ZUTARI
IMPACT. ENGINEERED.

JGDM Asset Register

Water Loss Evaluation Report Financial Year 2021/2022

Joe Gqabi District Municipality

Reference: 1001550

Contents

Appendices

Figures

Tables

Glossary

AC	Authorized Consumption
BABE	Background and Burst Estimates
BAC	Billed Authorized Consumption
CARL	Current Annual Real Losses
COGTA	Department of Co-operative Governance and Traditional Affairs
DWS	Department of Water and Sanitation
IDP	Integrated Development Plan
IWA	International Water Association
JGDM	Joe Gqabi District Municipality
LM	Local Municipality
NRW	Non-Revenue Water
UAC	Unbilled Authorized Consumption
WC	Water Conservation
WCDMP	Water Conservation and Demand Management Plan
WDM	Water Demand Management
WRC	Water Research Commission
WSA	Water Service Authority
WSP	Water Services Provider

Executive Summary

Joe Gqabi District Municipality (JGDM) is responsible for developing, operating and maintaining extensive water and sanitation infrastructure to service residents and provide basic water to most of its population. JGDM is the designated authority for three Local Municipalities (LM), namely Elundini, Senqu and Walter Sisulu which incorporates the previous Maletswai and Gariep local authorities. The billing and meter reading information is still provided for Maletswai and Gariep areas hence the reference to them in the report.

JGDM is preparing a long-term water management plan to alleviate water backlogs and aid in the management of conserving water. As a first step in implementing the long-term plan, JGDM appointed Aurecon to conduct a short-term high-level evaluation of its water losses during 2012/13. The evaluation was conducted using various engineering principles and proved to be a successful and useful tool for auditing purposes. It was decided that the same format and principles be applied annually to provide a high-level water loss evaluation of the District Municipality. This report provides an overview of the water losses during 2020/21 FY. The assessment and report were developed using supplementary documentation which included the Census 2011, the JGDM IDP plan, the National WCDMP as outlined by DWS and the 2016 Community Survey.

The assessment is carried out using software developed by the Water Research Commission (WRC) to determine the water balance within each system. This was agreed in consultation with JGDM since the software is free, easily accessible and is supported by the DWS, WRC and applies the IWA principles. It is the intention that the software be used as a platform for further development. The software is called “Bench-Leak” and can evaluate water losses for any prescribed period. Water is accounted for by balancing the total input volume (i.e. purified water, exported water), the total output bulk volume and the authorized consumption (i.e. metered consumers, indigent supply etc.). The basic principle for accountability is thus:

$$\textit{Water loss} = \textit{Bulk volume in} - \textit{Consumption} - \textit{Bulk volume out}$$

However, it is recommended that future analysis and annual submissions to the Department of Water and Sanitation be conducted using the DWS 2014 Drop format since this is recommended by DWS and applies the same principles as the “Benchleak” Software.

The evaluation uses water meter readings, billed volumes and indigent water supply. Other parameters were system specific and included characteristics such as supply population, operating pressures and pipeline length. This information was not always available, and assumptions had to be made. These areas have been ear-marked as future improvement areas and form part of the longer-term implementation.

It should be noted this is a high-level analysis including various assumptions made to rectify shortfalls in data. As more detailed information becomes available, a better estimate can be obtained. Improvement of such information can only occur over time and can be aided by the implementation of a WCDMP. The 2021/22 FY results for each area is summarised as follows:

	Elundini	Maletswai	Senqu	Gariep	JGDM Total
Total population	144,314	53,605	138,611	29,633	366,163
Indigent households - No	1,559	3,780	23,112	2,842	31,293
Kilo litres raw	3,522,887	3,821,480	4,979,682	3,905,359	16,229,409
Kilo litres treated	2,992,973	3,084,114	4,246,138	2,874,818	13,198,043
Kilo litres accounted for	2,724,272	2,416,396	3,430,592	1,669,155	10,240,415
Kilo litres lost (raw-sold)	798,615	1,405,084	1,549,090	2,236,204	5,988,994
% Non-revenue Water (lost/raw)	22.7%	36.8%	31.1%	57.3%	36.9%
Cost per kl	R 16.36	R 16.36	R 16.36	R 16.36	R 16.36
Loss in Rands (Raw)	R 13,065,342	R 22,987,181	R 25,343,116	R 36,584,297	R 97,979,936
Loss in Rands (Treated))	R 4,395,948	R 10,923,868	R 13,342,333	R 19,724,645	R 48,386,794

% Non-revenue water	Elundini LM	Maletswai LM	Senqu LM	Gariep LM	JGDM Total
2013/14	57.8%	55.8%	40.0%	57.1%	51.7%
2014/15	34.7%	41.5%	30.4%	49.8%	39.6%
2015/16	50.0%	65.0%	27.5%	29.4%	45.8%
2016/17	42.0%	62.7%	27.2%	53.3%	49.0%
2017/18	36.0%	53.6%	38.7%	38.6%	44.2%
2018/19	5.6%	50.5%	32.1%	41.8%	34.9%
2019/20	7.8%	44.2%	36.4%	51.6%	36.4%
2020/21	21.7%	19.4%	34.8%	53.4%	32.7%
2020/22	22.7%	36.8%	31.1%	57.3%	36.9%

The 2021/22FY the non-revenue water from July 2021 to June 2022 has increased by in JGDM. More revenue is lost in 2021/22FY, in comparison to the 2020/21 FY. There is an increase of 4.2% from FY2020/21 to FY202/22. The number of estimations made need to be reduced and effort made to obtain actual reading that will provide a realistic reflection of supply and distribution of water.

The table below displays water loss in the system from abstraction to the point of consumption or volume of water billed:

	Elundini LM		Maletswai LM		Senqu LM		Gariep LM		JGDM Total	
	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22	2020/21	2021/22
Kilo litres Raw Water	3,544,424	3,522,887	3,206,205	3,821,480	5,082,387	4979682.2	3,453,180	3,905,359	15,286,196	16,229,409
Kilo litres Treated Water	2,963,170	2,992,973	2,660,829	3,084,114	4,335,958	4246138	2,900,068	2,874,818	12,860,025	13,198,043
Kilo litres Sold (Accounted For)	2,776,945	2,724,272	2,585,487	2,416,396	3,311,431	3430592	1,610,394	1,669,155	10,284,257	10,240,415
Kilo litres Loss During Cleaning	581,254	529,914	545,376	737,366	746,429	733544.2	553,112	1,030,541	2,426,171	3,031,366
Kilo litres Loss From Treated	186,225	268,701	75,342	667,718	1,024,527	815546	1,289,674	1,205,663	2,575,768	2,957,628
Kilo litres Loss From Raw	767,479	798,615	620,718	1,405,084	1,770,956	1549090.2	1,842,786	2,236,204	5,001,939	5,988,994
Percentage Water Loss During Cleaning	16.4%	15.0%	17.0%	19.3%	14.7%	14.7%	16.0%	26.4%	15.9%	18.68%
Percentage Water Loss from Treated vs Billed	6.3%	9.0%	2.8%	21.7%	23.6%	19.2%	44.5%	41.9%	20.0%	22.4%
Percentage Water Loss Since Abstraction	21.7%	22.7%	19.4%	36.8%	34.8%	31.1%	53.4%	57.3%	32.7%	36.9%
Average Cost per kl in Rands (Treated Water)	R19.36	R16.36	R19.36	R16.36	R19.36	R16.36	R19.36	R16.36	R19.36	R16.36
Average Cost per kl in Rands (Raw Water)	R0.04	R0.04	R0.02	R0.02	R1.63	R1.65	R0.71	R0.71	R0.60	R0.60
Loss in Rand Value (Raw)	R14,858,393.44	R13,065,341.57	R12,017,100.48	R22,987,180.98	R34,285,708.16	R25,343,115.67	R35,676,336.96	R36,584,297.40	R96,837,539.04	R97,979,935.63
Loss in Rand Value (Treated)	R3,605,316.00	R4,395,948.50	R1,458,621.12	R10,923,867.87	R19,834,842.72	R13,342,332.56	R24,968,088.64	R19,724,645.15	R49,866,868.48	R48,386,794.08
Loss in Rand Value (From Abstraction)	R128,662.59	R133,517.42	R54,826.11	R65,347.32	R8,267,010.69	R8,198,050.81	R2,444,851.44	R2,764,994.17	R9,125,859.01	R9,775,378.55

JGDM is busy implementing WCDM. This is done through the following activities:

- On-going district wide water balance exercise,
- Installation of Smart Bulk Water Meters,
- Containment exercise on major water leaks,
- Continuation of consumer education and awareness on WCDM matters,
- Refurbishment of WTWs to maximise production and minimise water losses,
- Installation of Telemetry Systems (remote management of infrastructure to ensure maximum performance and guard against water losses).

Unit cost of supply

Detail of the methodology and calculation of the unit cost is contained in Annexure G.

- 2014/15 the cost per kl for water was R 11.21
- 2015/16 the cost per kl for water was R 10.16
- 2016/17 the cost per kl for water was R 7.38.
- 2017/18 the cost per kl for water was R 7.19
- 2018/19 the cost per kl for water was R 10.23
- 2019/20 the cost per kl for water is R 17.75.
- 2020/21 the cost per kl for water is R 19.36
- 2021/22 the cost per kl for water is R 16.36

Total cost of supply for FY2021/22 = R 265 454 627.81 for a volume of 16 229 409 kl compared to 15 286 196 kl at a cost of R 295 868 697.64 for the 2020/21FY. This 2021/22 FY operation cost is R 30 414 069.83 less than the FY2020/21 – this is 10% cheaper.

