water via a pipeline from Bloem Water's Welbedacht – Bloemfontein Pipeline, and from local boreholes when they are operational. However, the current WARMS database does not reflect any groundwater use by the town. Wepener Town Area receives it potable water supply wholly from Bloem Water and commands no surface water sources of its own (Phethogo Consulting, 2016).

Water Supply System

The details of the bulk water supply pipeline are:

- Gravity pipeline from the Welbedacht Water Treatment Works;
- 200mm Ø, 32.5km pipeline, capacity of 34ℓ/s or 2.9Mℓ/day.

Storage

Wepener receives potable water in two (2) reservoirs, one with a capacity of 2.5 Mℓ and the other a capacity of 1.5 Mℓ resulting in a total available storage capacity of 4.0 Mℓ. Both the Dewetsdorp- and Wepener pipelines were initially gravity pipelines which were both subsequently upgraded with a booster pump station. The indicated capacity for Wepener is without the boosted capacity (Phethogo Consulting, 2016).

Water Quality

The Welbedacht Dam is owned by DWS and operated and maintained by Bloem Water and is the primary source of water for both Dewetsdorp and Wepener. Despite the well-known very high silt content carried by the Caledon River, the water quality of this water resource complies with domestic water use requirements failing into the ideal water quality range. The water is suitable for potable use with conventional water treatment. The water quality is also suitable for industrial and irrigation use. The Welbedacht WTP has a capacity of 145Mℓ/day supplying primarily in the water needs of Bloemfontein (Phethogo Consulting, 2016).

5.1.3. Van Stadensrus

Van Stadensrus Town Area consists of Van Stadensrus and Thapelang settlements and is located in the Eastern part of the Free State Province.

The current water resource for the Van Stadensrus Town area is the Van Stadensrus Dam and groundwater. Van Stadensrus Town Area receives its surface water supply from the Van Stadensrus Dam originally constructed for irrigation purposes. The Van Stadensrus Dam situated in the Wit Spruit has an earth fill dam wall with a height of 12m. The capacity of the dam is 1 800 million m^3 and it has a surface area of 50 ha at full supply capacity. The yield of the dam is estimated at 0.25 million m^3/annum (Phethogo Consulting, 2016).

Water Supply System

A local Water Treatment Plant constructed on the eastern outskirts of town owned and operated by the Municipality at times supplies potable water to the town. Raw water to the plant is supplied from the Van Stadensrus Dam. The capacity of the plant could not be accurately determined but it is thought to be 0.1Mℓ/day (if operated 18 hours) and the works are in operational condition. The town is supplied with water both from the package plant at the Van Stadensrus Dam and from existing boreholes. The portion of the total requirements supplied from each source is unknown (Phethogo Consulting, 2016).

Storage

Purified water from the Van Stadensrus water purification plant is transferred to three (3) reservoirs with a combined capacity of 0.45 Mℓ. The reservoirs are in a good condition but will need to be upgraded to increase the capacity (Phethogo Consulting, 2016).

Water Quality

The Van Stadensrus Dam is the primary source of water for Van Stadensrus. The water quality of this water resource complies with domestic water use requirements falling into the ideal water quality range. The water is suitable for potable use with conventional water treatment. The water quality is also suitable for industrial and irrigation use (Phethogo Consulting, 2016).

The Van Stadensrus Dam as a raw water source has a limited and insufficient capacity to supply raw water continuously and is a supplementary raw water source. The raw water quality is considered acceptable.

5.1.4. Soutpan

The town of Soutpan consisting of Soutpan and Ikgomotseng is situated about 50km to the North of Bloemfontein on the R700 in the Free State Province.

The area's main water resource is the Krugersdrift Dam (owned and operated by DWS). Water is abstracted from the Krugersdrift Dam and purified at Ikgomotseng Water Treatment Works, and pumped through bulk supply lines to storage facilities (reservoirs and water towers) at the settlements mentioned (Phethogo Consulting, 2016).

Soutpan – Ikgomotseng Town Area receives its surface water supply from the Krugersdrift Dam situated in the Modder River. Krugersdrift Dam with a Full Supply Volume of 76, 71 million m^3 has a yield of approximately 14 million m^3 per annum. The yield represents the historic firm yield of the dam. It excludes the contribution of local runoff downstream of the dam. The local runoff is also used to supply some of the downstream irrigation demands along the Modder River and is supported by releases from Krugersdrift Dam directly into the river (Phethogo Consulting, 2016).

The water quality of this water resource generally complies with domestic water use requirements falling into the ideal water quality range. The water quality is suitable for potable use with conventional water treatment. Water quality is also suitable for industrial and irrigation use.

Given that the three (3) larger cities of the Mangaung Metropolitan Municipality drains towards the Modder River and feeds the Krugersdrift Dam naturally, in occasion the raw water quality may be impeded especially during drought periods and seasonally at the end of winter before the rainy season starts (Phethogo Consulting, 2016).

Water Supply System

The raw water supply system consists of the following facilities:

- Abstraction pump station on the right bank of the Krugersdrift Dam situated close to the dam wall; and a
- Raw water pipeline from the dam to WTP situated at the Krugersdrift Dam wall.

The final water supply system consists of the following facilities:

- Water Treatment Plant (WTP);
- Balancing reservoir;
- Booster pump station;
- Final water pipeline of ±30km from the WTP to Ikgmotseng town; and a
- Command reservoir at Ikgomotseng.

A water purification plant is situated at the wall of the Krugersdrift Dam. The capacity of the existing plant is indicated as 0.6 Mℓ/day (based on an 18 hour/day operational cycle) and the works are in an operational condition. The latest source (IDP) indicates the plant capacity as 0.75 Mℓ/day (Phethogo Consulting, 2016).

Storage

Water from the purification plant is transferred to a reservoir site where a single ground level reservoir with a capacity of 0.2 Mℓ is situated (Phethogo Consulting, 2016).

Ground Water

Ground water resources are not utilised as supplementary supply to the town area even though seven (7) boreholes are available. Ground water quality is not being monitored with limited information primarily due to the fact that the boreholes aren't being utilised. No ground water abstraction is registered for use (Phethogo Consulting, 2016).

All the boreholes in use (with the exception of Van Stadensrus and Soutpan) are operated by Bloem Water. Insufficient information is available regarding the number of boreholes in operation, condition of equipment, pumping capacity or actual borehole yields (Phethogo Consulting, 2016).

5.2. Water Balance Modelling and Key Shortfalls

In order to formulate a WCDM strategy the execution of a first-order water balance of the specific small town is required as a basis for defining Key Performance Indicators (KPI's). For the execution of a water balance several key input factors are required, including but not limited to: System Input Volumes (SIV's); and Billed Metered Consumption (BMC). From the water balance a percentage of Non-Revenue Water (NRW) can be determined which gives a first-order indication of the state of water management in the towns. In addition to this technical Key Performance Indicators (KPI's) are calculated including Unavoidable Annual Real Losses (UARL) which is a function of the number of service connections, length of reticulation and the average operating pressures.

The following critical shortfalls emanating from the review of Soutpan, Dewetsdorp, Wepener and Van Stadensrus' water balances are highlighted:

1. The first and most critical point of concern is that there are no records of billed usage (i.e. Billed Metered Consumption) in Soutpan which implies that all water supplied to Soutpan is defined as Non-Revenue Water (NRW). The potential for water recovery costs in Soutpan with the correct meter installation and implementation program is thus of great value. With the necessary support this area could thus be prioritised for converting the ratio of Non-Revenue Water to Revenue Water into a favourable situation for MMM.
2. In addition to this the values linked to the BMC of Van Stadensrus is questionably low considering the population size. It is thus assumed that, as for Soutpan, the need for thorough metering in Van Stadensrus could prove beneficial for MMM in reducing the amount of NRW in this town.

3. An additional shortfall pertaining to Van Stadensrus is the inaccurate representation of the System Input Value in this town as there is no bulk water meter installed at the abstraction of Van Stadensrus Dam implying that the only recorded SIV for Van Stadensrus is that of groundwater abstraction at boreholes. In order to have an accurate representation of the water balance of the town it is of critical importance that the correct SIV's are recorded and assistance in motivating the installation of a bulk water meter at the Van Stadensrus Dam's abstraction would be highly beneficial in defining accurate KPI's for Van Stadensrus' WCDM Strategy.
4. It should also be highlighted that the accuracy of available BMC data for the towns of Dewetsdorp, Wepener and Van Stadensrus presents concerning data as recorded individual meter readings is unrealistic in comparing the individual meter's adjacent months' data. The need for a thorough meter installation; -monitoring; and -reading program is thus highlighted.
5. In terms of the validity of SIV data across the spectrum of all the towns, a concern is raised regarding the lack of a detailed and accurate monitoring and metering borehole database as it can be concluded that not all boreholes are accurately registered and/or monitored.
6. It should also be noted that there is currently no Geographic Information System (GIS) data available for the town of Soutpan. This implies that the number of households, service connections, and the length of reticulation services is assumed based on historic data which currently merely adds to the inaccuracy and irrelevance of current KPI's formulated on a basis of unconfirmed and possibly outdated data. The need for thorough surveying (or other means) in obtaining accurate GIS information in the town of especially Soutpan is thus highlighted. This proposal is also extended to the towns of Dewetsdorp, Wepener and Van Stadensrus for the accurate recording of Global Positioning System (GPS) coordinates of all user, as well as bulk meters as there is no GIS data currently available pertaining to any metering positions.

As mentioned previously, a further proposed expansion of the WCDM Strategy is to develop targets and KPI's for each specific sub-entity to monitor the WCDM progress of the different smaller towns specifically. In order for this to realise the above critical shortfalls need to be addressed as a matter of urgency in order to formulate a thorough water balance model for the smaller towns as the credibility of the existing models and demand calculations cannot be verified and confirmed with certainty especially due to the lack of GIS data and service connection figures. Specific targets for the smaller towns will thus need to be revisited once the above shortfalls have been addressed and a solid database of information could be collected for review and analysis for the smaller towns.

It is proposed that the above shortfalls are addressed within the short-term (within the next 3 years) in order for the necessary structures to be put in place which will enable the thorough and accurate formulation of a water balance for each of these towns. This method is proposed as MMM has inherited these entities' water management systems and the first three (3) years should be applied to ensure that all the necessary structures are in place to obtain a solid database of information required to build on and evaluate the efficiency of the various water networks more effectively.

Estimates for addressing these shortfalls were included in the larger WCDM Strategy's cost estimate in Section 4.5 of the Report.

6. PART 5 - CONCLUSIONS AND RECOMMENDATIONS

The development of a WCDM strategy and business plan is essential to ensure the sustainability of a municipal water supply system. An in-depth analysis and modelling of the key elements of the MMM water balance revealed that significant improvements can be made to the current SIV and NRW figures. This does, however, require a significant amount of capital. The key cost drivers in the WCDM capital budget is the upgrading and replacement of old infrastructure. The investment required is summarised in Table 6-1.

Cost of WCDM interventions	WCDM Investment Requirements (R x million)											
	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	TOTAL
SIV input reduction cost	13	275	388	620	0	0	0	0	0	0	0	1 296
Real loss reduction cost	253	254	245	245	246	247	248	249	249	250	251	2 736
Mains & reticulation replacement	232	232	223	224	225	226	226	227	228	229	230	2 501
Valves replacement	21	21	21	21	21	21	21	21	21	21	21	228
Reservoir losses	1	1	1	1	1	1	1	1	1	1	1	8
Apparent loss reduction cost	17	16	16	16	16	16	16	16	16	16	16	178
Unbilled consumption reduction cost	19	19	19	19	19	19	19	19	19	19	19	207
Total WCDM cost	302	563	667	900	281	282	283	283	284	285	286	4 417

Table 6-1: Summary of WCDM Capital Requirements

It should be noted that MMM may elect not to include the Maselspoort WTW upgrade as part of the WCDM programme. This will, however, increase the SIV and also the cost of water significantly. Should RBIG or USDG grant funding be obtained for the Maselspoort WTW upgrade the capital cost contribution by MMM will reduce significantly.

In order for MMM to implement the full extent of all the recommended WCDM initiatives as prescribed by the DWS and IWA guidelines will be almost impossible and very costly. It is therefore recommended that the WCDM strategy focusses firstly on the initiatives that will make a real difference to the sustainable, efficient and cost effective operation of the water supply system.

Towards the aim of **focussing** only on the high value add interventions the modelling of five WCDM scenarios were used to assess the potential impact of various interventions. It was concluded that Scenario 5 meets the strategy 10 year targets for NRW and that the WCDM programmes be developed around this scenario.

The basic building blocks of the 10 year strategy is shown in Figure 6-1. A list of the recommended programmes that needs to form part of the 10 year WCDM strategy is attached as Annexure B.