The water losses indicate that JGDM must continue with their strategy to better manage and assess its systems. In the preceding financial years, a WCDMP outline has been proposed to aid in achieving better management and conservation of water. This strategy is still applicable for the area. Shortages of accurate water meter readings, checking indigent populations and system characteristics restrict the accuracy of analysis. However, JGDM now has a way forward in which goals have been outlined.

This report recommends some immediate infrastructure provisions required to improve the accuracy of water measurement and control. This will entail the installation of more bulk and zonal/village-level water meters to monitor water usage and wastage more closely.

1 Introduction

1.1 Project Background

Joe Gqabi District Municipality (JGDM) is responsible for developing, operating and maintaining extensive water and sanitation infrastructure to service residents and provide basic water to most of its population. JGDM is the designated authority for three Local Municipalities (LM), namely Elundini, Senqu and Walter Sisulu which incorporates the previous Maletswai and Gariep local authorities. During 2012/2013, JGDM identified the need to eradicate water backlogs and address over-utilization of current assets. Since then JGDM has submitted water loss reports similar to this document for audit purposes.

Although the results obtained are still of a high-level and the accuracy of the data can be improved, this report still provides a platform for estimating the water losses.

The position of the municipality regarding water conservation and demand management is as follows:

- Water losses within the local municipalities are a serious concern.
- The DWS is encouraging all municipalities to ensure sustainable use of water and JGDM needs to identify the measures required to achieve the legislated delivery of services.
- JGDM needs to eradicate water backlogs and this can only be achieved by ensuring efficient use of water.

Previous evaluations were based on the Water Research Commissions' "Benchleak" methodology and the methods used were in line with DWS standards. To develop a sustainable water management system, a WCDM plan was outlined to assist in improving water supply and distribution networks.

1.2 Project Scope

In order to monitor and assess the current level of service (in relation to water delivery) being provided for audit purposes, Aurecon has been appointed by JGDM to provide a high-level analysis and determine the current water loss situation within JGDM. Specific objectives, that have remained the same as previous evaluations, were outlined by JGDM and these focus on:

- Assessing the current level of service.
- Determining the water losses across the entire system.
- Using "Best Practice" guidelines to assess the system.
- Assessing the cost implications of water losses.
- Assisting JGDM to conform with the DWS requirements on evaluating losses.
- Outlining a WCDMP that will help improve the system.
- Recommending improvements to JGDM's current water infrastructure to advance water use monitoring.

The above mentioned is in accordance with the Integrated Development Plan and conforms to current government legislation. It should be noted that during the previous financial years, methods for improvement were outlined, but the listed plans have not been fully implemented due to various obstacles such as funding, cleaning up of accounts and changing the billing authorities for the various LM's. Internal changes related to employee structures have also delayed the full-scale implementation of the long-term plan.

1.3 Purpose of Report

The purpose of this report is to provide a summary of the high-level analysis of the municipality's current water management system for the financial period of 2021/22. The report is intended to be used for audit purposes due to the simple nature of the analysis. To obtain a more comprehensive report, various shortfalls with regards to data collection need to be rectified. A detailed analysis that accurately depicts the system can only be provided once the relevant input information such as water meter readings, supply populations, household connections and indigent populations is available. The report will thus cover the following aspects:

- Applied Methodology for analysis as listed in the reports for the previous financial years.
- Discussion of results for the 2021/2022 period.
- Emphasize the way forward with respect to the WCDMP.
- Summarise actions identified during this financial year.

2 Information Review

2.1 Information Sources

To calculate system water losses, it is necessary to understand JGDM's water supply and distribution scheme's current configuration and operational procedures. The type and format of information received was of a similar nature to the previous financial periods. In an instance where information was not updated, the figure from the previous periods was used. Updated population figures and indigent households are now based on the 2016 Community Survey. The quality and extent of the system's water loss results are dependent on the input data's comprehensiveness and the nature of assumptions that had to be made.

The following sources of information were reviewed:

Table 1: Local Information resources

Ref No	Document Title	Source	Date Received
1.	Updated Bulk Water Meter Readings for 2021/2022	JGDM	27/07/2022
2.	Updated Schematic diagrams of Layout	JGDM	26/08/2022
3.	Asset Register	JGDM GIS system	27/02/2013
4.	General procedures of JGDM, such as billing data format, LM boundaries and Tariff rates	Mr Lance Booysen	02/04/2020
5.	Billed Volumes and Indigent Register	Ms Sulene du Toit and Mr Fusi Mabe	02/08/2022
6.	Water Loss Reports from 2012/13 to 2021/22	Zutari	N/A
7.	2016 Community Survey	Stats SA	30/07/2018

Mr Booysen, from JGDM and responsible for their GIS department has been a valuable source of assistance.

2.2 Reference Documents

The reference documents used for the evaluation process were the same as used for the previous financial year. In addition, the DWS blue drop audit sheet was consulted as a guide for determining water losses. Although, it was previously stated that the Blue Drop Audit Sheet should be used going forward, it was found that the systems are of a similar nature. In addition, previous audits have been successful and therefore the "Benchleak format" has been preserved. However, interchanging between the two is relatively easy.

The reference documents listed in the table overleaf were used to develop a water loss calculation methodology which complies with "Best Practice" approaches and follows approved institutional principles.

Table 2: Additional Information resources

Ref No	Document Title	Authors	Source	Date Received
1.	Bench-Leak software and Manual Published August 2002 Available @ www.wrc.org.za	R. Mckenzie A. Lambert J. Kock W. Mtshweni	WRC	26/02/2013
2.	Econo-Leak software and Manual Published January 2002 Available @ **www.wrc.org.za**	R. Mckenzie A. Lambert	WRC	26/02/2013
3.	Census 2011 and 2016 Community Survey	Stats SA	Mr Booysen & Aurecon	30/07/2018
4.	JGDM Water conservation and Demand Management Plan Published March 2012 Available @ **www.dwaf.gov.za**	DWS	DWS	17/04/2013
5.	JGDM Municipality Profile Published 2011 Available @ **www.nda.agric.za**	COGTA	COGTA	17/04/2013
6.	National Water Conservation and Demand Management Strategy Published May 2000 **www.info.gov.za**	DWS	DWS	17/04/2013
7.	Blue Drop Audit Analysis	DWS	DWS	12/06/14

2.3 Identification of Major Information Shortfalls

The following shortfalls were identified during the evaluation of the information provided by JGDM:

- Some readings were not available at strategic points such as at dams and boreholes. Zonal water meter readings were not available to be analysed.
- Incorrect water meter readings: In some cases, the total billed volume was larger than the input volume. Other errors indicate a lack of correlation between the total volume leaving a treatment plant compared to the volume entering the plant.
- The indigent population registers must be maintained because they are a significant percentage of the total population. Information regarding the type of connections used to supply these populations must be improved.
- The total number of service connections and the number of accounts being billed should be verified. Connections to indigent households and other users that were not on the prepaid system requires attention.
- Incomplete water meter readings.
- Newly installed meters were not commissioned and in such instance, meters were not read.

The information shortfalls have improved since the previous period but require further attention. It is important to note that this report provides only a high-level analysis of the bulk water volumes entering and leaving the system. Due to the lack of zonal meter readings, the analysis could not be drilled down to a detailed town level. Analysis was therefore carried out per local municipality. If the system is analysed to a detailed level, the results obtained may differ from those currently presented. It should be noted that the systems used for the billing data and the water meter readings are analysed by separate departments within JGDM and there should be more cohesion between the systems. Further detail of information shortfalls is provided in Annexure A.

2.4 Formulation of Assumptions

Due to the nature of the information shortfalls as well as the limited time frame for this high-level water loss calculation exercise, certain assumptions had to be made. The schematic below indicates the assumption selection hierarchy which was applied in instances where accurate input data was not available.

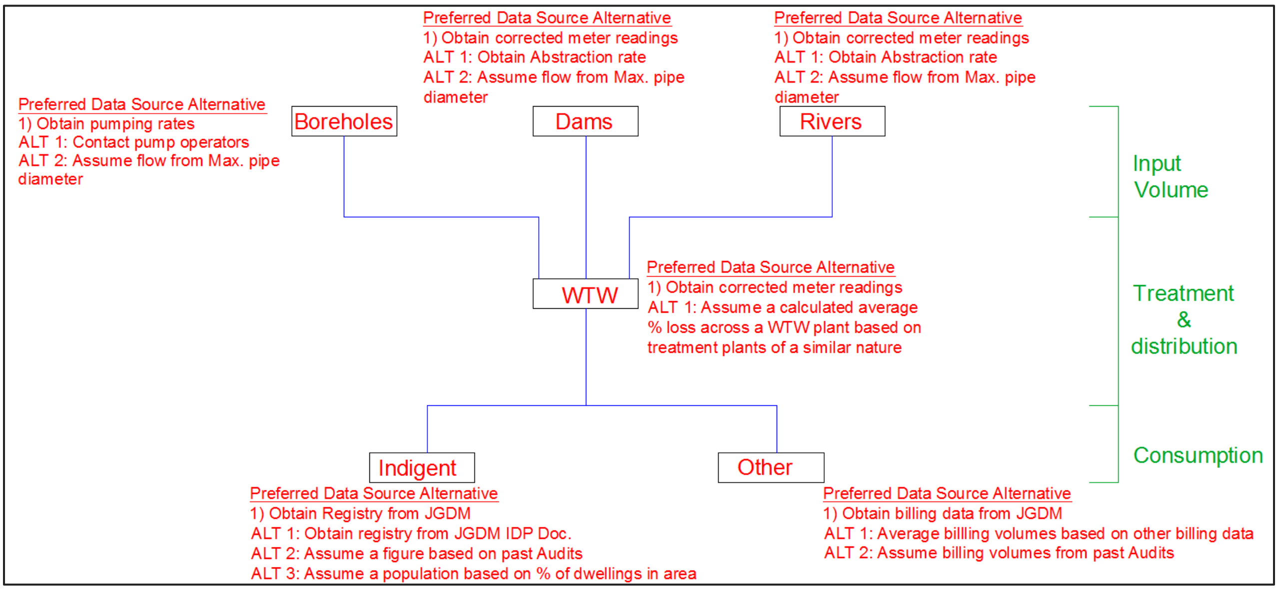


Figure 1: Schematic of Assumption Hierarchy

The abovementioned assumptions ultimately determine the accuracy of the analysis. As mentioned earlier, if the analysis is carried out using more detailed information, the results may differ significantly from those currently being presented. Obtaining information for the "input volume" category was difficult, and, in some cases, certain sources were no longer operational whilst in other cases water meter readings were not available. In such occurrences, the water meter reading prior to the WTW was assumed to depict the total input volume.

To indicate the accuracy of assumptions, the same approach as for JGDM's asset management, was applied. In general, the confidence level for each assumption was divided in to 5 categories as shown in the table below:

Table 3: Confidence Level of Estimations and Calculations

Item	Confidence Level	Confidence Interval
1	Accurate	80%-100%
2	Minor Inaccuracies	60%-80%
3	50% Estimated	40%-60%
4	Significant Data Estimated	20%-40%
5	All Data Estimated	0%-20%

Each category is dependent on the type of field work and data obtained. The confidence level of an item was thus classified as follows:

1. **Accurate**: Data received has supporting documentation and can be supported by field tests and field studies. If a sample set is obtained for the various components calculated, the actual figure might have a minimal deviation from the estimated figure.
2. **Minor Inaccuracies**: Most data received has supporting documentation. A few values may have been estimated using general codes of practice or past information from projects of a similar nature. If a sample set is obtained for the various components calculated, the actual figure might have a slight deviation from the estimated figure.

3. **50% Estimated**: All estimations made are based on more or less 50% of actual data available. In addition to this, theoretical knowledge and practical experience are applied based on past studies/projects of a similar nature. If a sample set is obtained for the various components calculated, the actual figure might be accurate in certain instances and might deviate in other instances.
4. **Significant Data Estimated:** A significant amount of data has been estimated based on theoretical knowledge and practical experience. If an actual sample set is obtained for the item, the accuracy will range between being accurate to varying significantly within the sample size.
5. **All Data Estimated:** Due to a complete lack of available information, an estimate is made based on past trends, practical experience and theoretical knowledge. If an actual field study is carried out, the estimation might show a degree of accuracy in some cases but might vary with a large percentage in other cases.

3 Water Loss Calculation Methodology

3.1 Water Loss Definition

In an ideal environment, the volume of water flowing into a system must be equal to the sum of the volume consumed by system users and the volume of water flowing out of the system. This can be presented as follows:

$$Input\ Volume(V_i) = System\ Consumption(C_s) + Outflow\ Volumes(V_0) \quad (1)$$

In Reality, V_i is larger than the sum of C_s and V_0 because the system is not fully sealed from external factors, which by nature also utilises water. This undesired water utilisation is termed "Water Loss" V_L and to maintain system equilibrium, the above formula needs to be rewritten as:

$$V_i = C_s + V_L + V_0 \quad (2)$$

Water can be lost through a variety of avenues, which can be grouped together as follows:

- Evaporation (V_{LE})- An example is wherever water is open to the atmosphere such as at open reservoirs
- Treatment (V_{LT})- An example is at purification plants where a portion of water is used to clean the system.
- Connection Leaks (V_{LC})- An example is leaks that occur at pipe joints and fittings
- Pipe Leaks (V_{LP})- An example of this is when water leaks out through cracks in the pipes.
- Illegal Use (V_{LU})- An example is when illegal connections are made onto supply pipes or where water meters are faulty.

The figure below illustrates the different types of losses which can be experienced:

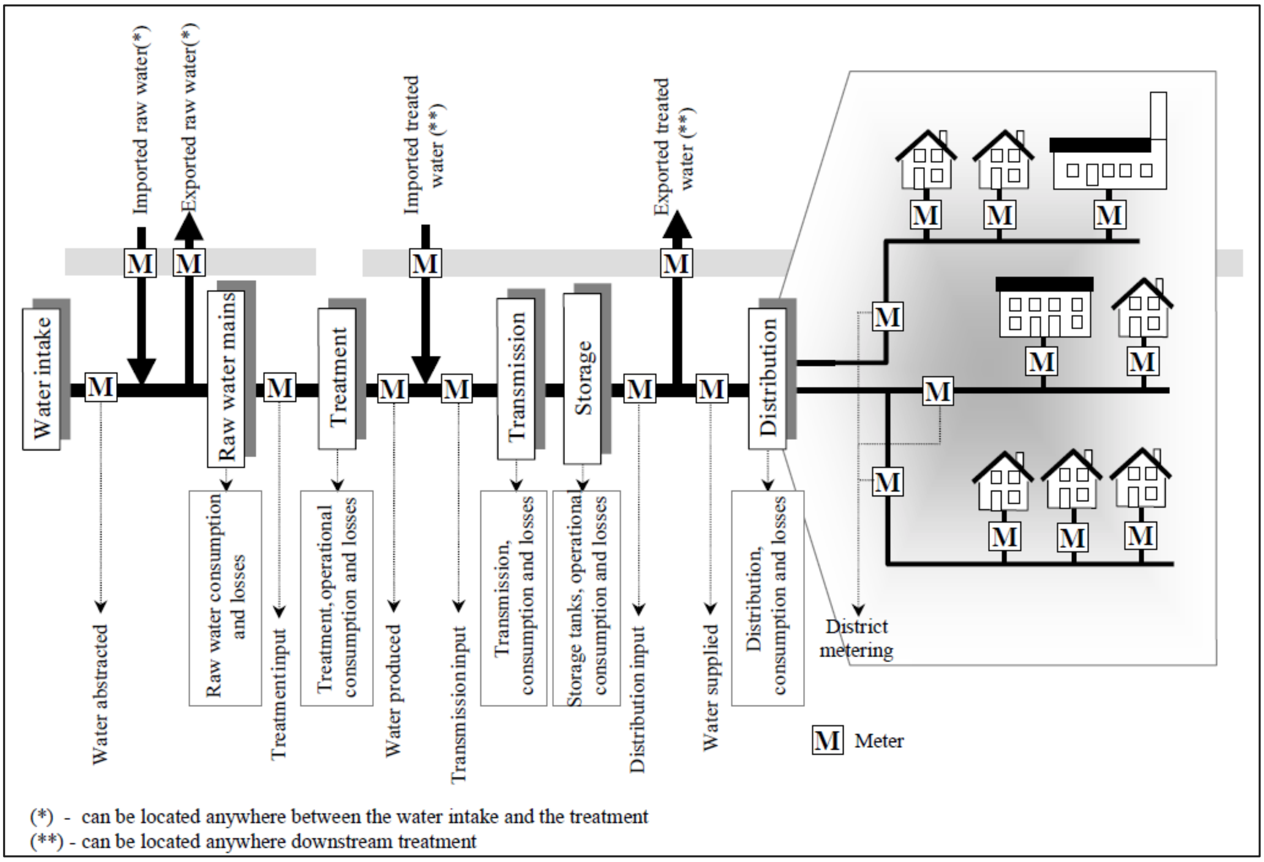


Figure 2: Schematics of water loss components as outlined by the IWA (Source: IWA White Paper)

Thus:

$$V_L = V_{LE} + V_{LT} + V_{LC} + V_{LP} + V_{LU} \quad (3)$$

By substituting formula (3) into (2) above, the system equilibrium becomes:

$$V_i = C_s + (V_{LE} + V_{LT} + V_{LC} + V_{LP} + V_{LU}) + V_0 \quad (4)$$

The water loss definition has remained the same as the last financial year.

3.2 The Role of Water Conservation and Demand Management

Due to the increasing demands of water and its limited nature, the DWS has outlined policies to protect its most valuable resource. The management strategy has been labelled as the “Water Conservation and Demand Management Plan” and is in line with current international practices. It has already been implemented across numerous municipalities, with the key focus being the following:

- Eradicating water supply backlogs
- Efficient allocation of clean water
- Asset management and monitoring
- Maximizing water productivity
- Reducing water losses to acceptable levels which is defined as being less than 20% of the system input volume (as stipulated in the JGDM water plan 2012).

Further aims of a WCDMP need to include:

- Improve efficiency of asset operation and maintenance (O&M)
- Reduce and regulate water consumption
- The conservation of scarce water resources
- To improve revenue collection.

JGDM has commenced their own WCDMP which is in line with DWS’s guidelines and objectives. The current study only focuses on water loss calculations, which is required to implement a WCDMP. The results of the water loss calculations will aid in conceptualising the WCDMP and assist in formulating the most effective WCDMP strategies to be implemented. Proposed WCDMP strategies are briefly discussed in sections to follow.

The role of a WCDM plan has not changed significantly since the last financial year. It is in the best interest of the JGDM that the proposed plan be implemented and enforced throughout their jurisdiction.