<table>
<tr><td rowspan="3">MMM 10 year WCDM strategy</td><td colspan="2">SOLUTIONS</td><td colspan="2">SERVICES</td><td colspan="2">STRUCTURES</td></tr>
<tr><td colspan="2">WCDM ideas, technical solutions and financial impact of solutions</td><td colspan="2">People and service providers required to execute the Solutions</td><td colspan="2">Framework and systems within which the Services and Solutions will be executes</td></tr>
<tr><td>Technical aspects</td><td>Financial aspects</td><td>Education aspects</td><td>Human Capital and Service provider aspects</td><td>Institutional aspects</td><td>System aspects</td></tr>
</table>

Figure 6-1: Basic elements of 10 year strategy and implementation programmes

Annexure A

General Strategic

A. ANNEXURE A – GENERIC STRATEGIC WCDM ELEMENTS AND ACTIVITIES

Item	Intervention	Strategy	Ref No.	Description of Activities	Comments
1	**INSTITUTIONAL AND HUMAN CAPITAL DEVELOPMENT**	HR resources / Outsourcing through;	**a.1**	Interactive visits and proactive engagement with other National WSA/WSP's	The institutional and human capital strategy should address the following; • Establishment of a dedicated WCDM program management function • Establishment of clear and detailed WCDM programmes and projects. • Develop and map WCDM business process • Determine suitable WCDM structure • Develop appropriate training procedures • Identify and develop key policies and procedures
			a.2	Interaction with international public sector water utilities	
			a.3	Attendance at relevant training courses as and when held (e.g. through WISA or WRC)	
			a.4	Development of a standards and procedures manual that can serve both as a quality management system and induction training manual	
			a.5	Development of customized accreditation criteria, such as leak detection, that allows for Client assurance in a quality product.	
		Policy development through;	**a.6**	Metering policy for meter selection, installation and replacement	
			a.7	Meter reading policy	
			a.8	Billing and cost recovery policy	
			a.9	Water tariff policy	
			a.10	Asset Management Policy	
			a.11	Financial Policy	
			a.12	Human resource policy	
		Planning, Information and Programme management through;	**a.13**	Establishment of WCDM management within MMM i.e. Information Management Systems (IMS), Revenue Management Systems (RMS), Customer Management Systems (CMS), Monitoring and Evaluation Management Systems (M&E), Quality Assurance & Performance Management Systems (QAS), Risk Management Systems (RMS), Communication Management Systems (CMS) and Operation and Maintenance Systems (O&M)	
		Business process refinement	**a.14**	Mapping up of a WCDM business related process	

Table A-1: Summary of Institutional and Human Capital Strategy

Item	Intervention	Strategy	Ref No.	Description of Activities	Comments
2	COMMUNICATION DEVELOPMENT	Consumer Awareness and Education	b.1	An extensive schools programme to include annual competitions between schools	The consumer awareness and education strategy should include the following; • Develop a clear WCDM stakeholder and consumer awareness and education programme
			b.2	Public awareness programme (PAP) conducted with the media focusing on "lead by example"	
			b.3	Addressing issues regarding non-payment of water	
			b.4	Large water consumers' one on one customer methods to reduce demand	

Table A-2: Summary of Communication Strategy

Item	Intervention	Strategy	Ref No.	Description of Activities	Comments
3	FINANCIAL MANAGEMENT	Revenue management	c.1	Tariff setting	Key aspects of the financial strategy should include the following; • Tariff setting • Metering, billing and cost recovery • Short term annual operational budget • Long term funding requirements
			c.2	Metering, billing and cost recovery	
		Expense budgeting	c.3	Long term WCDM operational and capital budgets	
		Funding strategy	c.4	Review current water balance and funding strategy	

Table A-3: Summary of Financial Management Strategy

Item	Intervention	Strategy	Ref No.	Description of Activities	Comments
4	INFORMATION MANAGEMENT	GIS based water network information and model	d.1	Water system age, payment History, High consumption areas and areas in which frequent pipe bursts occur	The main information management strategy should include; • Identify information that needs to collected for effective WCDM programme
		Integrated asset and meter data base	d.2	Meter data base	

		WCDM performance measurement system	d.3	Water balances for month and year-to-date, physical progress on WCDM activities, Progress against target, Key performance Indicators, Budget and expenditure, Identification of challenges, Success stories, Recommended changes to interventions strategy	• Identify GIS system suitable for encapsulating WCDM information • Populate GIS system with meter information and functionality to perform meter queries and WCDM performance indicators • Link GIS with financial, budget and tariff systems • Establish control centre with suitable information management tools to monitor actual WCDM and financial performance , quality of repairs and many other performance measures
		Quality Assurance and Performance Management	d.4	Standards	
		Control centre integration	d.5	Establishment of Control Centre	
Item	**Intervention**	**Strategy**	**Ref No.**	**Description of Activities**	**Comments**
5	**ASSET MANAGEMENT**	**Asset management**	**e.1**	Asset information, maintenance and replacement systems	

Table A-4: Summary of Information and Asset Management Strategy

Item	Intervention	Strategy	Ref No.	Description of Activities	Comments
6	**ZONING AND WATER BALANCE**	Zoning	**f.1**	DMA establishment; discreet pressure zones, pressure logging monitoring	The Zoning and water balance strategy should therefore include the following aspects: • GIS based zoning plan with clearly delineated metering and pressure zones; • Live water balance model for each water zone to determine: input volume, metered use, non-
		Pressure management	**f.2**	Pressure control and modelling (PVR),	
		Non-Revenue Water Interactive Model	**f.3**	System Input Reduction Modelling, Billing Improvement, NRW Target establishment, Cost benefit	
		Reduction in Plumbing Leaks – Domestic Consumers	**f.4**	Leak repair projects, Communication and Education Campaigns	
		Retrofitting of Existing Plumbing Fitting	**f.5**	Retrofits projects, Communication and Education, Regulation of by-laws, marketing of new technology, school audits	

		Reduction in gardening Water use	f.6	Communication and Education campaigns, Water wise demonstration exhibits, marketing for new technology, grant incentives for lawn replacement and zero scaping	revenue water, average zone pressure; • Meter installation and replacement programme; • Pipe replacement programme; • Consumer fitting replacement programme; • A clear water re-use action plan to reduce system input volume and total water cost • Active telemetry system controlling water supply into system, transferring water across system through booster pumps, controlling reservoir levels and reducing pressure into pressure zones.
		Reduction in Demand – Reduction of Natural Growth rate	f.7	Introduction of prepayment meters, Communication and Education campaigns, Regulation and by-laws, negotiations and incentives to developers, improved reticulation design and plumbing standards	
		Meter management / Apparent Loss Management	f.8	Customer meter accuracy, data transfer error, data analysis errors, accounting errors	
		Water Re-Use	f.9	Supernatant Water Reuse at Maselspoort WTW	
			f.10	Planned direct reuse option at the new North-Eastern WwTW	
			f.11	Planned Indirect reuse option by transferring effluent discharged into the Rhenosterspruit to the Mockes/Maselspoort Dam for treatment potable standards at Maselspoort WTW	
			f.12	In order to use more raw water from Maseslpoort the current Bloem Water supply agreement will have to be revised. This will allow MMM treating more of the local resources and purchasing less from Bloem Water.	

Table A-5: Summary of Zoning and Water Balance Strategy

Item	Intervention	Strategy	Ref No.	Description of Activities	Comments
7	**OPERATIONS MANAGEMENT**	Business Plan	**g.1**	Identify WCDM measures	The operations strategy should therefore include aspects such as; • WCDM Business plan development with detailed and prioritised project execution plans, schedules and return on investment information and adequate financial and human resource allocation • Detailed WCDM business plan operational and capital budget
			g.2	Develop WCDM programmes/projects	
			g.3	Prioritize projects	
			g.4	Implementation	
			g.5	Monitoring	

					• WCDM Master plan with frequent reporting on progress, costs and risks • WCDM procurement schedule for products and services

Table A-6: Summary of the Operation Management

Item	Intervention	Strategy	Ref No.	Description of Activities	Comments
8	**WATER BALANCE SYSTEM AUDIT**	Updating of Water Balance	**h.1**	System Input Volume (SIV)	The 2011/2012 Water Balance on which the 5 Year WCDM for MMM was based contains notable challenges. It is important that an audit for the new water balance is undertaken to ensure accurate planning
			h.2	System Authorized Consumption	
			h.3	System Water Losses	
			h.4	System Billed Authorized Consumption	
			h.5	System Unbilled Authorized Consumption	
			h.6	System Apparent Losses	
			h.6	System Real Losses	
			h.7	System Billed Metered Consumption	
			h.8	System Billed Unmetered Consumption	
			h.9	System Unbilled Municipal Use	
			h.10	System Unbilled Unmetered	
			h.11	System Illegal Consumption	
			h.12	System Metering Inaccuracies	
			h.13	Mains and Distribution Leaks	
			h.14	System Reservoir Overflows	
			h.15	System Service Connection Leaks	
			h.16	System Revenue Water	

			h.17	System None Revenue Water	
		System Indicators	h.18	System Current Annual Real Loss *(liter/service connection/day)*	
			h.19	System Water Loss *(liter/service connection/day)*	
			h.20	System Apparent Loss *(liter/service connection/day)*	
			H21	System Non-Revenue Water by Volume %	
			H.22	System Registered Water Connections	
			h.23	System Length of Trunk Mains and Reticulation *(km)*	
			h.24	System Operating Pressure *(m)*	
			h.25	System Inefficiency Use of Water %	
			h.26	System CARL (Total Water Loss per Connection)	
			h.27	System UARL *(Unavoidable Annual Real Loss (liter/service connection/day)*	
			h.28	System Infrastructure Leakage Index (ILI)	

Table A-7: Summary of the Water Balance Strategy

Item	Intervention	Water Balance Strategies	Ref No.	Description of Activities	Comments
9	WCDM	Steering Committee	i.1	Setting up of WC/WDM Steering Committee – fully functional – collective planning & buy-in	In general data reliability is very low. In particular, water supply and billed consumption information has a direct impact on Water Balance accuracy (duplicate data, lack of usage type to separate type of measurement, etc.).
		Real Loss Reduction	i.2	Replacement of Water Mains	
			i.3	Pipeline Upgrading Programme	
			i.4	Pro-Active Leak Detection and Repair	
			i.5	Discretization of Water Supply Zones	
			i.6	Installation of Control Valves and Advanced Pressure Management	
			i.7	Cathodic Protection of Steel Pipelines	
			i.8	Indigent Programs	

			i.9	Standardization of designs (Pressure regimes, pipe materials etc.), Identification of High Burst Areas)	
		Apparent Losses	**i.10**	Identification of Top 100 Consumers	
			i.11	Metering of Council /Private Properties	
			i.12	Replacement of MMM supply meters	
			i.13	Replacement of ageing large meters (Quantities to be determined -- meters > 10 years old)	
			i.14	Setting up of Telemetry System – Early warnings – Bulk Meters, Reservoirs, Water Towers, Security.	
			i.15	Replacement of ageing domestic meters (meters > 5 years old): Sorting	
			i.16	Metering of Informal Settlements	
			i.17	Metering of all unmetered stands and registration in billing database	
			i.18	Illegal Connection Program	

Table A-8: Summary of the NRW strategies

Ref	WATER RE-USE PROGRAMMES
C1	**Supernatant Water Re-Use** Of the current 84 million m^3/a (MCA) SIV, 18 MCA is lost as real losses (~21%). Maselspoort WTW currently does not recycle supernatant and SIV is based on raw water purchases. The losses should therefore be about 1.7 MCA (10% of 17 MCA) higher than reported, i.e. 19.2 MCA of 84 MCA or 23%. Recovery of supernatant can be a quick win to reduce water losses. Reconciliation study showed MMM is currently in water balance scenario (WCDM is most critical intervention). It is important to develop additional sources. **Note** • Treatment losses ~ 10% • Water purchased ~ 47.5 Ml/d (2012/13) • Water cost ~ R 62 488 000 @ R4/kl • Water lost ~ R 6 862 000 per year • About 10% of this water constitutes backflow water. A feasibility to investigate the possible reuse of the water may be undertaken
C2	**Investigate the possibilities of reviewing the Bulk Raw Water License between Bloem Water and Mangaung MM (Approx. 10% Water is repurchased)** About 10% of the water purchased by Mangaung Municipality which constitutes the supernatant flows is discharged back into the Mockes dam. The water is repurchased at the next cycle. Mangaung MM losses 10% of its revenue in the process. There is need to review the current Bulk Water License between the two service providers to address the anomaly. **Note:** This strategy does not physically improve the volume of treated water for MMM but rather cuts down on the cost of the bulk raw water. • Treatment Losses ~ 1% • Water Purchased ~ 42.8 Ml/d (2012/13) • Water Cost ~ R 62 488 000 @ R4/kl • Water Lost ~ R 6 862 000 per year

Table A-9: SIV reduction Programme

Annexure B

MMM 10 Year WCDM Strategy Programmes

B. ANNEXURE B – MMM 10 YEAR WCDM STRATEGY AND PROGRAMMES

MMM 10 year WCDM strategy					SOLUTIONS				SERVICES				STRUCTURES			
					WCDM ideas, technical solutions and financial impact of solutions				*People and service providers required to execute the Solutions*				*Framework and systems within which the Services and Solutions will be executes*			
					Technical aspects		Financial aspects		Education aspects		Human Capital and Service provider aspects		Institutional aspects		System aspects	
Water Conservation and Water Demand Management	*Development of solutions, services and structures to ensure sustainable water use*	Water Demand Management aspects	Real loss reduction	Pipes	T1	Midblock replacement programme	F1	Water tariff policy revision programme	E1	Consumer awareness and education programme	H1	Organogram review programme	I1	WCDM Steering committee management	S1	Asset management programme
					T2	Mains replacement programme (replace over 50 years)	F2	Capital investment policy revision programme			H2	Internal staff gap analysis programme	I2	Bloem Water supply agreement revision	S2	Telemetry system and control programme (early warning, level control, bulk meters, security, major leaks)
					T3	Service connection replacement programme (replace over 50 years)	F3	Asset depreciation and replacement policy revision			H3	Recruitment and retention programme	I3	Business process review programme	S3	Equipment and tools gap analysis programme
					T4	Pipeline upgrading programme	F4	WCDM business plan development programme			H4	Service provider gap analysis programme			S4	Control centre development programme
					T5	Cathodic protection programme (of steel pipes)	F5	Water tariff review programme			H5	Service provider management programme			S5	WCDM performance management programme
											H7	Skills development of internal resources programme			S6	Integrated GIS based information management programme
				Valves & Fittings	T6	System condition audit and recording programme										
					T7	Valve maintenance & replacement programme (15 years)										
					T8	Fitting replacement programme (indigent)										
				Zoning & Metering	T9	Nework zoning and zone metering programme										
					T10	New connection programme (meter installation)										
					T11	Pressure management programme (control valves)										
					T12	Remove monitoring of pressure management system programme (licensing)										
				Network Control	T13	Pro-active Leak detection programme										
					T14	Leak repair programme (indigent, normal consumers)										
			Apparent loss reduction	Meter management	T15	Supply meter replacement programme (MMM internal and Bloemwater)										
					T16	Large meter replacement programme (very old, older than 5 years, faulty>40 mm)										
					T17	Domestic meter replacement programme (very old, older than 7 years, faulty meters)										
					T18	Domestic meter unmetered and relocation programme (Thaba Nchu & Botshabelo)										
					T19	Communical stand meters installation programme (very old, 7 years and faulty)										
					T20	Government meter installation programme (new, 7 years and faulty)										
					T21	Lifting of bulk meter to above ground										
				Consumer mana	T22	Illegal consumption management (assume 1% off stands illegal)										
					T23	Top 500 consumers identification										
		Water Conservation			T24	Filter washwater recovery at Maselspoort WTW										
					T25	Increased local production of Maselspoort WTW										