3.3 Industry Guidelines on Calculation Water Loss

It is desired that a policy or programme be implemented to monitor and restrict water loss across the system. A primary measure has already been installed by DWS as it has outlined a national policy through the national strategy for implementing a WCDMP. Secondary measures on a more detailed local scale include the monitoring and maintenance of assets to provide efficient services. The WRC bench-leak model and the IWA standards, as adopted by the DWS, usually calculate these water losses using the water loss definition given in section 3.1. However, these calculations and their accuracy depend on the type of system being used. For accurate control, as has been implemented at e.g., Drakenstein Local Municipality, the following control measures are recommended:

- Functional water meters at abstraction points, WTW and at distribution reservoirs.
- Records of daily water meter readings.
- Records of billed volumes.
- Records of unbilled volumes.

The above mentioned allows for constant monitoring and annual review of the system. It can therefore aid in developing water plans for improvement. The WRC uses a similar methodology and it will be used as a guideline for assessing JGDM. However, it is strongly recommended that JGDM use the DWS Blue Audit Drop Form Analysis tool for future monthly and yearly analysis. Cognisance should be taken to ensure input parameters are clearly identified, so that the physical system can be modified to provide these inputs accurately. The abovementioned control measures should also be implemented and monitored to ensure that the Blue Audit requirements can be easily met. The less control measures that are in place, the harder it is to track water losses.

3.4 Proposed Calculation Methodology

For the analysis of the JGDM a secondary measure will be used. This measure is based on the WRC "Bench-leak" software that has been implemented on an international scale.

Because some water losses are difficult to accurately quantify, the total system water losses are determined by restructuring the water balance equation discussed in section 3.1, as follows:

$$\boldsymbol{Total\ losses = Input\ Volume - System\ consumption - Outflow\ Volume}$$

As previously mentioned, water loss occurs in various forms and at different locations within the system. Combined, they form the total system water loss:

$$\boldsymbol{Total\ losses = Evaporation\ losses + Illegal\ Usage\ loss + Pipe\ Leak\ Loss + connection\ loss + treatment\ loss}$$

Some losses are easy to determine, for example, "Pipe leak losses" on a pipe can be determined by subtracting the downstream water meter readings from the upstream water meter reading for the same period. The differences, if water meter readings are accurate, are the losses along the pipe.

Other losses, such as "evaporation losses," "treatment losses" or where no water meter readings are available are more difficult to calculate. In these instances, an empirical approach to water loss calculation is required.

The "Bench-Leak" model thus overcomes the above mentioned by applying empirical formulas, based on a range of operational scenarios, to calculate the various water losses within the system.

The IWA (&DWS) has also provided specific criteria according to which any system's water usage is categorized and evaluated. The IWA's criteria has also been applied to this study, thus the following terminology needs to be understood when attempting to interpret the study's results:

- *System input volume:* The total volume of water that is purified and which enters the system
- *Total consumption:* The total volume used by consumers
- *Authorized Consumption (AC):* The sum of billed and unbilled authorized consumption
- *Billed Authorized Consumption:* The volume of water that has been charged out to a consumer but excludes the indigent rebate.
- *Unbilled Authorized Consumption (UAC):* The volume of water that is issued free of charge
- *Indigent Rebate:* The volume of water that is supplied to indigent households and a monetary rebate is obtained from the government
- *Real losses:* The volume of water being lost by the system and includes evaporation, connection losses, pipe leak losses, treatment losses and illegal losses.
- *Unavoidable Real losses:* The minimum level of real losses that can be achieved under the most efficient operating conditions
- *Apparent Losses:* These are losses which relate to theft, illegal connections and administrative errors
- *Total losses:* The sum of apparent and real losses

- *Non-Revenue Water:* The volume of water that does not provide any income to JGDM. Examples include free water supply to a household and all water losses.
- *Revenue Water:* The volume of water that provides revenue for JGDM
- *Infrastructure Leakage Index:* The ratio of current total losses to unavoidable real losses. This is therefore a tool that can be used to measure the efficiency of the system.
- *Performance indicators:* The performance values of the system relative to best practice values.
- *Typical Range:* The performance values by which other systems within South Africa have been audited.

For JGDM, the system's water balance is illustrated in Figure 3. This figure also shows the various water use categories and their inter-dependencies.

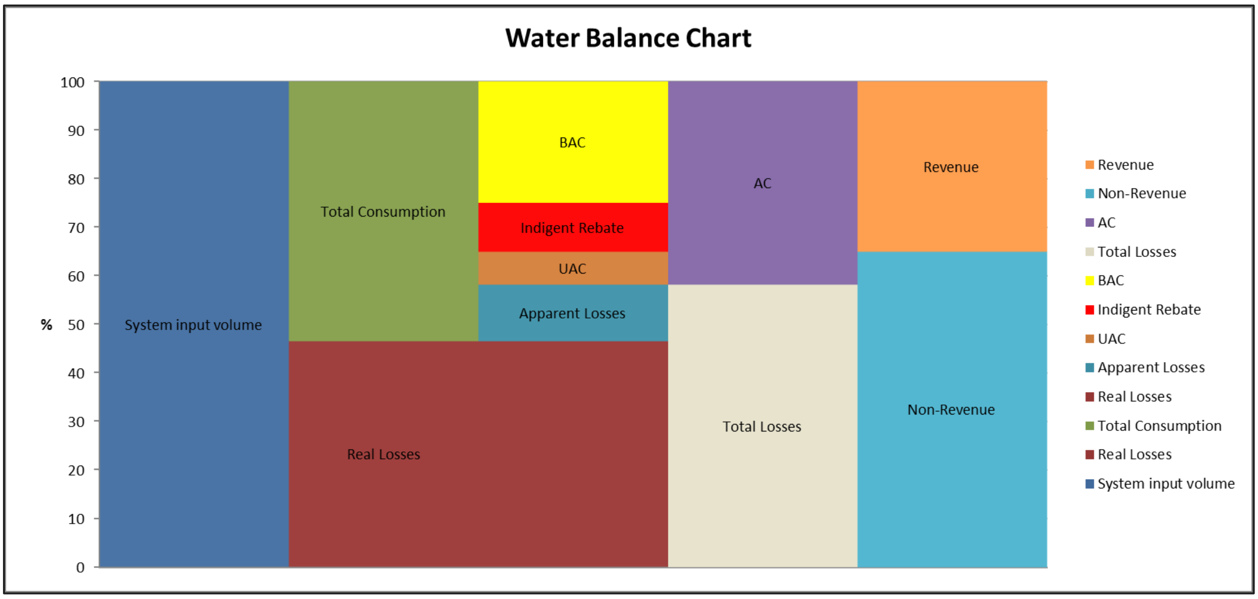


Figure 3: Water Balance components

For water loss calculations, the general category used to measure the system's operational status is the Non-Revenue water (NRW). As per DWS, this figure provides a good financial indicator of the actual system. The NRW will thus be used to assess the efficiency and functionality of the JGDM's water schemes. The proposed calculation methodology for the current period has remained the same as the last financial year as detailed below.

3.5 Proposed Execution Plan for Analysis

The following action plan was followed to perform the necessary analysis:

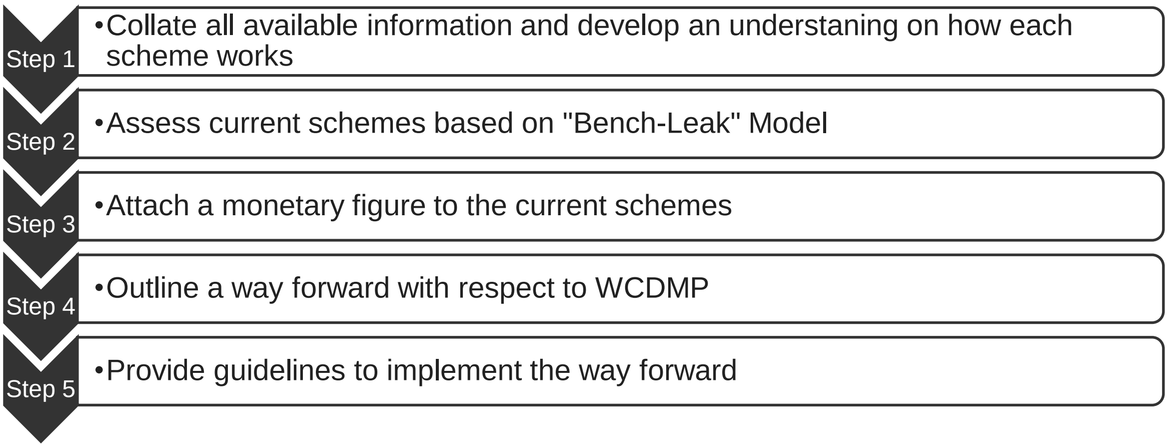


Figure 4: Proposed execution plan for analysis

For accurate analysis, the model requires sufficient data inputs. Data relating to the pipeline characteristics and volume inflow/outflows will influence the analysis. The more accurate these values are, the better the analysis output.

The abovementioned execution plan was listed for the previous period and will remain the same for the current period. The yearly analysis also differs slightly from the monthly analysis due to errors being rectified during the year.

3.6 Integration of Project Assumptions

The Bench-leak model requires that a wide range of data be acquired before analysis. The following data is required:

- Input volume
- Authorized Consumption volumes
- Pipeline Characteristics (Length, number of connections, Operating pressure)
- Financial Indicators (Unit cost of water and Billing cost)
- Number of Households supplied Billed and Unbilled volumes
- Water Meter Readings

Due to the extent of information needed and the ongoing but incomplete improvements to the system, not all the above was available. Assumptions have been made regarding certain aspects to ensure reasonable results were obtained.

4 Input and Analysis of System

For this report, the towns have been grouped together per local municipality / area; these are Elundini, Maletswai, Senqu and Gariep.

4.1 Elundini Local Municipality

4.1.1 Overview of Elundini Area

The area of Elundini covers the towns of Ugie, Maclear and Mount Fletcher. The water supply schemes for each of these towns are schematically illustrated in Annexure B.

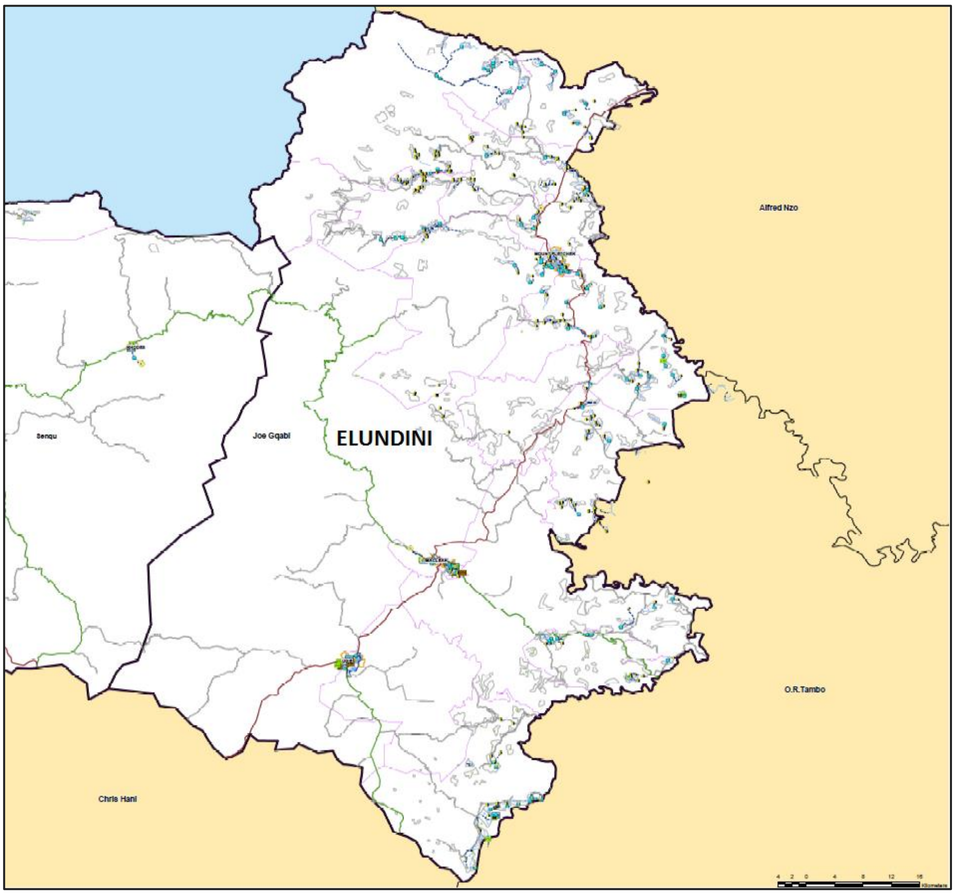


Figure 5: Locality Map of Elundini LM

The bulk volume entering the system is supplied from the following sources:

- Maclear- Maclear dam & Aucamp dam. In the 2018/19 FY an additional source was added to the scheme, referred to as the Mooi River
- Mount Fletcher- Mount Fletcher dam. The boreholes are no longer operational.
- Ugie- Wildebeest Weir.
- In the months July 2020 to 10th January 2022 water carting was utilised in Mount Fletcher from a fire hydrant at the water treatment works and in Ugie from a fire hydrant in town. Both were not metered. It is known that 40 kl/d and 120 kl/d was used in Mount Fletcher and Ugie respectively.

The demographics for the Elundini area are as follows:

Table 4: Elundini Demographics

Total Population	Indigent Households	Length of Bulk lines	No. of Households
(People)	HH	Km	HH
144 314	1 559	155	26 076

4.1.2 Assumptions made for the Elundini Area

The following assumptions were made for the Elundini region:

- An indigent household receives a total of 6 kl per month based on the JGDM's indigent policy.
- The average household consists of 4 people. This was extracted from the 2016 Community Survey.
- The Flat Rate (Billed and Unmetered) users for 2018/19 FY were assumed to consume 30 kl per household, this is still applicable in 2021/22FY. The total unmetered connections were recorded to be 6 628 in the 2020/21FY.
- New smart meters were installed Mid-June 2019, and these have the value of 10 factored in.
- Majority of the meter reading were estimated due to meters not working, rendering the circumstances of the effect of WCDM difficult to determine and for a substantial analysis to be made and thus conclusion to be made. Only Ugie had actual meter readings for 2021/22FY to date.
- The meter readings for Mount Fletcher and Maclear were adjusted by escalating last year's readings by 30% for the raw and treated water.
- In the 2020/21 FY, the calculation for the total water accounted for in Elundini's Benchleak, includes the Indigent consumption (Number of Indigents x 6 kl)
- Population figures were updated using the Stats SA guideline, to apply a growth rate of 1.35% from 2016 onwards until Stats SA releases updated figures.
- Water carting was added as a firefighting component under unbilled unmetered authorised consumption.
- The number of billed unmetered services connections (indicated on the input page in Benchleak) were determined by averaging the total flat rate consumption and dividing this by 30 kl. This approach was suggested by Sulene from JGDM for the FY2021/22.
- Water carting in the FY2021/22 was only in August-21, October-21, November-21 and April-22.
- The running cost for the combined schemes is R 56 286 548.99 per annum.

The confidence level for the above mentioned is depicted in the table below:

Table 5: Confidence level for Elundini LM

Item	Confidence Level	Confidence Interval	Task						
			Indigent Supply	Population Stats	Billing Volume	Running Costs	Meter Readings	WTW losses	Tariffs
1	Accurate	80%-100%		X					X
2	Minor Inaccuracies	60%-80%	X			X			
3	50% Estimated	40%-60%			X				
4	Significant Estimates	20%-40%					X	X	
5	All Data Estimated	0%-20%							

4.1.3 Results for the Elundini Area

The detailed bench-leak calculations are provided in Annexure C, with the summarised results below.

Table 6: Summary of Elundini LM

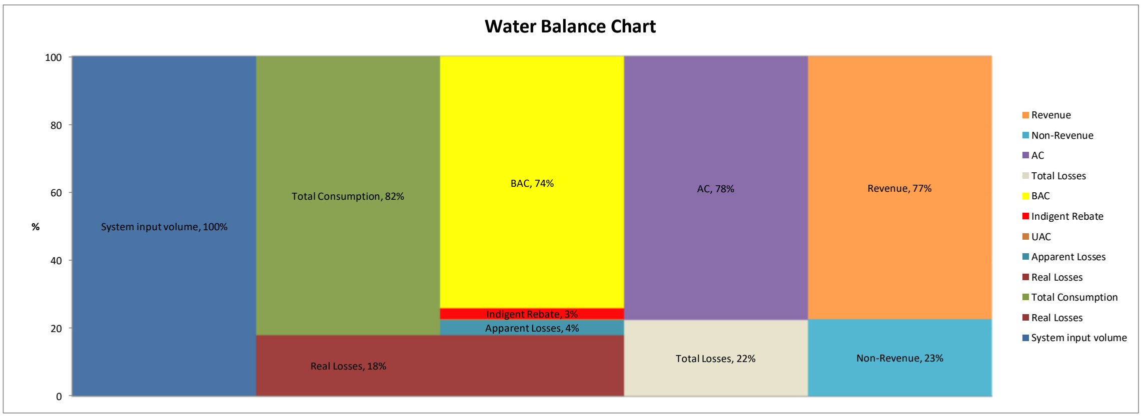
WATER LOSS ASSESSMENT:RESULTS SUMMARY

PROJECT:	JGDM ASSET MANAGEMENT
PROJECT NO:	1001550
CALCULATION METHOD:	WATER RESEARCH COUNCIL ANALYSIS
CALCULATED BY:	M CHIRWA
DATE:	2022/08/31
CHECKED BY:	G PATON
DATE:	2022/08/31
COMMUNITY/TOWN	ELUNDINI
REVISION	3

SUMMARY OF SYSTEM

Water Distribution losses	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Estimated kl/year
Kilo litres Produced	342,656	324,729	290,335	310,049	274,772	311,246	334,624	243,507	264,450	281,592	268,867	276,060	3,522,887.01
Kilo litres Sold	226,890	231,235	228,531	226,684	225,469	224,063	223,322	226,109	224,064	233,050	222,374	232,481	2,724,272.00
Kilo litres lost in distribution	115,766	93,494	61,804	83,365	49,303	87,183	111,302	17,398	40,386	48,542	46,493	43,579	798,615.01
% lost during distribution	33.8	28.8	21.3	26.9	17.9	28.0	33.3	7.1	15.3	17.2	17.3	15.8	22.7%
Average cost in Rands	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36
Loss in Rand Value	R 1,893,936	R 1,529,564	R 1,011,116	R 1,363,859	R 806,605	R 1,426,306	R 1,820,894	R 284,626	R 660,712	R 794,145	R 760,627	R 712,953	R 13,065,342

Population with water supply - 2020 Esc @1.35%		96,553	people
Number of connections		13,290	connections
Indigent Population as per 2016 Survey		1,559	HH
Total number of Households served - 2020 Esc @1.35%		26,076	HH
Infrastructure Leakage Index		2.86	-



- ***2013/2014 Total Loss Percentage: 57.8%***
- ***2014/2015 Total Loss Percentage: 34.7%***
- ***2015/2016 Total Loss Percentage: 50.0%***
- ***2016/2017 Total Loss Percentage: 42.0%***
- ***2017/2018 Total Loss Percentage: 36.0%***
- ***2018/2019 Total Loss Percentage: 5.6%***
- ***2019/2020 Total Loss Percentage: 7.8%***
- ***2020/2021 Total Loss Percentage: 21.7%***
- ***2021/2022 Total Loss Percentage: 22.7%***

Infrastructure Leakage Index: The Infrastructure Leakage index of 2.86 This shows in between good and poor efficiency management of the distribution system at the current operating pressure. The current losses are higher than the 2020/21FY total loss percentage.