Table B-1: Key WCDM Strategic Programmes, Projects and Policies

Annexure C

FY 2013/14 Water Balance

C. ANNEXURE C – FY 2013/14 WATER BALANCE

Step	Water Balance Component	Financial Year Volumes (kl)				Average Daily Volumes (kl/day)			
		Bloemfontein	Botshabelo	Thaba Nchu	Mangaung	Bloemfontein	Botshabelo	Thaba Nchu	Mangaung
1	Own Sources	18 533 429	-	-	18 533 429	50 777	0	0	50 777
2	Water Imported	49 686 037	10 971 153	7 380 643	68 037 833	136 126	30 058	20 221	186 405
3	**System Input Volume (SIV)**	**68 219 467**	**10 971 153**	**7 380 643**	**86 571 262**	**186 903**	**30 058**	**20 221**	**237 182**
4	Water Exported	-	-	-	-	0	0	0	0
5	**Water Supplied (WS)**	**68 219 467**	**10 971 153**	**7 380 643**	**86 571 262**	**186 903**	**30 058**	**20 221**	**237 182**
23	**Authorised Consumption**	**51 248 716**	**6 551 364**	**3 331 754**	**61 131 834**	**140 407**	**17 949**	**9 128**	**167 484**
8/20	Billed Authorised Consumption	50 204 200	6 364 983	2 806 463	59 375 646	137 546	17 438	7 689	162 673
	Billed Water Exported to Other Systems	-	-	-	-	0	0	0	0
7/19	Billed Metered Consumption (BMC)	49 102 120	5 834 343	2 741 807	57 678 270	134 526	15 985	7 512	158 023
6	Free Basic Water/Indigent Consumption	1 102 080	530 640	64 656	1 697 376	3 019	1 454	177	4 650
	Billed Unmetered Consumption	-	-	-	-	0	0	0	0
9/21	**Potential Revenue Water (PRW)**	**50 204 200**	**6 364 983**	**2 806 463**	**59 375 646**	**137 546**	**17 438**	**7 689**	**162 673**
13	Unbilled Authorised Consumption (UAC)	1 044 516	186 381	525 291	1 756 188	2 862	511	1 439	4 811
11	Unbilled Metered Consumption	703 418	76 669	451 485	1 231 572	1 927	210	1 237	3 374
12	Unbilled Unmetered Consumption	341 097	109 712	73 806	524 615	935	301	202	1 437
24	**Total Water Losses**	**16 970 751**	**4 419 789**	**4 048 888**	**25 439 429**	**46 495**	**12 109**	**11 093**	**69 697**
25	**Apparent Losses**	**1 926 509**	**330 934**	**783 710**	**3 041 152**	**5 278**	**907**	**2 147**	**8 332**
27	Illegal Consumption	1 435 488	155 903	701 456	2 292 847	3 933	427	1 922	6 282
26	Meter Under-Registration	491 021	175 030	82 254	748 306	1 345	480	225	2 050
17	**Real Losses**	**15 044 242**	**4 088 856**	**3 265 178**	**22 398 276**	**41 217**	**11 202**	**8 946**	**61 365**
14	Leakage on Mains	270 229	460 617	457 418	1 188 264	740	1 262	1 253	3 256
15	Leakage and Overflows on Reservoirs	180 153	460 617	45 742	686 511	494	1 262	125	1 881
16	Leakage on Service Connections	14 593 860	3 167 622	2 762 019	20 523 501	39 983	8 678	7 567	56 229
10/22	**Non-Revenue Water**	**18 015 267**	**4 606 170**	**4 574 180**	**27 195 616**	**49 357**	**12 620**	**12 532**	**74 509**

Table C-1: 2013/14 Financial Year Water Balance (JOAT, 2014)

Annexure D

FY 2016/17 Water Balance

D. ANNEXURE D – FY 2016/17 WATER BALANCE

Step	Water Balance Component	2016/17 Financial Year Volumes (kl)								2016/17 Average Daily Volumes (kl/day)							
		Bloemfontein	Botshabelo	Thaba Nchu	Wepener	Dewetsdorp	Vanstadensrus	Soutpan	Mangaung	Bloemfontein	Botshabelo	Thaba Nchu	Wepener	Dewetsdorp	Vanstadensrus	Soutpan	Mangaung
1, 1a	Own Sources	8 170 385	-	-	-	-	-	375 185	8 545 570	22 385	0	0	0	0	0		23 413
2	Water Imported	41 731 632	10 905 588	6 296 682	645 358	884 783	33 909	60 469	60 558 420	114 333	29 878	17 251	1 926	2 641	186		165 913
3	**System Input Volume (SIV)**	**49 902 017**	**10 905 588**	**6 296 682**	**645 358**	**884 783**	**33 909**	**435 654**	**69 103 990**	**136 718**	**29 878**	**17 251**	**1 926**	**2 641**	**186**		**189 326**
4	Water Exported	-	-	-	-	-	-	-	-	0	0	0	0	0	0		0
5	**Water Supplied (WS)**	**49 902 017**	**10 905 588**	**6 296 682**	**645 358**	**884 783**	**33 909**	**435 654**	**69 103 990**	**136 718**	**29 878**	**17 251**	**1 926**	**2 641**	**186**		**189 326**
21	**Authorised Consumption**	**38 661 176**	**7 545 556**	**3 659 386**	**303 867**	**579 560**	**22 536**	**112 420**	**50 884 501**	**105 921**	**20 673**	**10 026**	**907**	**1 730**	**124**		**139 410**
10	Billed Authorised Consumption	34 956 522	6 645 048	2 472 550	239 329	328 119	12 575	112 420	44 766 563	95 771	18 206	6 774	714	979	69		122 648
6	Billed Water Exported to Other System	-	-	-	-	-	-	-	-	0	0	0	0	0	0		0
7	Billed Metered Consumption (BMC)	31 052 922	4 233 648	1 738 390	163 693	245 949	5 483	-	37 440 085	85 076	11 599	4 763	489	734	30		102 576
8	Free Basic Water/Indigent Consumptic	1 708 680	1 283 760	367 800	75 636	82 170	7 092	-	3 525 138	4 681	3 517	1 008	226	245	39		9 658
9	Billed Unmetered Consumption	2 194 920	1 127 640	366 360	-	-	-	112 420	3 801 340	6 013	3 089	1 004	0	0	0		10 415
11	**Potential Revenue Water (PRW)**	**34 956 522**	**6 645 048**	**2 472 550**	**239 329**	**328 119**	**12 575**	**112 420**	**44 766 563**	**95 771**	**18 206**	**6 774**	**714**	**979**	**69**		**122 648**
18	Unbilled Authorised Consumption (UA	3 704 654	900 507	1 186 836	64 538	251 441	9 961	-	6 117 938	10 150	2 467	3 252	193	751	55		16 761
19	Unbilled Unmetered Consumption	499 020	109 056	62 967	6 454	8 848	339	-	686 683	1 367	299	173	19	26	2		1 881
20	Unbilled Metered Consumption	3 205 634	791 451	1 123 870	58 084	242 593	9 622	-	5 431 254	8 783	2 168	3 079	173	724	53		14 880
17	**Total Water Losses**	**11 240 841**	**3 360 032**	**2 637 295**	**341 491**	**305 223**	**11 373**	**-**	**17 896 255**	**30 797**	**9 206**	**7 225**	**1 019**	**911**	**62**		**49 031**
16	**Apparent Losses**	**2 971 304**	**332 252**	**123 627**	**35 899**	**49 218**	**1 886**	**-**	**3 514 188**	**8 141**	**910**	**339**	**107**	**147**	**10**		**9 628**
14	Illegal Consumption	1 747 826	132 901	49 451	23 933	32 812	1 258	-	1 988 180	4 789	364	135	71	98	7		5 447
15	Meter Under-Registration	1 223 478	199 351	74 176	11 966	16 406	629	-	1 526 007	3 352	546	203	36	49	3		4 181
13	**Real Losses**	**8 269 537**	**3 027 780**	**2 513 668**	**305 592**	**256 005**	**9 486**	**-**	**14 382 068**	**22 656**	**8 295**	**6 887**	**912**	**764**	**52**		**39 403**
	Leakage on Mains	1 623 679	597 621	494 799	59 828	49 431	1 829	-	2 827 187	4 448	1 637	1 356	179	148	10		7 746
	Leakage and Overflows on Reservoirs	151 142	39 674	39 674	6 454	8 848	339	-	246 130	414	109	109	19	26	2		674
	Leakage on Service Connections	6 494 716	2 390 485	1 979 195	239 311	197 726	7 318	-	11 308 750	17 794	6 549	5 422	714	590	40		30 983
12	**Non-Revenue Water**	**14 945 495**	**4 260 540**	**3 824 132**	**406 029**	**556 664**	**21 334**	**323 234**	**24 337 427**	**40 947**	**11 673**	**10 477**	**1 212**	**1 662**	**117**		**66 678**

Table D-1: 2016/17 Financial Year Water Balance (JOAT, 2017)

Annexure E

Proposed WCDM Technical Structure

E. ANNEXURE E – PROPOSED WCDM STRUCTURE

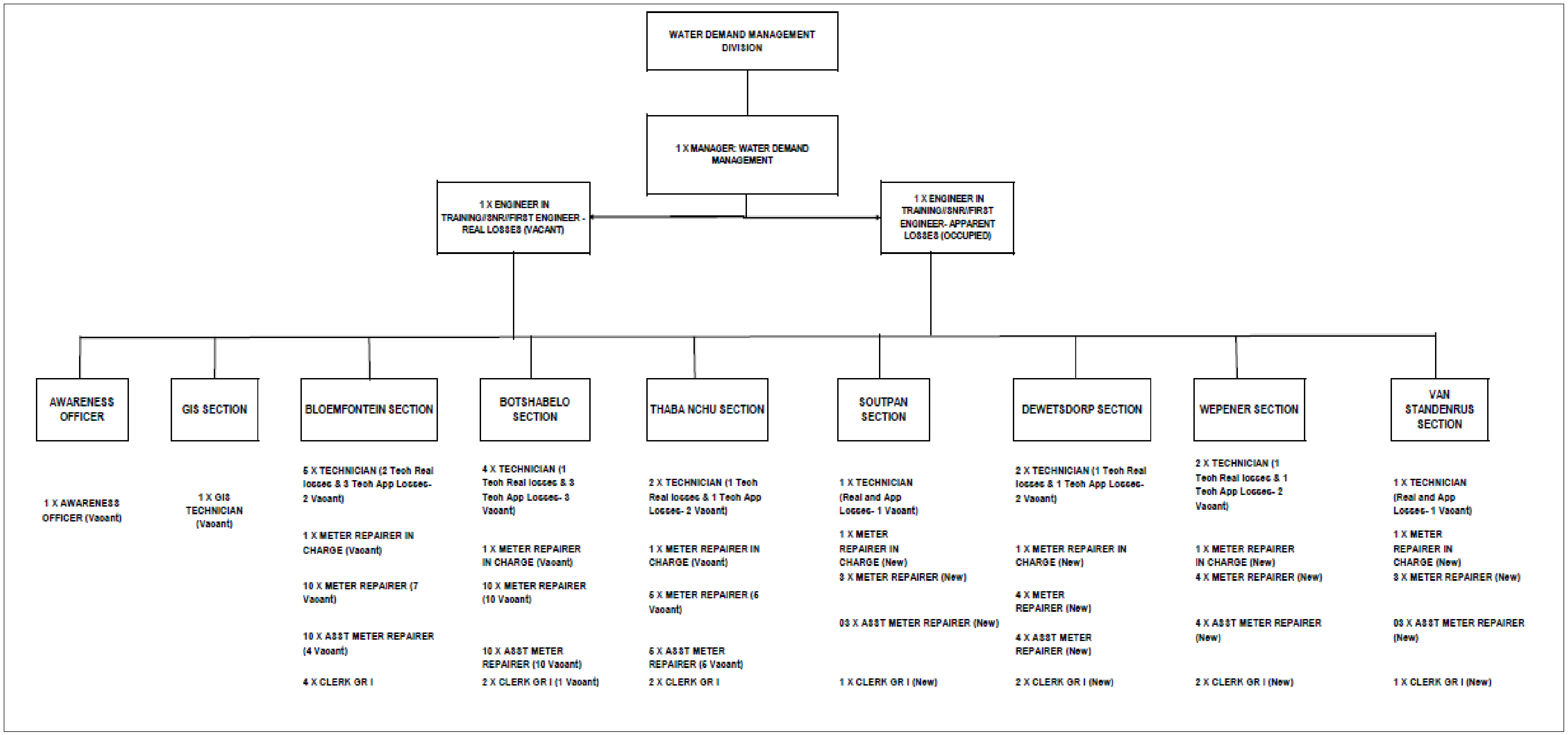
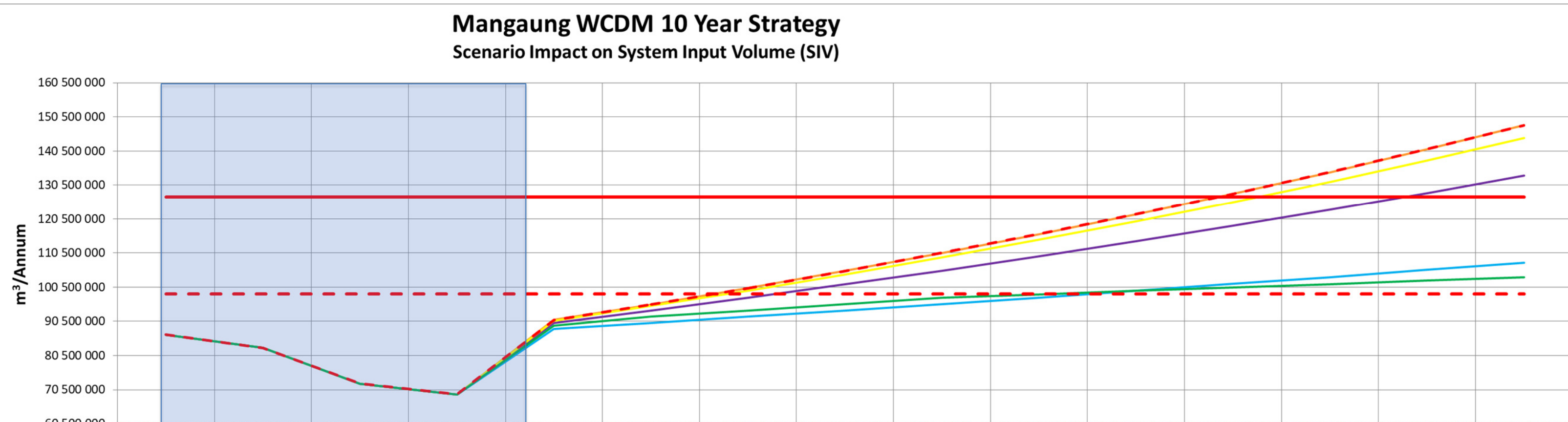


Table E-1: Proposed WCDM Structure

Annexure F

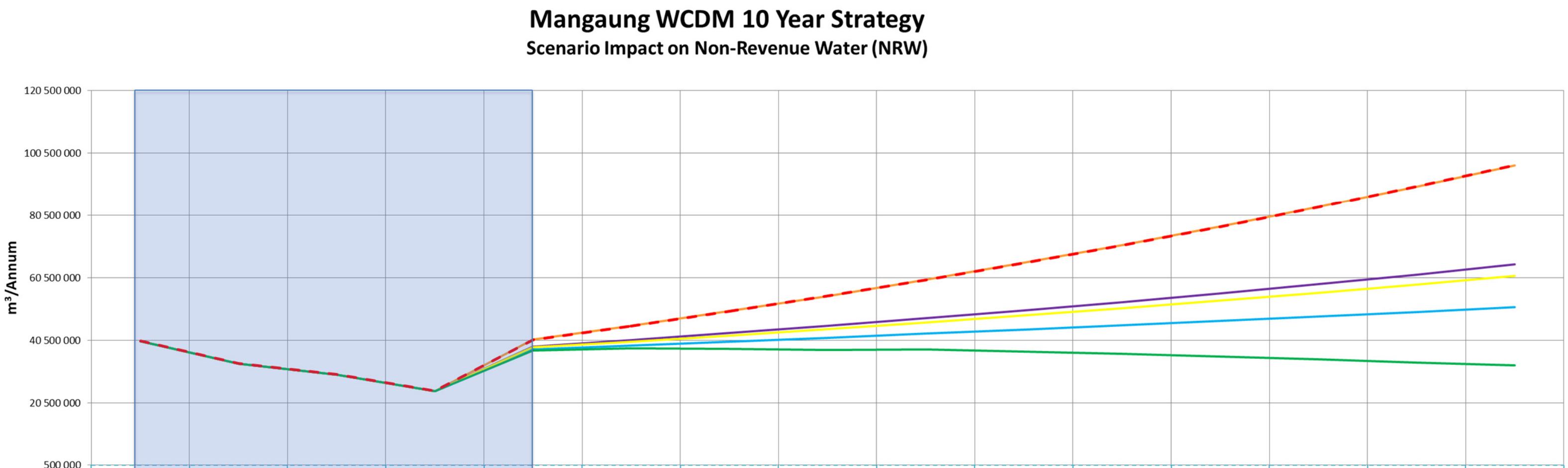
WCDM Modelling Data and Graphs

F. ANNEXURE F – GRAPHS



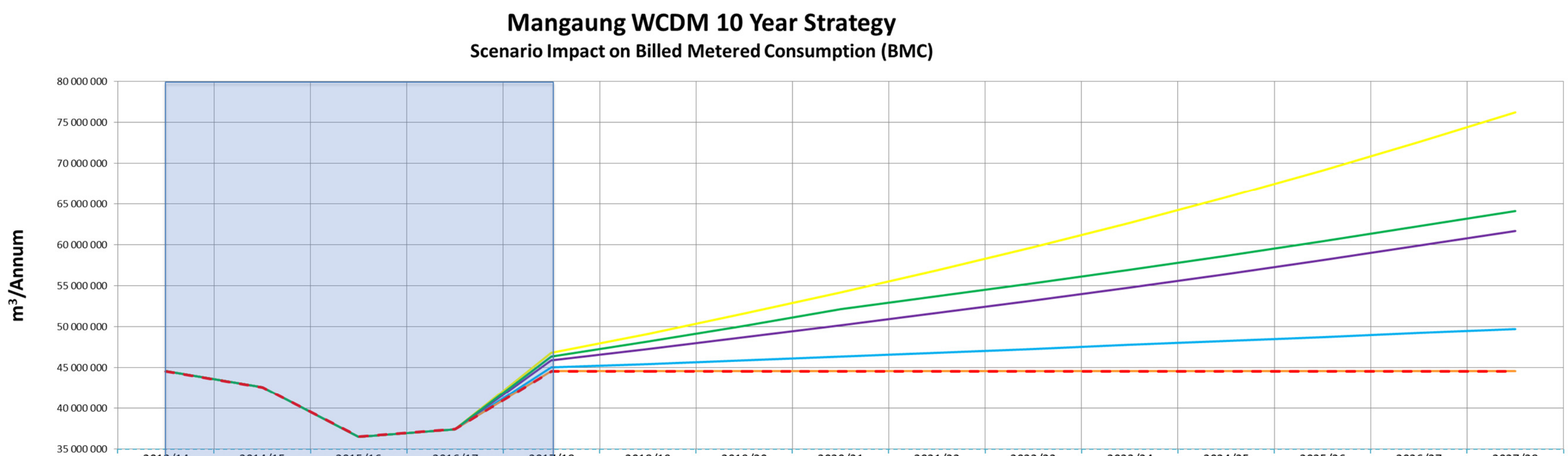
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	86 571 262	82 772 378	72 306 705	69 103 990	88 302 688	90 068 741	91 870 116	93 707 518	95 581 669	97 493 302	99 443 168	101 432 032	103 460 672	105 529 886	107 640 483
Scenario 2	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Scenario 3	86 571 262	82 772 378	72 306 705	69 103 990	90 034 113	93 635 477	97 380 896	101 276 132	105 327 178	109 540 265	113 921 875	118 478 750	123 217 900	128 146 616	133 272 481
Scenario 4	86 571 262	82 772 378	72 306 705	69 103 990	90 683 397	94 990 859	99 502 924	104 229 313	109 180 206	114 366 266	119 798 663	125 489 100	131 449 832	137 693 699	144 234 150
Scenario 5	86 571 262	82 772 378	72 306 705	69 103 990	89 168 400	91 843 452	93 680 321	95 553 928	97 465 006	98 439 656	99 424 053	100 418 293	101 422 476	102 436 701	103 461 068
Base Case	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Rated Treatment Capacity	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000	127 020 000
Current Capacity during rainy season	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000	98 550 000

Table F-1: Impact of various WCDM scenarios of SIV



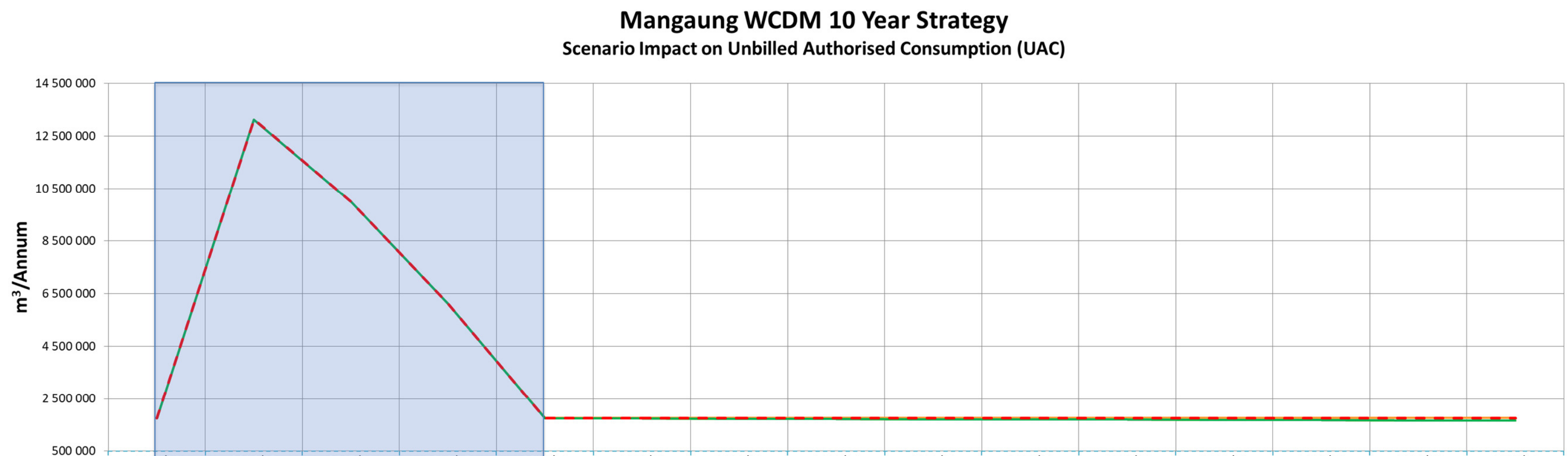
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	40 299 627	33 097 464	29 606 739	24 337 427	37 690 989	38 895 008	40 127 611	41 389 412	42 681 042	44 003 142	45 356 370	46 741 394	48 158 897	49 609 577	51 094 146
Scenario 2	40 299 627	33 097 464	29 606 739	24 337 427	40 733 869	45 167 026	49 825 197	54 719 697	59 862 414	65 265 827	70 943 041	76 907 821	83 174 618	89 758 609	96 675 730
Scenario 3	40 299 627	33 097 464	29 606 739	24 337 427	38 530 929	40 643 115	42 855 798	45 173 457	47 600 762	50 142 583	52 804 000	55 590 310	58 507 038	61 559 943	64 755 034
Scenario 4	40 299 627	33 097 464	29 606 739	24 337 427	38 288 728	40 144 207	42 085 046	44 115 069	46 238 268	48 458 810	50 781 045	53 209 515	55 748 961	58 404 332	61 180 792
Scenario 5	40 299 627	33 097 464	29 606 739	24 337 427	37 219 473	37 928 402	37 722 740	37 474 395	37 702 427	36 944 726	36 146 012	35 304 883	34 419 894	33 489 557	32 512 336
Base Case	40 299 627	33 097 464	29 606 739	24 337 427	40 733 869	45 167 026	49 825 197	54 719 697	59 862 414	65 265 827	70 943 041	76 907 821	83 174 618	89 758 609	96 675 730

Table F-2: Impact of various WCDM scenarios of NRW



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	44 574 259	42 595 034	36 501 846	37 440 085	45 020 002	45 470 202	45 924 904	46 384 153	46 847 995	47 316 474	47 789 639	48 267 536	48 750 211	49 237 713	49 730 090
Scenario 2	44 574 259	42 595 034	36 501 846	37 440 085	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259
Scenario 3	44 574 259	42 595 034	36 501 846	37 440 085	45 911 487	47 288 832	48 707 497	50 168 722	51 673 783	53 223 997	54 820 717	56 465 338	58 159 298	59 904 077	61 701 199
Scenario 4	44 574 259	42 595 034	36 501 846	37 440 085	46 802 972	49 143 121	51 600 277	54 180 291	56 889 305	59 733 771	62 720 459	65 856 482	69 149 306	72 606 771	76 237 110
Scenario 5	44 574 259	42 595 034	36 501 846	37 440 085	46 357 230	48 211 519	50 139 980	52 145 579	53 709 946	55 321 245	56 980 882	58 690 308	60 451 018	62 264 548	64 132 485
Base Case	44 574 259	42 595 034	36 501 846	37 440 085	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259

Table F-3: Impact of various WCDM scenarios of BMC



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Scenario 1	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327
Scenario 2	1 756 188	13 129 600	9 998 615	6 117 938	1 756 188	1 756 188	1 756 188	1 756 188
Scenario 3	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327
Scenario 4	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327
Scenario 5	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327
Base Case	1 756 188	13 129 600	9 998 615	6 117 938	1 756 188	1 756 188	1 756 188	1 756 188

	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Scenario 1	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Scenario 2	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188
Scenario 3	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Scenario 4	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Scenario 5	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Base Case	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188