Table 7: Water Loss Figures for Elundini Annual System

Component	m3/year	m3/connection/day	% of System Input volume
Water Exported	0	not applicable	0.0
Authorised Consumption excluding exports	2,733,452	0.56	77.6
Apparent Losses	157,887	0.03	4.5
Actual Consumption excluding exports	2,891,339	0.60	82.1
Real Losses	631,548	0.13	17.9
System Input Volume	3,522,887	0.73	100.0

Table 7 (above) shows the actual water figures that can be attached to the water balance chart. The value of the real losses has in the last twelve months increased from 16.6% to 17.9%. The actual consumption excluding exports of 82.1% indicates that the system is providing more of its water to end users and a small percentage of water is being lost within the system.

4.1.4 Recommendations for the Elundini Area

It is suggested that the following be done to improve the system:

- The number of household connections for the area needs to be clearly defined. If possible, a site investigation should take place to determine these values or they should be extracted from "As-Built" drawings.
- Install zonal/village water meters at strategic points to account for the volume being billed and unbilled.
- Monitor the system regularly and try to locate illegal connections. The more water meters inserted, the easier it is to account for volumes of water.
- Ensure billed volumes are separated between indigent populations, rural areas and urban areas.
- Record all water carting and water exporting volumes.
- Implement a WCDMP.
- Update the schematics to reflect the systems as we have them currently operating and clearly indicate on schematic where the water meters are located and their serial number, to ease the tracking of meter reading received. Also indicated operation status (working or not working). In progress.
- Install more prepaid and metered meter installation in the next FY to decrease the number of billed unmetered users (flat rate).
- All bulk meters should be calibrated to improve/ensure high confidence in their readings.
- The high flat rate volumes from billing data as well as the numerous numbers of estimates made on the meter readings could result in skewed reflection of the water supply and distribution. Rectify this by ensuring that as many as possible consumers are metered, obtain more actual meter readings and reduce the number of estimations made.

There has been refurbishment at the Ugie, Mount Fletcher and Maclear Water Treatment Works and there is an ongoing programme to install telemetry. However, there is still much of the recommended work to be implemented.

4.2 Maletswai (part of Walter Sisulu LM)

4.2.1 Overview of Maletswai Area

The area of Maletswai covers the towns of Aliwal North and Jamestown. The water supply schemes for each of these towns are schematically illustrated in Annexure B.

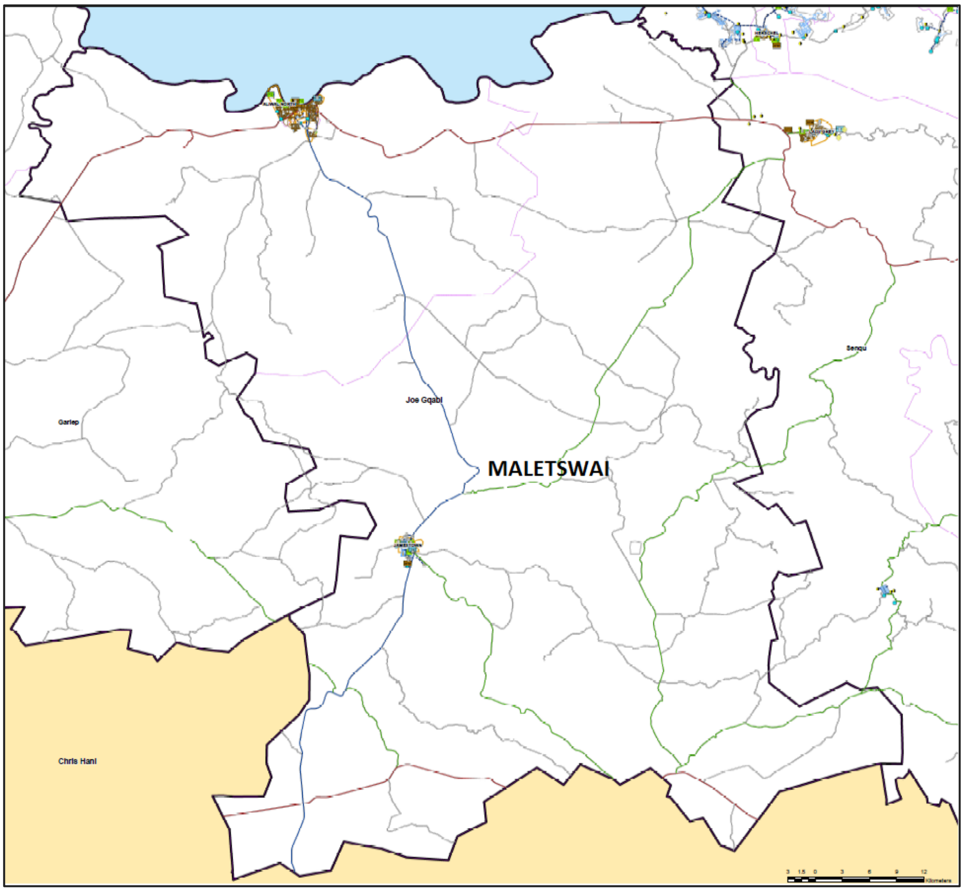


Figure 6: Locality Map of Maletswai

The bulk volume entering the system is supplied from the following sources:

- Aliwal North- Supplied from a nearby weir. No actual water meter readings were obtained for 2020/21FY and to date in the 2021/22FY
- Jamestown- Supplied from boreholes, Jamestown Dam and the Jamestown weir.

The demographics for the Maletswai area are as follows:

Table 8: Maletswai Demographics

Total Population	Indigent Households	Length of Bulk lines	No of Households
(People)	HH	Km	HH
53 605	3 780	107	15 029

4.2.2 Assumptions made for the Maletswai Area

The following assumptions were made for the Maletswai region:

- The Jamestown weir abstracts water directly from the Jamestown dam and thus the area is only being supplied from one source rather than 2 sources, as shown in the schematics.
- An indigent household receives a total of 6 kl per month based on the JGDM's indigent policy.
- The average household consists of 4 people. This was extracted from the 2016 Community Survey.

- The Flat Rate (Billed and Unmetered) users for 2018/19 FY were assumed to consume 30 kl per household, this is still applicable in 2021/22FY. The total unmetered connections were assumed to be 1 806 in the 2021/22FY.
- Every household that is billed pays at the rates in accordance with the tariffs supplied by JGDM.
- In the 2021/22 FY, the calculation for the total water accounted for in Maletswai's Benchleak, includes the Indigent consumption (Number of Indigents x 6 kl).
- Meter reading for Jamestown were a combination of average estimates and actual readings read off meters.
- Population figures were updated using the Stats SA guideline, to apply a growth rate of 1.35% from 2016 onwards until Stats SA release updated figures.
- In the 2021/22FY, the Aliwal North raw water meter readings were assumed to be 30% more than treated water volumes obtained. The raw water meter was reported as not working correctly.
- In the 2021/22FY, the Maletswai the final water meter C3 is still not working properly. Therefore, the figures for meter C3 were increased by 30% of last year's figures.
- The number of billed unmetered services connections (indicated on the input page in Benchleak) were determined by averaging the total flat rate consumption and dividing this by 30 kl. This approach was suggested by Sulene from JGDM for the FY2021/22.
- The running costs for the combined schemes are R 38 855 875.75 per annum.

The confidence level for the above mentioned is depicted in the table below:

Table 9: Confidence Level for Maletswai

Item	Confidence Level	Confidence Interval	Task						
			Indigent Supply	Population Stats	Billing Volume	Running Costs	Meter Readings	WTW losses	Tariffs
1	Accurate	80%-100%		X					X
2	Minor Inaccuracies	60%-80%	X		X	X		X	
3	50% Estimated	40%-60%							
4	Significant Data Estimated	20%-40%					X		
5	All Data Estimated	0%-20%							

(Refer to Annexure F for Calculations and Values)

4.2.3 Results for the Maletswai Area

The detailed bench-leak calculations are provided in Annexure C, and summarised results depicted below.