Table F-4: Impact of various WCDM scenarios of UAC

Annexure G

Projected Water Balance Models

G. ANNEXURE G – PROJECTED WATER BALANCE MODELS

Water Balance Component	Historic Information						Ten Year Projections (Based on FY 2013/14)										
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
														Exceeds Rated Treatment Capacity	Exceeds Rated Treatment Capacity	Exceeds Rated Treatment Capacity	Exceeds Rated Treatment Capacity
									Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity
Own Sources (OS)	19 627 318	17 346 160	18 533 429	15 176 615	8 059 441	8 545 570	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429
Water Imported (WI)	63 306 660	67 321 906	68 037 833	67 595 763	64 247 264	60 558 420	72 366 396	76 911 387	81 683 628	86 694 481	91 955 877	97 480 342	103 281 030	109 371 753	115 767 013	122 482 035	129 532 808
System Input Volume (SIV)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Water Exported (WE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Supplied (WS)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Authorised Consumption (AC)	47 174 698	55 407 215	48 027 823	62 804 514	52 698 581	50 884 501	51 922 144	52 033 978	52 148 049	52 264 401	52 383 080	52 504 132	52 627 606	52 753 549	52 882 011	53 013 043	53 146 695
Billed Authorised Consumption (BAC)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	50 165 956	50 277 790	50 391 861	50 508 213	50 626 892	50 747 945	50 871 418	50 997 362	51 125 824	51 256 855	51 390 507
Billed Water Exported to Other Systems (BWEOS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billed Metered Consumption (BMC)	44 763 274	51 479 975	44 574 259	42 595 034	36 501 846	37 440 085	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259
Free Basic Water/Indigent Consumption (FBW)	2 411 424	3 927 240	1 697 376	3 295 200	2 654 040	3 525 138	1 731 324	1 765 950	1 801 269	1 837 294	1 874 040	1 911 521	1 949 751	1 988 747	2 028 521	2 069 092	2 110 474
Billed Unmetered Consumption (BUC)	0	0	0	3 784 680	3 544 080	3 801 340	3 860 374	3 937 581	4 016 333	4 096 659	4 178 593	4 262 164	4 347 408	4 434 356	4 523 043	4 613 504	4 705 774
Potential Revenue Water (PRW)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	50 165 956	50 277 790	50 391 861	50 508 213	50 626 892	50 747 945	50 871 418	50 997 362	51 125 824	51 256 855	51 390 507
Unbilled Authorised Consumption (UAC)	3 655 002	9 313 488	1 756 188	13 129 600	9 998 615	6 117 938	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188
Unbilled Metered Consumption (UMC)	3 655 002	9 313 488	1 231 572	12 301 877	8 819 068	5 431 254	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572
Unbilled Unmetered Consumption (UUC)	0	0	524 615	827 724	1 179 547	686 683	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615
Total Water Losses (WL)	32 104 278	19 947 364	38 543 439	19 967 864	19 608 124	17 896 255	38 977 681	43 410 839	48 069 009	52 963 510	58 106 226	63 509 639	69 186 854	75 151 633	81 418 431	88 002 421	94 919 543
Apparent Losses (AL)	3 403 932	1 939 253	3 041 152	4 470 742	4 665 025	3 514 188	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152
Illegal Consumption (IC)	1 941 516	221 629	2 292 847	1 986 995	2 537 101	1 988 180	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847
Meter Under-Registration (MUR)	1 462 416	1 717 624	748 306	2 483 747	2 127 924	1 526 007	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306
Real Losses (RL)	28 700 346	18 008 112	35 502 287	15 497 122	14 943 099	14 382 068	35 936 529	40 369 686	45 027 857	49 922 357	55 065 074	60 468 486	66 145 701	72 110 481	78 377 278	84 961 269	91 878 390
Leakage on Mains (LM)	6 276 206	5 157 815	1 188 264	3 052 065	2 941 260	2 827 187	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264
Leakage and Overflows on Reservoirs (LOR)	621 230	246 482	686 511	236 799	236 799	246 130	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511
Leakage on Service Connections (LSC)	21 802 910	12 603 815	20 523 501	12 208 258	11 765 040	11 308 750	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501
Non-Revenue Water (NRW)	35 759 280	29 260 852	40 299 627	33 097 464	29 606 739	24 337 427	40 733 869	45 167 026	49 825 197	54 719 697	59 862 414	65 265 827	70 943 041	76 907 821	83 174 618	89 758 609	96 675 730
Static Information	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**
Number of service connections	126 582	126 582	132 689	131 054	142 565	193 591	197 463	201 412	205 440	209 549	213 740	218 015	222 375	226 823	231 359	235 986	240 706
Length of trunk mains (km)	696	696	696	696	696	710	725	739	754	769	784	800	816	832	849	866	883
Length of reticulation (km)	2 962	2 962	2 962	2 962	2 989	3 106	3 168	3 231	3 296	3 362	3 429	3 498	3 568	3 639	3 712	3 786	3 862
Average Zone Operating Pressure (m)	54	62	64	62	61	60	60	60	60	60	60	60	60	60	60	60	60
UARL (ℓ/conn/day)	8 360	9 274	77	3 452 683	3 619 197	4 387 716	65	65	65	65	65	65	65	65	65	65	65
Population	721 157	721 367	721 157	788 881	836 711	825 686	842 200	859 044	876 225	893 749	911 624	929 857	948 454	967 423	986 771	1 006 507	1 026 637
CARL (ℓ/conn/day)							499	549	600	653	706	760	815	871	928	986	1 046

Table G-1: Base Case Water Balance Projections

Water Balance Component	Historic Information						Ten Year Projections (Based on FY 2013/14)										
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
													Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity	Exceeds Current Treatment Capacity
Own Sources (OS)	19 627 318	17 346 160	18 533 429	15 176 615	8 059 441	8 545 570	18 533 429	22 183 429	22 183 429	47 158 429	47 158 429	47 158 429	58 838 429	58 838 429	58 838 429	58 838 429	58 838 429
Water Imported (WI)	63 306 660	67 321 906	68 037 833	67 595 763	64 247 264	60 558 420	70 634 971	69 660 023	71 496 892	48 395 498	50 306 577	51 281 227	40 585 624	41 579 864	42 584 047	43 598 272	44 622 639
System Input Volume (SIV)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	89 168 400	91 843 452	93 680 321	95 553 928	97 465 006	98 439 656	99 424 053	100 418 293	101 422 476	102 436 701	103 461 068
Water Exported (WE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Supplied (WS)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	89 168 400	91 843 452	93 680 321	95 553 928	97 465 006	98 439 656	99 424 053	100 418 293	101 422 476	102 436 701	103 461 068
Authorised Consumption (AC)	47 174 698	55 407 215	48 027 823	62 804 514	52 698 581	50 884 501	53 696 334	55 653 720	57 687 558	59 800 859	61 475 299	63 199 086	64 973 677	66 800 568	68 681 304	70 617 472	72 610 708
Billed Authorised Consumption (BAC)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	51 948 927	53 915 050	55 957 581	58 079 533	59 762 579	61 494 930	63 278 041	65 113 411	67 002 582	68 947 144	70 948 732
Billed Water Exported to Other Systems (BWEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billed Metered Consumption (BMC)	44 763 274	51 479 975	44 574 259	42 595 034	36 501 846	37 440 085	46 357 230	48 211 519	50 139 980	52 145 579	53 709 946	55 321 245	56 980 882	58 690 308	60 451 018	62 264 548	64 132 485
Free Basic Water/Indigent Consumption (FBW)	2 411 424	3 927 240	1 697 376	3 295 200	2 654 040	3 525 138	1 731 324	1 765 950	1 801 269	1 837 294	1 874 040	1 911 521	1 949 751	1 988 747	2 028 521	2 069 092	2 110 474
Billed Unmetered Consumption (BUC)	0	0	0	3 784 680	3 544 080	3 801 340	3 860 374	3 937 581	4 016 333	4 096 659	4 178 593	4 262 164	4 347 408	4 434 356	4 523 043	4 613 504	4 705 774
Potential Revenue Water (PRW)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	51 948 927	53 915 050	55 957 581	58 079 533	59 762 579	61 494 930	63 278 041	65 113 411	67 002 582	68 947 144	70 948 732
Unbilled Authorised Consumption (UAC)	3 655 002	9 313 488	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Unbilled Metered Consumption (UMC)	3 655 002	9 313 488	1 231 572	12 301 877	8 819 068	5 431 254	1 225 415	1 219 287	1 213 191	1 207 125	1 201 089	1 195 084	1 189 109	1 183 163	1 177 247	1 171 361	1 165 504
Unbilled Unmetered Consumption (UUC)	0	0	524 615	827 724	1 179 547	686 683	521 992	519 382	516 785	514 201	511 630	509 072	506 527	503 994	501 474	498 967	496 472
Total Water Losses (WL)	32 104 278	19 947 364	38 543 439	19 967 864	19 608 124	17 896 255	35 472 067	36 189 733	35 992 764	35 753 069	35 989 707	35 240 570	34 450 376	33 617 725	32 741 173	31 819 229	30 850 360
Apparent Losses (AL)	3 403 932	1 939 253	3 041 152	4 470 742	4 665 025	3 514 188	2 972 846	2 906 131	2 840 967	2 777 318	2 715 147	2 654 418	2 595 097	2 537 149	2 480 541	2 425 241	2 371 218
Illegal Consumption (IC)	1 941 516	221 629	2 292 847	1 986 995	2 537 101	1 988 180	2 246 990	2 202 050	2 158 009	2 114 849	2 072 552	2 031 101	1 990 479	1 950 669	1 911 656	1 873 423	1 835 954
Meter Under-Registration (MUR)	1 462 416	1 717 624	748 306	2 483 747	2 127 924	1 526 007	725 857	704 081	682 958	662 470	642 596	623 318	604 618	586 480	568 885	551 819	535 264
Real Losses (RL)	28 700 346	18 008 112	35 502 287	15 497 122	14 943 099	14 382 068	32 499 220	33 283 602	33 151 796	32 975 750	33 274 560	32 586 152	31 855 279	31 080 577	30 260 632	29 393 988	28 479 141
Leakage on Mains (LM)	6 276 206	5 157 815	1 188 264	3 052 065	2 941 260	2 827 187	1 128 851	1 072 408	1 018 788	967 848	919 456	873 483	829 809	788 319	748 903	711 458	675 885
Leakage and Overflows on Reservoirs (LOR)	621 230	246 482	686 511	236 799	236 799	246 130	679 646	672 850	666 121	659 460	652 866	646 337	639 874	633 475	627 140	620 869	614 660
Leakage on Service Connections (LSC)	21 802 910	12 603 815	20 523 501	12 208 258	11 765 040	11 308 750	19 497 326	18 522 460	17 596 337	16 716 520	15 880 694	15 245 466	14 635 647	14 050 221	13 488 213	12 948 684	12 430 737
Non-Revenue Water (NRW)	35 759 280	29 260 852	40 299 627	33 097 464	29 606 739	24 337 427	37 219 473	37 928 402	37 722 740	37 474 395	37 702 427	36 944 726	36 146 012	35 304 883	34 419 894	33 489 557	32 512 336
Static Information	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**
Number of service connections	126 582	126 582	132 689	131 054	142 565	193 591	197 463	201 412	205 440	209 549	213 740	218 015	222 375	226 823	231 359	235 986	240 706
Length of trunk mains (km)	696	696	696	696	696	710	725	739	754	769	784	800	816	832	849	866	883
Length of reticulation (km)	2 962	2 962	2 962	2 962	2 989	3 106	3 168	3 231	3 296	3 362	3 429	3 498	3 568	3 639	3 712	3 786	3 862
Average Zone Operating Pressure (m)	54	62	64	62	61	60	60	60	60	60	60	60	60	60	60	60	60
UARL (ℓ/conn/day)	8 360	9 274	77	3 452 683	3 619 197	4 387 716	65	65	65	65	65	65	65	65	65	65	65
Population	721 157	721 367	721 157	788 881	836 711	825 686	842 200	859 044	876 225	893 749	911 624	929 857	948 454	967 423	986 771	1 006 507	1 026 637
CARL (ℓ/conn/day)							451	453	442	431	427	410	392	375	358	341	324

Table G-2: Scenario 5 Water Balance Projections

Water Balance Component	Historic Information						Ten Year Projections (Based on FY 2013/14)										
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Own Sources (OS)	19 627 318	17 346 160	18 533 429	15 176 615	8 059 441	8 545 570	18 533 429	22 183 429	22 183 429	47 158 429	47 158 429	47 158 429	58 838 429	58 838 429	58 838 429	58 838 429	58 838 429
Water Imported (WI)	63 306 660	67 321 906	68 037 833	67 595 763	64 247 264	60 558 420	69 769 258	67 885 312	69 686 687	46 549 089	48 423 240	50 334 873	40 604 739	42 593 602	44 622 243	46 691 456	48 802 054
System Input Volume (SIV)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	88 302 688	90 068 741	91 870 116	93 707 518	95 581 669	97 493 302	99 443 168	101 432 032	103 460 672	105 529 886	107 640 483
Water Exported (WE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Supplied (WS)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	88 302 688	90 068 741	91 870 116	93 707 518	95 581 669	97 493 302	99 443 168	101 432 032	103 460 672	105 529 886	107 640 483
Authorised Consumption (AC)	47 174 698	55 407 215	48 027 823	62 804 514	52 698 581	50 884 501	52 359 106	52 912 403	53 472 482	54 039 433	54 613 347	55 194 316	55 782 434	56 377 795	56 980 497	57 590 637	58 208 314
Billed Authorised Consumption (BAC)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	50 611 699	51 173 733	51 742 506	52 318 107	52 900 627	53 490 160	54 086 798	54 690 638	55 301 775	55 920 309	56 546 338
Billed Water Exported to Other Systems (BWEOS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billed Metered Consumption (BMC)	44 763 274	51 479 975	44 574 259	42 595 034	36 501 846	37 440 085	45 020 002	45 470 202	45 924 904	46 384 153	46 847 995	47 316 474	47 789 639	48 267 536	48 750 211	49 237 713	49 730 090
Free Basic Water/Indigent Consumption (FBW)	2 411 424	3 927 240	1 697 376	3 295 200	2 654 040	3 525 138	1 731 324	1 765 950	1 801 269	1 837 294	1 874 040	1 911 521	1 949 751	1 988 747	2 028 521	2 069 092	2 110 474
Billed Unmetered Consumption (BUC)	0	0	0	3 784 680	3 544 080	3 801 340	3 860 374	3 937 581	4 016 333	4 096 659	4 178 593	4 262 164	4 347 408	4 434 356	4 523 043	4 613 504	4 705 774
Potential Revenue Water (PRW)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	50 611 699	51 173 733	51 742 506	52 318 107	52 900 627	53 490 160	54 086 798	54 690 638	55 301 775	55 920 309	56 546 338
Unbilled Authorised Consumption (UAC)	3 655 002	9 313 488	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Unbilled Metered Consumption (UMC)	3 655 002	9 313 488	1 231 572	12 301 877	8 819 068	5 431 254	1 225 415	1 219 287	1 213 191	1 207 125	1 201 089	1 195 084	1 189 109	1 183 163	1 177 247	1 171 361	1 165 504
Unbilled Unmetered Consumption (UUC)	0	0	524 615	827 724	1 179 547	686 683	521 992	519 382	516 785	514 201	511 630	509 072	506 527	503 994	501 474	498 967	496 472
Total Water Losses (WL)	32 104 278	19 947 364	38 543 439	19 967 864	19 608 124	17 896 255	35 943 582	37 156 339	38 397 634	39 668 085	40 968 322	42 298 986	43 660 734	45 054 236	46 480 175	47 939 249	49 432 169
Apparent Losses (AL)	3 403 932	1 939 253	3 041 152	4 470 742	4 665 025	3 514 188	3 003 258	2 965 892	2 929 046	2 892 713	2 856 883	2 821 551	2 786 706	2 752 343	2 718 453	2 685 030	2 652 065
Illegal Consumption (IC)	1 941 516	221 629	2 292 847	1 986 995	2 537 101	1 988 180	2 269 918	2 247 219	2 224 747	2 202 499	2 180 474	2 158 670	2 137 083	2 115 712	2 094 555	2 073 609	2 052 873
Meter Under-Registration (MUR)	1 462 416	1 717 624	748 306	2 483 747	2 127 924	1 526 007	733 340	718 673	704 299	690 213	676 409	662 881	649 623	636 631	623 898	611 420	599 192
Real Losses (RL)	28 700 346	18 008 112	35 502 287	15 497 122	14 943 099	14 382 068	32 940 324	34 190 447	35 468 588	36 775 373	38 111 438	39 477 436	40 874 028	42 301 893	43 761 722	45 254 219	46 780 104
Leakage on Mains (LM)	6 276 206	5 157 815	1 188 264	3 052 065	2 941 260	2 827 187	1 152 616	1 118 038	1 084 496	1 051 962	1 020 403	989 791	960 097	931 294	903 355	876 255	849 967
Leakage and Overflows on Reservoirs (LOR)	621 230	246 482	686 511	236 799	236 799	246 130	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511
Leakage on Service Connections (LSC)	21 802 910	12 603 815	20 523 501	12 208 258	11 765 040	11 308 750	19 907 796	19 310 562	18 731 245	18 169 308	17 624 228	17 095 502	16 582 637	16 085 157	15 602 603	15 134 525	14 680 489
Non-Revenue Water (NRW)	35 759 280	29 260 852	40 299 627	33 097 464	29 606 739	24 337 427	37 690 989	38 895 008	40 127 611	41 389 412	42 681 042	44 003 142	45 356 370	46 741 394	48 158 897	49 609 577	51 094 146

Table G-3: Scenario 1 Water Balance Projections

Water Balance Component	Historic Information						Ten Year Projections (Based on FY 2013/14)										
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Own Sources (OS)	19 627 318	17 346 160	18 533 429	15 176 615	8 059 441	8 545 570	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429	18 533 429
Water Imported (WI)	63 306 660	67 321 906	68 037 833	67 595 763	64 247 264	60 558 420	72 366 396	76 911 387	81 683 628	86 694 481	91 955 877	97 480 342	103 281 030	109 371 753	115 767 013	122 482 035	129 532 808
System Input Volume (SIV)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Water Exported (WE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Supplied (WS)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 899 825	95 444 817	100 217 058	105 227 910	110 489 306	116 013 771	121 814 460	127 905 183	134 300 442	141 015 464	148 066 237
Authorised Consumption (AC)	47 174 698	55 407 215	48 027 823	62 804 514	52 698 581	50 884 501	51 922 144	52 033 978	52 148 049	52 264 401	52 383 080	52 504 132	52 627 606	52 753 549	52 882 011	53 013 043	53 146 695
Billed Authorised Consumption (BAC)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	50 165 956	50 277 790	50 391 861	50 508 213	50 626 892	50 747 945	50 871 418	50 997 362	51 125 824	51 256 855	51 390 507
Billed Water Exported to Other Systems (BWEOS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billed Metered Consumption (BMC)	44 763 274	51 479 975	44 574 259	42 595 034	36 501 846	37 440 085	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259	44 574 259
Free Basic Water/Indigent Consumption (FBW)	2 411 424	3 927 240	1 697 376	3 295 200	2 654 040	3 525 138	1 731 324	1 765 950	1 801 269	1 837 294	1 874 040	1 911 521	1 949 751	1 988 747	2 028 521	2 069 092	2 110 474
Billed Unmetered Consumption (BUC)	0	0	0	3 784 680	3 544 080	3 801 340	3 860 374	3 937 581	4 016 333	4 096 659	4 178 593	4 262 164	4 347 408	4 434 356	4 523 043	4 613 504	4 705 774
Potential Revenue Water (PRW)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	50 165 956	50 277 790	50 391 861	50 508 213	50 626 892	50 747 945	50 871 418	50 997 362	51 125 824	51 256 855	51 390 507
Unbilled Authorised Consumption (UAC)	3 655 002	9 313 488	1 756 188	13 129 600	9 998 615	6 117 938	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188	1 756 188
Unbilled Metered Consumption (UMC)	3 655 002	9 313 488	1 231 572	12 301 877	8 819 068	5 431 254	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572	1 231 572
Unbilled Unmetered Consumption (UUC)	0	0	524 615	827 724	1 179 547	686 683	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615	524 615
Total Water Losses (WL)	32 104 278	19 947 364	38 543 439	19 967 864	19 608 124	17 896 255	38 977 681	43 410 839	48 069 009	52 963 510	58 106 226	63 509 639	69 186 854	75 151 633	81 418 431	88 002 421	94 919 543
Apparent Losses (AL)	3 403 932	1 939 253	3 041 152	4 470 742	4 665 025	3 514 188	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152	3 041 152
Illegal Consumption (IC)	1 941 516	221 629	2 292 847	1 986 995	2 537 101	1 988 180	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847	2 292 847
Meter Under-Registration (MUR)	1 462 416	1 717 624	748 306	2 483 747	2 127 924	1 526 007	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306	748 306
Real Losses (RL)	28 700 346	18 008 112	35 502 287	15 497 122	14 943 099	14 382 068	35 936 529	40 369 686	45 027 857	49 922 357	55 065 074	60 468 486	66 145 701	72 110 481	78 377 278	84 961 269	91 878 390
Leakage on Mains (LM)	6 276 206	5 157 815	1 188 264	3 052 065	2 941 260	2 827 187	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264	1 188 264
Leakage and Overflows on Reservoirs (LOR)	621 230	246 482	686 511	236 799	236 799	246 130	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511
Leakage on Service Connections (LSC)	21 802 910	12 603 815	20 523 501	12 208 258	11 765 040	11 308 750	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501	20 523 501
Non-Revenue Water (NRW)	35 759 280	29 260 852	40 299 627	33 097 464	29 606 739	24 337 427	40 733 869	45 167 026	49 825 197	54 719 697	59 862 414	65 265 827	70 943 041	76 907 821	83 174 618	89 758 609	96 675 730

Table G-4: Scenario 2 Water Balance Projections

Water Balance Component	Historic Information						Ten Year Projections (Based on FY 2013/14)										
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Own Sources (OS)	19 627 318	17 346 160	18 533 429	15 176 615	8 059 441	8 545 570	18 533 429	22 183 429	22 183 429	47 158 429	47 158 429	47 158 429	58 838 429	58 838 429	58 838 429	58 838 429	58 838 429
Water Imported (WI)	63 306 660	67 321 906	68 037 833	67 595 763	64 247 264	60 558 420	71 500 683	71 452 048	75 197 467	54 117 703	58 168 748	62 381 835	55 083 446	59 640 321	64 379 471	69 308 187	74 434 052
System Input Volume (SIV)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 034 113	93 635 477	97 380 896	101 276 132	105 327 178	109 540 265	113 921 875	118 478 750	123 217 900	128 146 616	133 272 481
Water Exported (WE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Supplied (WS)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 034 113	93 635 477	97 380 896	101 276 132	105 327 178	109 540 265	113 921 875	118 478 750	123 217 900	128 146 616	133 272 481
Authorised Consumption (AC)	47 174 698	55 407 215	48 027 823	62 804 514	52 698 581	50 884 501	53 250 591	54 731 032	56 255 075	57 824 002	59 439 136	61 101 838	62 813 511	64 575 598	66 389 584	68 257 001	70 179 423
Billed Authorised Consumption (BAC)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	51 503 184	52 992 363	54 525 098	56 102 675	57 726 416	59 397 682	61 117 876	62 888 440	64 710 863	66 586 673	68 517 447
Billed Water Exported to Other Systems (BWEOS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billed Metered Consumption (BMC)	44 763 274	51 479 975	44 574 259	42 595 034	36 501 846	37 440 085	45 911 487	47 288 832	48 707 497	50 168 722	51 673 783	53 223 997	54 820 717	56 465 338	58 159 298	59 904 077	61 701 199
Free Basic Water/Indigent Consumption (FBW)	2 411 424	3 927 240	1 697 376	3 295 200	2 654 040	3 525 138	1 731 324	1 765 950	1 801 269	1 837 294	1 874 040	1 911 521	1 949 751	1 988 747	2 028 521	2 069 092	2 110 474
Billed Unmetered Consumption (BUC)	0	0	0	3 784 680	3 544 080	3 801 340	3 860 374	3 937 581	4 016 333	4 096 659	4 178 593	4 262 164	4 347 408	4 434 356	4 523 043	4 613 504	4 705 774
Potential Revenue Water (PRW)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	51 503 184	52 992 363	54 525 098	56 102 675	57 726 416	59 397 682	61 117 876	62 888 440	64 710 863	66 586 673	68 517 447
Unbilled Authorised Consumption (UAC)	3 655 002	9 313 488	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Unbilled Metered Consumption (UMC)	3 655 002	9 313 488	1 231 572	12 301 877	8 819 068	5 431 254	1 225 415	1 219 287	1 213 191	1 207 125	1 201 089	1 195 084	1 189 109	1 183 163	1 177 247	1 171 361	1 165 504
Unbilled Unmetered Consumption (UUC)	0	0	524 615	827 724	1 179 547	686 683	521 992	519 382	516 785	514 201	511 630	509 072	506 527	503 994	501 474	498 967	496 472
Total Water Losses (WL)	32 104 278	19 947 364	38 543 439	19 967 864	19 608 124	17 896 255	36 783 522	38 904 445	41 125 822	43 452 131	45 888 042	48 438 426	51 108 364	53 903 153	56 828 316	59 889 616	63 093 058
Apparent Losses (AL)	3 403 932	1 939 253	3 041 152	4 470 742	4 665 025	3 514 188	2 957 880	2 877 396	2 799 588	2 724 348	2 651 576	2 581 174	2 513 049	2 447 110	2 383 275	2 321 461	2 261 591
Illegal Consumption (IC)	1 941 516	221 629	2 292 847	1 986 995	2 537 101	1 988 180	2 246 990	2 202 050	2 158 009	2 114 849	2 072 552	2 031 101	1 990 479	1 950 669	1 911 656	1 873 423	1 835 954
Meter Under-Registration (MUR)	1 462 416	1 717 624	748 306	2 483 747	2 127 924	1 526 007	710 890	675 346	641 579	609 500	579 025	550 073	522 570	496 441	471 619	448 038	425 636
Real Losses (RL)	28 700 346	18 008 112	35 502 287	15 497 122	14 943 099	14 382 068	33 825 642	36 027 049	38 326 234	40 727 782	43 236 465	45 857 252	48 595 316	51 456 042	54 445 041	57 568 155	60 831 467
Leakage on Mains (LM)	6 276 206	5 157 815	1 188 264	3 052 065	2 941 260	2 827 187	1 176 381	1 164 618	1 152 971	1 141 442	1 130 027	1 118 727	1 107 540	1 096 464	1 085 500	1 074 645	1 063 898
Leakage and Overflows on Reservoirs (LOR)	621 230	246 482	686 511	236 799	236 799	246 130	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511
Leakage on Service Connections (LSC)	21 802 910	12 603 815	20 523 501	12 208 258	11 765 040	11 308 750	20 318 266	20 115 083	19 913 932	19 714 793	19 517 645	19 322 469	19 129 244	18 937 952	18 748 572	18 561 086	18 375 475
Non-Revenue Water (NRW)	35 759 280	29 260 852	40 299 627	33 097 464	29 606 739	24 337 427	38 530 929	40 643 115	42 855 798	45 173 457	47 600 762	50 142 583	52 804 000	55 590 310	58 507 038	61 559 943	64 755 034

Table G-5: Scenario 3 Water Balance Projections

Water Balance Component	Historic Information						Ten Year Projections (Based on FY 2013/14)										
	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Own Sources (OS)	19 627 318	17 346 160	18 533 429	15 176 615	8 059 441	8 545 570	18 533 429	22 183 429	22 183 429	47 158 429	47 158 429	47 158 429	58 838 429	58 838 429	58 838 429	58 838 429	58 838 429
Water Imported (WI)	63 306 660	67 321 906	68 037 833	67 595 763	64 247 264	60 558 420	72 149 968	72 807 429	77 319 495	57 070 884	62 021 776	67 207 836	60 960 234	66 650 670	72 611 403	78 855 270	85 395 720
System Input Volume (SIV)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 683 397	94 990 859	99 502 924	104 229 313	109 180 206	114 366 266	119 798 663	125 489 100	131 449 832	137 693 699	144 234 150
Water Exported (WE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Supplied (WS)	82 933 978	84 668 067	86 571 262	82 772 378	72 306 705	69 103 990	90 683 397	94 990 859	99 502 924	104 229 313	109 180 206	114 366 266	119 798 663	125 489 100	131 449 832	137 693 699	144 234 150
Authorised Consumption (AC)	47 174 698	55 407 215	48 027 823	62 804 514	52 698 581	50 884 501	54 142 076	56 585 322	59 147 855	61 835 571	64 654 658	67 611 612	70 713 254	73 966 742	77 379 592	80 959 695	84 715 334
Billed Authorised Consumption (BAC)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	52 394 669	54 846 652	57 417 879	60 114 244	62 941 938	65 907 456	69 017 618	72 279 584	75 700 871	79 289 367	83 053 358
Billed Water Exported to Other Systems (BWEOS)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Billed Metered Consumption (BMC)	44 763 274	51 479 975	44 574 259	42 595 034	36 501 846	37 440 085	46 802 972	49 143 121	51 600 277	54 180 291	56 889 305	59 733 771	62 720 459	65 856 482	69 149 306	72 606 771	76 237 110
Free Basic Water/Indigent Consumption (FBW)	2 411 424	3 927 240	1 697 376	3 295 200	2 654 040	3 525 138	1 731 324	1 765 950	1 801 269	1 837 294	1 874 040	1 911 521	1 949 751	1 988 747	2 028 521	2 069 092	2 110 474
Billed Unmetered Consumption (BUC)	0	0	0	3 784 680	3 544 080	3 801 340	3 860 374	3 937 581	4 016 333	4 096 659	4 178 593	4 262 164	4 347 408	4 434 356	4 523 043	4 613 504	4 705 774
Potential Revenue Water (PRW)	47 174 698	55 407 215	46 271 635	49 674 914	42 699 966	44 766 563	52 394 669	54 846 652	57 417 879	60 114 244	62 941 938	65 907 456	69 017 618	72 279 584	75 700 871	79 289 367	83 053 358
Unbilled Authorised Consumption (UAC)	3 655 002	9 313 488	1 756 188	13 129 600	9 998 615	6 117 938	1 747 407	1 738 670	1 729 976	1 721 327	1 712 720	1 704 156	1 695 635	1 687 157	1 678 722	1 670 328	1 661 976
Unbilled Metered Consumption (UMC)	3 655 002	9 313 488	1 231 572	12 301 877	8 819 068	5 431 254	1 225 415	1 219 287	1 213 191	1 207 125	1 201 089	1 195 084	1 189 109	1 183 163	1 177 247	1 171 361	1 165 504
Unbilled Unmetered Consumption (UUC)	0	0	524 615	827 724	1 179 547	686 683	521 992	519 382	516 785	514 201	511 630	509 072	506 527	503 994	501 474	498 967	496 472
Total Water Losses (WL)	32 104 278	19 947 364	38 543 439	19 967 864	19 608 124	17 896 255	36 541 321	38 405 537	40 355 069	42 393 742	44 525 548	46 754 653	49 085 409	51 522 358	54 070 240	56 734 004	59 518 816
Apparent Losses (AL)	3 403 932	1 939 253	3 041 152	4 470 742	4 665 025	3 514 188	2 949 918	2 861 420	2 775 578	2 692 310	2 611 541	2 533 195	2 457 199	2 383 483	2 311 978	2 242 619	2 175 341
Illegal Consumption (IC)	1 941 516	221 629	2 292 847	1 986 995	2 537 101	1 988 180	2 224 061	2 157 339	2 092 619	2 029 841	1 968 945	1 909 877	1 852 581	1 797 003	1 743 093	1 690 800	1 640 076
Meter Under-Registration (MUR)	1 462 416	1 717 624	748 306	2 483 747	2 127 924	1 526 007	725 857	704 081	682 958	662 470	642 596	623 318	604 618	586 480	568 885	551 819	535 264
Real Losses (RL)	28 700 346	18 008 112	35 502 287	15 497 122	14 943 099	14 382 068	33 591 403	35 544 117	37 579 492	39 701 432	41 914 007	44 221 458	46 628 210	49 138 875	51 758 261	54 491 385	57 343 475
Leakage on Mains (LM)	6 276 206	5 157 815	1 188 264	3 052 065	2 941 260	2 827 187	1 164 499	1 141 209	1 118 385	1 096 017	1 074 097	1 052 615	1 031 562	1 010 931	990 712	970 898	951 480
Leakage and Overflows on Reservoirs (LOR)	621 230	246 482	686 511	236 799	236 799	246 130	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511	686 511
Leakage on Service Connections (LSC)	21 802 910	12 603 815	20 523 501	12 208 258	11 765 040	11 308 750	20 113 031	19 710 770	19 316 555	18 930 224	18 551 619	18 180 587	17 816 975	17 460 636	17 111 423	16 769 194	16 433 811
Non-Revenue Water (NRW)	35 759 280	29 260 852	40 299 627	33 097 464	29 606 739	24 337 427	38 288 728	40 144 207	42 085 046	44 115 069	46 238 268	48 458 810	50 781 045	53 209 515	55 748 961	58 404 332	61 180 792