Table 10: Summary of Maletswai

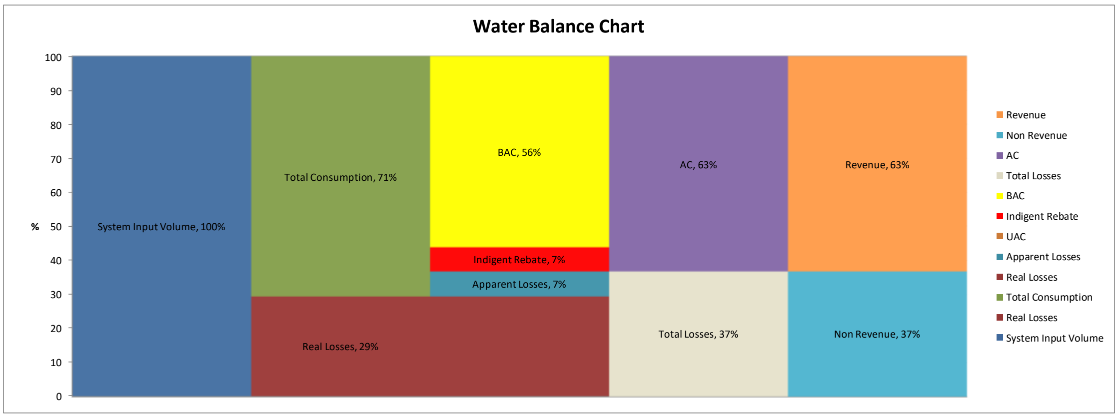
WATER LOSS ASSESSMENT:RESULTS SUMMARY

PROJECT:	JGDM ASSET MANAGEMENT
PROJECT NO:	1001550
CALCULATION METHOD:	WATER RESEARCH COUNCIL BENCHLEAI
CALCULATED BY:	M CHIRWA
DATE:	2022/08/31
CHECKED BY:	G PATON
DATE:	2022/08/31
COMMUNITY/TOWN	MALETSWAI
REVISION	3

SUMMARY OF SYSTEM

Water Distribution losses	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Estimated kl/year
Kilo litres Produced	260,158	247,410	202,756	219,660	501,724	341,696	364,133	391,766	294,134	369,226	332,676	296,142	3,821,480
Kilo litres Sold	206,979	221,686	216,147	218,517	225,335	213,804	210,019	215,655	196,615	175,996	178,241	137,402	2,416,396
Kilo litres lost in distribution	53,179	25,724	(13,391)	1,143	276,389	127,892	154,114	176,111	97,519	193,230	154,435	158,740	1,405,084
% lost during distribution	20.4	10.4	-6.6	0.5	55.1	37.4	42.3	45.0	33.2	52.3	46.4	53.6	36.8%
Average cost in Rands	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36
Loss in Rand Value	R 870,007	R 420,843	-R 219,082	R 18,694	R 4,521,724	R 2,092,308	R 2,521,309	R 2,881,173	R 1,595,418	R 3,161,244	R 2,526,557	R 2,596,986	R 22,987,181

Population with water supply - 2020 Esc @1.35%		53,216	people
Number of connections		8,540	connections
Indigent Population as per 2016 Survey		3,780	HH
Total number of Households served - 2020 Esc @1.35%		15,029	HH
Infrastructure Leakage Index		7.81	-



- ***2013/2014 Total Loss Percentage: 55.8%***
- ***2014/2015 Total Loss Percentage: 41.5%***
- ***2015/2016 Total Loss Percentage: 65.0%***
- ***2016/2017 Total Loss Percentage: 62.7%***
- ***2017/2018 Total Loss Percentage: 53.6%***
- ***2018/2019 Total Loss Percentage: 50.5%***
- ***2019/2020 Total Loss Percentage: 44.2%***
- ***2020/2021 Total Loss Percentage: 19.4%***
- ***2020/2021 Total Loss Percentage: 36.8%***

There is significant increase in the water loss in Maletswai in the 2021/22FY. This indicates a decline in last year's improvement. JDGM still needs to try obtaining actual meter readings so as to decrease the number of estimations made. Meters need to be in working condition.

Infrastructure Leakage Index (ILI): The infrastructure leakage index figure of 7.81 indicates the system is operating poorly. A detailed analysis is required to understand the reason for water losses in this area. The leakage index is dependent on the number of household connections. Since this parameter has not been clearly defined (i.e. distinguish between prepaid meters, indigent standpipes and metered connections), this value may not be a true indication of the systems operational efficiency. The greater the amount by which the ILI exceeds 1, the greater the potential opportunity for further management of real losses by infrastructure management and maintenance, more intensive active leakage control, or speed and quality of repairs (S. Hamilton, R. Mckenzie and C. Seago).

Table 11: Water Loss figures for Maletswai Annual System

Component	m3/year	m3/connection/day	% of System Input volume
Water Exported	0	not applicable	0.0
Authorised Consumption excluding exports	2,416,396	0.78	63.2
Apparent Losses	281,017	0.09	7.4
Actual Consumption excluding exports	2,697,413	0.87	70.6
Real Losses	1,124,068	0.36	29.4
System Input Volume	3,821,480	1.23	100.0

Table 11 (above) shows the actual water figures that can be attached to the water balance chart. The value of the real losses has increased from 15.5% end of 2020/21FY to 29.4% in the year to date. The total actual consumption excluding exports of 70.6% indicates that just above half of the produced water is being utilized by end-consumers.

4.2.4 Recommendations for the Maletswai Area

The results reduced losses however the following should be done to improve further:

- Implement bulk and zonal/village water meter readings.
- Separate volumes for the indigent populations, rural areas and urban areas.
- Implement a WCDMP.
- The billing data needs to be configured to be able to distinguish between the various towns and water users. In addition, the billing data should correlate with the water meter readings and the billing agent should ensure that interims raised do not exceed the available water supply.
- Input data such as the indigent populations and the number of household connections need to be accurately determined, so that a confident estimate can be made of the Infrastructure leakage index.
- The number of household connections for the area needs to be clearly defined. If possible, a site investigation should take place to determine these values or they should be extracted from "As-Built" drawings.
- Schematics need to be updated clearly indicating the current water sources utilised as per the Benchleak records or meter reading data provided, what source are now redundant, location and status of water meters (working or not working).
- All bulk meters should be calibrated to improve/ensure high confidence in their readings.
- Try obtaining the actual meter reading from November 2019 to February 2020 for Jamestown, because this is the pilot town that was selected to monitor the effect or impact of the implementation of WCDM.

There is an ongoing programme to install telemetry within the system. Pre-paid meters have been installed at many domestic and business consumers. However, there is still much of the recommended work to be implemented.

4.3 Senqu Local Municipality

4.3.1 Overview of Senqu Area

The area of Senqu covers the towns of Barkly East, Lady Grey, Rhodes and Sterkspruit. The water supply schemes for each of these towns are schematically illustrated in Annexure B.

Figure 7: Locality Map of Senqu LM

The bulk volume entering the system is supplies from the following sources:

- Barkly East- Supplied from a nearby weir and boreholes
- Lady Grey- Supplied from the Witfontein Dam, Lady Grey Dam and a few boreholes
- Rhodes-Supplied from a river abstraction and the Mountain Dam
- Sterkspruit- Supplied from the Holohlatsi Dam
- In the months July 2020 to June 2021 water carting was utilised in Sterkspruit from a standpipe. It is metered. It is known that an average of 80 kl/d was used.

The demographics for the Senqu area are as follows:

Table 12: Senqu Demographics

Total Population	Indigent Households	Length of Bulk lines	No. of Households
(People)	HH	Km	HH
138 611	23 112	253	38 339

4.3.2 Assumptions Made for the Senqu Area

The following assumptions were made for the Senqu region:

- Every household that is billed pays at the rates in accordance with the tariffs supplied by JGDM.
- An indigent household receives a total of 6 kl per month based on the JGDM's indigent policy
- he Flat Rate (Billed and Unmetered) Users for 2018/19 FY have been assumed to consume 30 kl per household, this is still applicable in the 2020/21FY. The total of unmetered connections assumed to be 3 373 in the 2021/22FY.

- In the 2021/22 FY, the calculation for the total water accounted for in Senqu's Benchleak, includes the Indigent consumption (Number of Indigents x 6 kl
- Population figures were updated using the Stats SA guideline, to apply a growth rate of 1.35% from 2016 onwards until Stats SA release updated figures.
- Raw water meter readings were escalated by 20% of the treated water for Lady Grey and no borehole meter readings for Lady Grey were recorded to date.
- Indigent figure of 1663 obtained from Finance was added to 21 449 to obtain the 2021/22FY indigent figure for Senqu.
- The number of billed unmetered services connections (indicated on the input page in Benchleak) were determined by averaging the total flat rate consumption and dividing this by 30 kl. This approach was suggested by Sulene from JGDM for the FY2021/22.
- In the FY2021/22 water carting was not implemented as a form of distribution to Senqu consumers, but rather the Military filled up tanks monthly.
- The running costs for the combined schemes are R91 874 173.51 per annum.

The confidence level for the above mentioned is depicted in the table below:

Table 13: Confidence Level for Senqu LM

Item	Confidence Level	Confidence Interval	Task						
			Indigent Supply	Population Stats	Billing Volume	Running Costs	Meter Readings	WTW losses	Tariffs
1	Accurate	80%-100%		X					X
2	Minor Inaccuracies	60%-80%	X		X	X			
3	50% Estimated	40%-60%					X		
4	Significant Data Estimated	20%-40%						X	
5	All Data Estimated	0%-20%							

(Refer to Annexure F for Calculations and Values)

4.3.3 Results for the Senqu Area

The detailed bench-leak calculations for the LM are provided in Annexure C, with the summarised results depicted in the tables below.