Table G-6: Scenario 4 Water Balance Projections

Annexure H

Scenario Assumptions

H. ANNEXURE H – SCENARIO ASSUMPTIONS

BASE CASE ASSUMPTIONS															
Annual percentage increase															
Population related inputs	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Population growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
System inputs															
Service connection growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Length of reticulation/trunk increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
SIV related inputs															
SIV annual increase (impact SIV)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Maselspoort WTW increased production and re-use implementation (m^3/a Stepped Increase)															
Unbilled consumption inputs															
Metered consumption increase (impact BMC)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Free basic water/informal settlement increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Reduction in unbilled metered consumption	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Reduction in unbilled unmetered consumption	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Real losses inputs															
Leakage on mains reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Leakage on reservoirs/overflows reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Leakage on consumer connections reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Filter washwater recovery at Maselspoort (impact SIV, imported sources)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Apparent losses inputs															
Illegal consumption reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Meter under registration reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table H-1: Base Case Assumptions

SCENARIO 5 ASSUMPTIONS - COMBINATION															
Annual percentage increase															
Population related inputs	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Population growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
System inputs															
Service connection growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Length of reticulation/trunk increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
SIV related inputs															
SIV annual increase (impact SIV)	4%	4%	3%	3%	3%	3%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Maselspoort WTW increased production and re-use implementation (m^3/a Stepped Increase)						3 650 000		24 975 000			11 680 000				
Unbilled consumption inputs															
Metered consumption increase (impact BMC)	4%	4%	4%	4%	4%	4%	4%	4%	3%	3%	3%	3%	3%	3%	3%
Free basic water/informal settlement increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Reduction in unbilled metered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Reduction in unbilled unmetered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Real losses inputs															
Leakage on mains reduction	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%
Leakage on reservoirs/overflows reduction	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Leakage on consumer connections reduction	-6%	-6%	-6%	-6%	-5%	-5%	-5%	-5%	-5%	-4%	-4%	-4%	-4%	-4%	-4%
Filter washwater recovery at Maselspoort (impact SIV, imported sources)	0%	0%	0%	0%	0%	-10%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Apparent losses inputs															
Illegal consumption reduction	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Meter under registration reduction	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%

Table H-2: Scenario 5 Assumptions

SCENARIO 1 ASSUMPTIONS -SIV															
Annual percentage increase															
Population related inputs	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Population growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
System inputs															
Service connection growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Length of reticulation/trunk increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
SIV related inputs															
SIV annual increase (impact SIV)	3%	3%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Maselspoort WTW increased production and re-use implementation (m^3/a Stepped Increase)						3 650 000		24 975 000			11 680 000				
Unbilled consumption inputs															
Metered consumption increase (impact BMC)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Free basic water/informal settlement increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Reduction in unbilled metered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Reduction in unbilled unmetered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Real losses inputs															
Leakage on mains reduction	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%
Leakage on reservoirs/overflows reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Leakage on consumer connections reduction	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%
Filter washwater recovery at Maselspoort (impact SIV, imported sources)	0%	0%	0%	0%	0%	-10%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Apparent losses inputs															
Illegal consumption reduction	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Meter under registration reduction	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%

Table H-3: Scenario 1 Assumptions

SCENARIO 2 ASSUMPTIONS - REAL LOSSES															
Annual percentage increase															
Population related inputs	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Population growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
System inputs															
Service connection growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Length of reticulation/trunk increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
SIV related inputs															
SIV annual increase (impact SIV)	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Maselspoort WTW increased production and re-use implementation (m^3/a Stepped Increase)						3 650 000		24 975 000			11 680 000				
Unbilled consumption inputs															
Metered consumption increase (impact BMC)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Free basic water/informal settlement increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Reduction in unbilled metered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Reduction in unbilled unmetered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Real losses inputs															
Leakage on mains reduction	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%
Leakage on reservoirs/overflows reduction	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Leakage on consumer connections reduction	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%
Filter washwater recovery at Maselspoort (impact SIV, imported sources)	0%	0%	0%	0%	0%	-10%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Apparent losses inputs															
Illegal consumption reduction	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Meter under registration reduction	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%

Table H-4: Scenario 2 Assumptions

SCENARIO 3 ASSUMPTIONS - APPARENT LOSSES															
Annual percentage increase															
Population related inputs	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Population growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
System inputs															
Service connection growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Length of reticulation/trunk increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
SIV related inputs															
SIV annual increase (impact SIV)	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Maselspoort WTW increased production and re-use implementation (m^3/a Stepped Increase)						3 650 000		24 975 000			11 680 000				
Unbilled consumption inputs															
Metered consumption increase (impact BMC)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Free basic water/informal settlement increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Reduction in unbilled metered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Reduction in unbilled unmetered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Real losses inputs															
Leakage on mains reduction	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Leakage on reservoirs/overflows reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Leakage on consumer connections reduction	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%	-1%
Filter washwater recovery at Maselspoort (impact SIV, imported sources)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Apparent losses inputs															
Illegal consumption reduction	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Meter under registration reduction	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%	-5%

Table H-5: Scenario 3 Assumptions

SCENARIO 4 ASSUMPTIONS - UNBILLED METERED CONSUMPTION															
Annual percentage increase															
Population related inputs	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Population growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
System inputs															
Service connection growth	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Length of reticulation/trunk increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
SIV related inputs															
SIV annual increase (impact SIV)	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%	4.75%
Maselspoort WTW increased production and re-use implementation (m^3/a Stepped Increase)						3 650 000		24 975 000			11 680 000				
Unbilled consumption inputs															
Metered consumption increase (impact BMC)	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Free basic water/informal settlement increase	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Reduction in unbilled metered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Reduction in unbilled unmetered consumption	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Real losses inputs															
Leakage on mains reduction	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Leakage on reservoirs/overflows reduction	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Leakage on consumer connections reduction	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%
Filter washwater recovery at Maselspoort (impact SIV, imported sources)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Apparent losses inputs															
Illegal consumption reduction	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%
Meter under registration reduction	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%	-3%

Table H-6: Scenario 4 Assumptions

Annexure I

Draft Meter Replacement Policy

I. ANNEXURE I – METER REPLACEMENT POLICY

DOCUMENT CONTROL SHEET		
Programme name	Water and Sanitation Asset Management	
Project name	10 Year Water Conservation Demand Management Strategy	
Policy Name	Mangaung Metropolitan Muncipality Metering Policy	
Policy Revision and date	Rev 1.0, April 2014	
Prepared by	JJ van der Walt, DMP W&S, Bigen Africa (mias.vanderwalt@bigenafrica.com)	
Approved by	Koki Mokhoabane, WCDM Manager, MMM (koki.Mokhoabane@mangaung.co.za)	

METER SELECTION, INSTALLATION, MAINTENANCE AND REPLACEMENT POLICY

1. Introduction and background documentation

1.1 Application

This policy provides the basis for selecting, installing, maintaining and replacement of water meters, both domestic and non-domestic and should form part of the overall Asset Management Program. This policy is based on a previous version that formed part of the 2012-2016 5 year strategic plan for reduction of non-revenue water. The policy was expanded to include other meter types and is no longer limited to consumer meters only.

This policy is meant to be a guide only, and is not a prescriptive standard – engineering judgment and environmental considerations (i.e. change in consumer, change in consumer profile, firefighting considerations, burst frequency etc.) must always be applied when selecting and replacing any consumer meter. Similar policies may be in place for other key aspects of the Mangaung business processes.

One of the key aspects that need to be included in the business processes shortly after the meter application is to confirm that the water supply network is capable of meeting the demand. In order to confirm that the water supply network is able to supply the projected demand it is necessary to model the water supply network and for this purpose an integrated dynamic pipe network model is required.

This meter policy applies to all meter types that includes the following:

- Internal bulk and supply meters
- District meters
- Control meters
- Consumer meters
    - Small consumers
    - Large consumers
    - Key consumers

The distinction between the different types of meters is briefly discussed below.

1.1.1 Internal bulk and supply meters

Bulk supply meters are used to measure the water purchased by MMM either in raw or potable form. Bulk supply meters are in most cases large diameter meters and should be of the type specified in the meter selection policy. These meters are critical in establishing the correct SIV and needs to be monitored continuously.

Internal bulk meters also includes large diameter meters measuring raw water, treated water and also effluent from WwTW. The latter bulk meter type is not always in a piped system and is often measured by hydraulic means such as measuring weirs.

1.1.2 District meters

District meters measures the water used by a water district that is supplied through a single point of supply. The district meter totalises the water consumed by all end consumers in the district fed through the district meter. The primary purpose of a district meter is to enable the water manager to calculate the water balance of the water district and determine the distribution losses.

A water treatment works can also be considered a water district and should have raw water meters and meters for all water/sludge leaving the water treatment plant. This enables the operator to establish the treatment losses.

1.1.3 Control meters

In some cases the volume of water measures is of such strategic importance and large quantity that two meters are installed in series. The purpose of installing two meters in series is not to improve the metering accuracy, but to improve meter reliability in case of meter failure. Control meters are also used to perform an independent 'audit' function. Control meters are therefore often installed in cases where one party sells to another party, i.e. between Bloem Water and MMM or where large consumers are metered. The manner in which differences between the two meters are accounted for requires special mention.

In the case where two meters differ by less than a prescribed minimum % the average of the two meters are used to calculate the consumption. In the case where the meters differ by more than a minimum percentage it needs to be determined which of the meters have failed. The reading of the meter that has not failed will then be used to estimate the consumption. The manner in which the meters are used to calculate the consumption needs to be agreed upon in the Water Supply Agreement between the parties.

1.1.4 Consumer meters

Consumer meters are used to measure the water use of the end consumer. End consumer consumption is mostly measured by a single meter suitably sized to accurately measure the consumption, but can also in some cases include control meters to ensure reliable flow measurement.

1.2 Related Documentation

This policy is to be interpreted in the light of other technical documents, specifications and standards (mentioned in the following section) and is not intended to be a replacement to these documents. The following related documentation must be read in conjunction with this policy, and has not been included:

- i) Mangaung Metropolitan Municipality Water Supply Bylaws
- ii) Scope and Technical Specification for the Supply and Delivery of Mechanical and Insertion-Type Electromagnetic Flow Water Meters
- iii) Trade Metrology Act 77 of 1973
- iv) South African National Standard SANS 1529-1: 2006: Water Meters for Cold Potable Water – Part 1: Metrological Characteristics of Mechanical Water Meters of Nominal Bore not Exceeding 100mm
- v) South African National Standard SANS 1529-4: 2004: Water Meters for Cold Potable Water – Part 4: Mechanical Meters of Nominal Bore Exceeding 100mm but not Exceeding 800mm
- vi) International Organisation of Legal Metrology (OIML). International Recommendation OIML R49-1 Edition 2006 (E). Water meters intended for the metering of cold potable water and hot water. Part 1: Metrological and technical requirements.

2. Meter Selection policy

All meter standards must conform to the relevant requirements of SANS 1529-1 and/or OIML R49-1. The type of meter, or the meter measuring principle, should be guided by both size and anticipated demand as presented in *Table 1*:

2.1 Meter types

Various types of meters used to meter piped water consumption in a municipal environment include mechanical meters, ultrasonic meters and electro-magnetic flow meters. Mechanical meters are generally used for smaller diameter meters. Mechanical meters are available for sizes up to 800 mm, but the advent of electronic meters has advanced to the point that it is more cost effective to install electronic meters instead of mechanical meters for sizes less than 300 mm. For meter sizes 300 mm and larger it is recommended that eletro-magnetic or ultrasonic flow meter be used. The major disadvantage of electronic flow meter is the requirement of a power supply source. Recent developments have to some extent addressed this shortcoming with the advent of long term battery operated electronic flow meters. The recommended meter types for different meter sizes are summarised in Table 1.

A special case needs to be considered in the case of non-piped flow measurement. In many cases especially in the case of WwTW flow measurement is effected by means of hydraulic principles, i.e. measurement by means of various types of weirs. Flow measurement by means of hydraulic structures are not included in Table 1, but is included in the meter sizing policy.

Meter category	Consumer Meter Nominal Diameter/Range	Anticipated Demand (kl/day)	Meter Measuring Principle/ Meter Type
Small meters	15mm up to and including 20mm	N/A	Volumetric
	25mm up to and including 40mm	Less than 7kl/day	Multijet
		Greater than or equal to 7kl/day	Woltmann
Medium meters	40mm up to and including 250mm	Varies depending on size	Woltmann
Large meters	300mm and greater	Varies depending on size	Woltmann (if power not available on site, maximum meter size 300mm nominal diameter
		Varies depending on size	Electromagnetic or ultrasonic (if power available on site and head loss through installation for firefighting requirements is a concern)

Table 1: Guidelines for the Selection of Meters Based on Measuring Principle

2.2 Meter accuracy

The practitioner must take due cognizance of the meter documentation and in particular the starting flow, the minimum flow (Q_{min} or Q1), the transitional flow (Q_t or Q2) and the nominal/continuous flow (Q_n, Q_p or Q3) when determining the preferred meter size. Furthermore, meters with superior turn-down ratios and low starting, minimum and transitional flows should be considered where very low usage and a wide usage range are anticipated. It should be noted that all meters should be accompanied with a test certificate documenting meter accuracy.

2.3 Meter sizing

Due consideration should be given to the sizing of a meter during the design stage as the meter size has a significant impact on the meter accuracy. Incorrectly sized meters will either under-register if oversized or will self-destruct if undersized. Both scenarios will result in a loss of water sales to the WSA. Meter sizing is a specialised area and is covered specifically under a separate policy document referred to MMM Meter Sizing Policy. Meter sizing should take into consideration at least the following aspects:

- Water use type (domestic, industrial, district, effluent)
- Water meter type(piped: mechanical, electronic, open channel: weir types)
- Seasonal and diurnal water use range (minimum, average and maximum flow)

- Fire fighting requirements (on larger diameter connections)
- Tariff structures

For the purposes of the remainder of this policy document, meters shall be categorized into either "**small diameter meters"** (meters from 15mm diameter up to and including 40mm diameter Multijet-type flow meters), **"medium diameter meters"** (meters greater than an including 40mm diameter Woltmann-type flow meters and smaller than 250mm) and **"large diameter meters"** (meters 300 mm and larger) as indicated in Table 1.

3. Meter Installation Policy

3.1 General installation requirements

The following general requirements must be met for all meter installations:

i) The meter must be installed to manufacturers details;
ii) It is preferable that all meters have a digital/pulse output to enable the flow to be recorded/logged;

3.1.1 Bulk meters

Two types of bulk meters can be distinguished; bulk supply meters and internal bulk meters. Bulk supply meters are installed at the interface between WSA and WSP whereas internal bulk meters are installed where the WSA measures internal bulk water use or effluent. Bulk meters are often large it is recommended that the bulk meters should be of the electronic type. As bulk meters provide essential information for the operation of the water network and also the SIV information it is recommended that all bulk meters shall have a digital/pulse output to enable the flow to be recorded/logged/integrated and that bulk meter information be relayed to a telemetry system and a SCADA system to enable instantaneous flow indication. If supplied from an external power supply the meter should be supplied with a battery backup power supply to ensure measurement during power failures;

The following general policy guidelines are provided for *bulk supply meters*:

i) Two meters shall be installed at supply meter points; one meter shall be supplied by the WSP and one control meter shall be supplied by the WSA as a check to the WSP meter;

The following general policy guidelines are provided for *internal bulk meters*:

i) For piped meter installations the meters should be electro-magnetic or ultrasonic flow meters or;
ii) For open channel flow the meters should be a calibrated hydraulic weir structure with an electronic flow and integration device

3.1.2 District meters

District meters will generally be used for two purposes; the one is for the measurement of a district in a domestic water district and the other is in the case of specific production area such as a WTW or WwTW. It is recommended that domestic district meter be of the mechanical meter type. Should the meter sizing require a meter larger than 300 mm it is recommended that the size of the district me reduced in order to measure the flow with a meter smaller than 300mm.

District meters for WTW and WWTW should preferably be of the electronic type as mechanical meters will be influenced by the impurities in the water measured.

3.1.3 Control meters

Control meters should be of the same type of the primary meter and be installed as close a technically possible to the primary meter without influencing the accuracy of the primary or control meter. The installation requirements of the other meters type will be applicable to the control meters, i.e. bulk, district or consumer meters.

Control meters are not only applicable to bulk meters, but should also be applicable to large consumer meters. It is recommended that control meters be installed for all consumer meter installations larger than 300 mm.

3.1.4 Consumer meters

The following general requirements must be met for all consumer meter installations:

- i) The meter should, wherever practical, be located above ground;
- ii) The meter should be located just outside the consumers premises to facilitate ease of meter reading;
- iii) The meter must be installed to manufacturers details in terms of required straight lengths of pipe upstream and downstream;
- iv) The meter must be protected either by an internal strainer built into the meter as supplied by the manufacturer (small diameter meters) or by an external strainer (large diameter meters). The maximum allowable aperture size in the strainer is 2.5mm;
- v) It is preferable that all meters have a digital/pulse output to enable the flow to be recorded/logged;
- vi) All plastic meters must be housed in an approved plastic meter box to protect it from UV radiation. Bulk meters for residential and industrial purposes should be installed with a cover;
- vii) All meters must have an isolation valve upstream and downstream of the meter;
- viii) Where a valve is installed upstream of a consumer meter, it should either be buried or require a special key to operate it;
- ix) No consumer meter should be installed with a bypass system. If a meter bypass currently exists, it must be removed if it is suspected that this valve has been opened.

3.2 Meter protection, isolation and maintenance

All meters shall be installed in such a manner as to protect the meter from external influences such a lightning and other electrical influences. For this purpose meters needs to be insulated electrically. Due consideration should be given to electrical influences during the meter sizing and design process. Consideration should also be given to the maintenance requirements and enable isolation of the meter from the water network. In cases where this is not possible consideration should be given on the removal of the entire meter.

3.3 Meter accuracy, upstream and downstream requirements

The meter accuracy is inherent to the meter design, but can be influenced by the installation design. During the meter installation design process the manufacturer requirements should be confirmed and adhered to. The minimum straight lengths of pipe before and after the meter for different meter types vary significantly. In the case of mechanical meters it can be as low as 5xpipe diameter and in the case of ultrasonic flow meters it can be as high as 20xpipe diameter.

3.4 Meter standard installation drawings

MMM is in the process of developing standardised drawings for the different meter type and meter size installations. When completed these standard drawings will be appended to this policy.

4. Meter maintenance, testing and replacement policy

Meter maintenance form an essential part of general asset management and has a fundamental impact on the ability of the WSA to ensure a sustainable business. Meters that are not properly monitored and maintained can result in significant revenue loss to the WSA.

4.1 Meter maintenance policy

Meter maintenance is guided by manufacturer's requirements. It is also recommended that the maintenance inspection frequency be adjusted according to the strategic importance of the meter. In the case of large bulk meter installations, where several million cubic meters are measured per day, it is recommended that daily maintenance inspections are conducted. The frequency of maintenance inspections on district and consumer meters should be conducted on a monthly basis when meter readings are conducted. Details of the aspects that should be inspected should be captured on the meter specific maintenance schedules.

4.2 Testing policy

Meter testing is guided by the requirements of the manufacturer as well as the applicable water supply agreements. It is recommended that bulk meters are calibrated at least once a year. In the case of district and large consumer meters it is recommended that these meters be tested on an annual basis. For this purpose it is recommended that spare internal mechanisms be purchased and stored to facilitate testing. It is recommended that a service provider agreement be entered into with a recognised meter supplier for the purpose of annual meter testing.

4.3 Meter replacement policy for different meter types

Meter replacement is required to ensure continued metering and billing. Any unplanned meter stoppage requires a meter replacement. In order to prevent unplanned meter interruption a planned meter replacement is required. Meter replacement can be guided in a number of different ways:

4.3.1 Time based replacement

Time based meter replacement is applicable to all meter sizes and is indicated in Table 3.

4.3.2 Consumption based replacement

Consumption based meter replacement is applicable to all mechanical meter sizes and is indicated in Table 3. Electronic meters are not subject to mechanical are do not require consumption based replacement.

4.3.3 Check meter replacement

Check meters are installed in series to ensure improved reliability. In the case of a metering difference of more than 5% both meters need to be replaced. In order to facilitate this policy spare meters need to be kept in stock. Alternatively a service provider agreement needs to be entered into with a performance indicator specifying a minimum reaction time for meter replacement.

4.3.4 District meter replacement

District meters are used to calculate the water balance for a water district. Should the total consumption for a district measured by the individual consumers equal more than the consumption metered by the district meter then it indicates that the district meter is faulty. In such cases the district meter should be replaced if the basic steps in 4.3.5 does not indicate otherwise. (It is also possible that one or more of the consumer meters are reading higher than it should and this could also result in a positive water balance. It is, however, very unusual for mechanical meters to read higher than the actual consumption.)

4.3.5 Water balance based meter replacement

At the end of each month the water balance for each water district and the WSA as a whole needs to be calculated. Should the district water balance indicate any loss in excess of +- 15% an investigation needs to be launched to understand the reason for the losses. The WSA should develop a detailed procedure in order to determine if the loss is due to:

- A physical loss
- A inaccurate district meter
- Inaccurate consumer meters
- Incorrect meter factors applied
- A administrative error where meters were replaced and incorrect consumption was calculated

4.3.6 Risk based meter replacement

Key meters have to be monitored on a daily or weekly basis. Should it become apparent that the key consumer/bulk meter or district meter behaves in a non-consistent manner it is advised to replace/recalibrate the meter in order to prevent apparent water losses.

4.4 Meter replacement policy for different meter sizes

4.4.1 Small Diameter Meters

The current replacement standard for small diameter meters is to ensure that all small diameter meters in use for billing purposes are not older than 20 years, determined from the date of meter installation. The recommended initial guidelines for the replacement of domestic consumer meters have been presented in the *Table 2*.

Consumer Meter Size (nominal diameter)	Consider Replacement of Consumer Meter When (whichever condition is reached first)...		
	Meter Age	Volume Passed	External Considerations
15mm	Exceeds or equals 20 years, calculated from date of meter installation	Exceeds one complete counter revolution i.e. 9 999kl	Average daily consumption through meter exceeds 18kl/day for 3 consecutive months – possible meter upsizing or reduced replacement period
			Burst frequency or mains failure in the supply zone exceeds 40 bursts/100 km/year (IWA Op31 indicator)
20mm	Exceeds or equals 20 years, calculated from date of meter installation	Exceeds one complete counter revolution i.e. 9 999kl	Average daily consumption through meter exceeds 30kl/ day for 3 consecutive months – possible meter upsizing or reduced replacement period
			Burst frequency or mains failure in the supply zone exceeds 40 bursts/100 km/year (IWA Op31 indicator)
25mm			Average daily consumption through meter exceeds 42kl/ day for 3 consecutive months –

	Exceeds or equals 20 years, calculated from date of meter installation	Exceeds one complete counter revolution i.e. 9 999kl	possible meter upsizing or reduced replacement period
			Burst frequency or mains failure in the supply zone exceeds 40 bursts/100 km/year (IWA Op31 indicator)

Table 2: Recommended Meter Replacement Guidelines for Small Diameter Consumer Meters

4.4.2 Medium and Large Diameter Meters

The current replacement standard for medium and large diameter meters is to ensure that all consumer meters in use for billing purposes are not older than 10 years, determined from the date of meter installation. The recommended initial guidelines for the replacement of large diameter consumer meters have been presented in *Table 3*.

Consumer Meter Size (nominal diameter)	Consider Replacement of Consumer Meter When.. (whichever condition is reached first)		
	Meter Age	**Volume Passed**	**External Considerations**
40mm Woltmann-type meter	Exceeds or equals 10 years, calculated from date of meter installation	Exceeds one complete counter revolution i.e. 99 999kl	Average daily consumption through meter exceeds 48kl – possible meter upsizing or reduced replacement period
			Burst frequency or mains failure in the supply zone exceeds 40 bursts/100 km/year (IWA Op31 indicator)
Woltmann-type meters from 50mm up to and including 100mm	Exceeds or equals 5 years, calculated from date of meter installation	Exceeds one complete counter revolution i.e. 999 999kl	Average daily consumption through meter exceeds 70kl – possible meter upsizing or reduced replacement period
			Burst frequency or mains failure in the supply zone exceeds 40 bursts/100 km/year (IWA Op31 indicator)
	Exceeds or equals 10 years, calculated from date of meter installation	Exceeds one complete counter revolution i.e. 999 999kl	Average daily consumption through meter exceeds 30kl – possible meter upsizing or reduced replacement period
			Burst frequency or mains failure in the supply zone exceeds 40 bursts/100 km/year (IWA Op31 indicator)
Mechanical meters from 150mm up to and including 300mm	Exceeds or equals 5 years, calculated from date of meter installation	Exceeds one complete counter revolution i.e. 9 999 999kl	Average daily consumption through meter exceeds 70kl – possible meter upsizing or reduced replacement period
			Burst frequency or mains failure in the supply zone exceeds 40 bursts/100 km/year (IWA Op31 indicator)
	Exceeds or equals 10 years, calculated from date of meter installation	Exceeds one complete counter revolution i.e. 9 999 999kl	Average daily consumption through meter exceeds 30kl – possible meter upsizing or reduced replacement period
			Burst frequency or mains failure in the supply zone exceeds 40 bursts/100 km/year (IWA Op31 indicator)
Electromagnetic or ultrasonic meters greater than or equal to 200mm	Exceeds or equals 5 years, calculated from the date of meter installation	Meter accuracy not influenced by volume passed	Meter must be verified at least annually and replaced if any electronic or primary measuring element check fails

Table 3: Recommended Meter Replacement Guidelines for Large Diameter Consumer Meters

When dealing with Woltmann-type flow meters, it is important to realize that the cost of meter replacement does not necessarily mean that the entire meter installation needs to be renewed or replaced. Serious consideration must be given to replacing the meter insert mechanism only and not the entire meter when the existing meter installation conforms with the meter installation policy as presented earlier in this document. In this regard it is recommended that appropriately sized meter insert mechanisms are purchased as a stock item and used for this purpose.