Table 14: Summary of Senqu LM

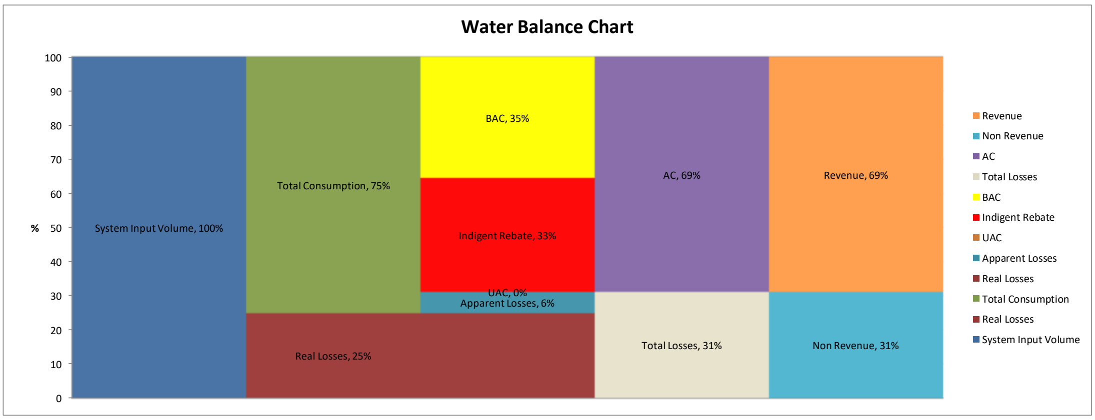
WATER LOSS ASSESSMENT:RESULTS SUMMARY

PROJECT:	JGDM ASSET MANAGEMENT
PROJECT NO:	1001550
CALCULATION METHOD:	WATER RESEARCH COUNCIL BENCHLEAK
CALCULATED BY:	M CHIRWA
DATE:	2022/08/31
CHECKED BY:	G PATON
DATE:	2022/08/31
COMMUNITY/TOWN	SENQU
REVISION	3

SUMMARY OF SYSTEM

Water Distribution losses	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Estimated kl/year
Kilo litres Produced	344,335	378,429	374,571	427,285	440,550	314,378	500,049	445,676	474,657	439,520	440,290	399,941	4,979,682
Kilo litres Sold	277,854	280,916	279,861	279,963	277,750	277,519	283,039	281,650	281,667	281,929	283,450	344,994	3,430,592
Kilo litres lost in distribution	66,481	97,513	94,710	147,322	162,800	36,859	217,010	164,026	192,990	157,591	156,840	54,947	1,549,090
% lost during distribution	19.3	25.8	25.3	34.5	37.0	11.7	43.4	36.8	40.7	35.9	35.6	13.7	31.1%
Average cost in Rands	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36
Loss in Rand Value	R 1,087,626	R 1,595,313	R 1,549,452	R 2,410,188	R 2,663,411	R 603,017	R 3,550,287	R 2,683,472	R 3,157,320	R 2,578,195	R 2,565,902	R 898,933	R 25,343,116

Population with water supply - 2020 Esc @1.35%		135,161	people
Number of connections		12,078	connections
Indigent Population as per 2016 Survey		23,112	HH
Total number of Households served - 2020 Esc @1.35%			HH
Infrastructure Leakage Index		5.31	-



2013/2014 Total Loss Percentage: 40%

2014/2015 Total Loss Percentage: 30.4%

2015/2016 Total Loss Percentage: 27.5%

2016/2017 Total Loss Percentage: 27.2%

2017/2018 Total Loss Percentage: 38.7%

2018/2019 Total Loss Percentage: 32.1%

2019/2020 Total Loss Percentage: 36.4%

2020/2021 Total Loss Percentage: 32.5%

2021/2022 Total Loss Percentage: 31.1%

Reason for Variance: The water loss has decreased primarily because work was done at the Sterkspruit and Lady Grey Water Treatment Works (WTW). Further, there currently is an upgrade in progress in Barkly East WTW which started last year.

Infrastructure Leakage Index: The infrastructure leakage index of 5.31 which is greater than 3 thus rated as very poor on the performance indicators for water loss. There is room for improvement if more control measures are implemented. It should also be noted that this value is dependent on the number of household connections. This parameter requires better definition (i.e., distinguish between prepaid meters, indigent standpipes and metered connections), as this value may not be a true indication of the system.

Table 15: Water Loss Figures for Senqu Annual System

Component	m3/year	m3/connection/day	% of System Input volume
Water Exported	0	not applicable	0.0
Authorised Consumption excluding exports	3,431,091	0.78	68.9
Apparent Losses	309,718	0.07	6.2
Actual Consumption excluding exports	3,740,809	0.85	75.1
Real Losses	1,238,873	0.28	24.9
System Input Volume	4,979,682	1.13	100.0

Table 15 (above) shows the actual water figures that can be attached to the water balance chart. The value of the current real losses of 24.9% is lower than the 49.1% at the end of the 2020/21FY. The total actual consumption excluding exports of 75.1% indicates the system is providing more than half of the produced water volume to its end-consumer which is an indication that the system is operating at more than average. It should be noted that most of the supply is to rural areas.

4.3.4 Recommendations for the Senqu Area

It is recommended that the following be done to improve the system:

- Acquire the correct pumping rates for the Dams and Boreholes.
- Implement bulk and zonal/village water meter readings.
- Separate the volumes for indigent populations, rural areas and urban areas. This will allow for a better idea on water usage and distribution.
- Ensure quality control during the monitoring process of activities such as water meter readings especially for area such as Sterkspruit and Barkly East.
- Water sources that are no longer in use should be removed from the system and schematics updated to reflect the physical system.
- Schematics need to be updated clearly indicating the current water sources utilised as per the Benchleak records or meter reading data provided, what source are now redundant, location and status of water meters (working or not working).
- Implement a WCDMP.
- The billing data needs to be configured to be able to distinguish between the various towns and water users.
- The number of household connections for the area needs to be clearly defined. If possible, a site investigation should take place to determine these values or they should be extracted from "As-Built" drawings.
- A factor of ten was assumed for Jozana due to the calibration of the water meters.
- All bulk meters should be calibrated to improve/ensure high confidence in their readings.
- Obtaining actual meter readings for Lady Grey.

Smart bulk meters have been installed at Lady Grey and Sterkspruit. The reservoir level control valves in Sterkspruit have been attended to. There is an ongoing programme to install telemetry within the system. Pre-paid meters have been installed at many domestic and business consumers. However, there is still much of the recommended work to be implemented.

4.4 Gariep (part of Walter Sisulu LM)

4.4.1 Overview of the Gariep Area

The area of Gariep covers the towns of Burgersdorp, Steynsburg, Oviston and Venterstad. The water supply schemes for each of these towns are schematically illustrated in Annexure B.

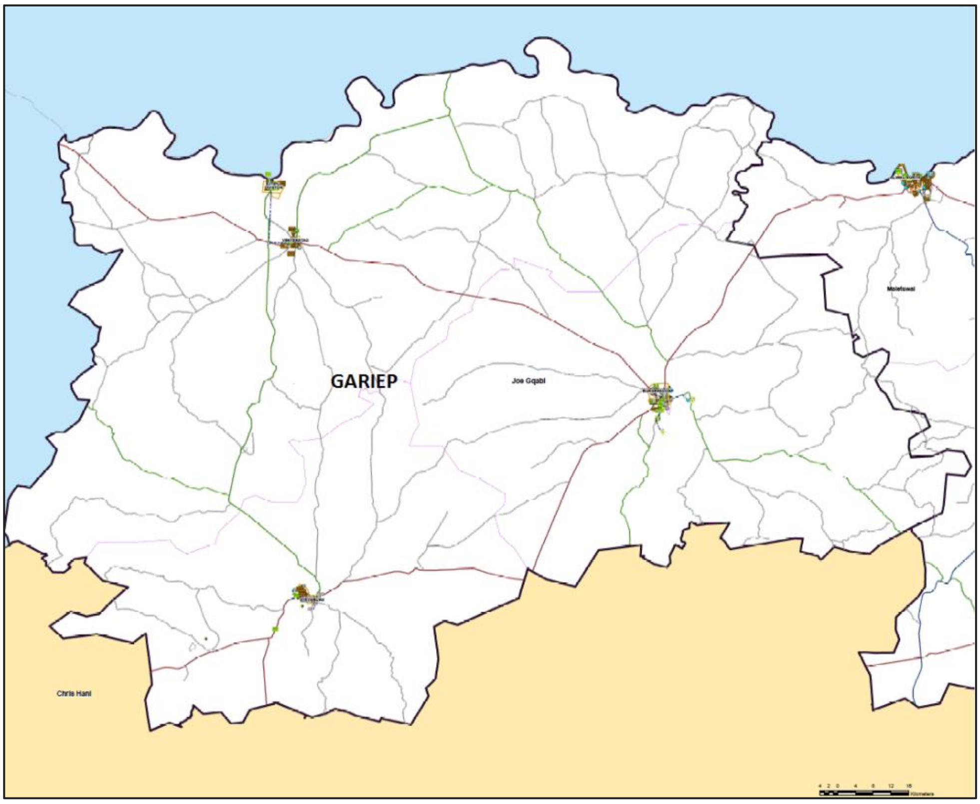


Figure 8: Locality Map of Gariep LM

The bulk volume entering the system is supplied from the following sources:

- Burgersdorp - Supplied from JL de Bruin Dam, Chiapinni's Klip Dam and various boreholes. In the 2018/19 FY there were no borehole meter reading included for processing.
- Oviston and Venterstad - Supplied from the Gariep Dam
- Steynsburg - Supplied from the Orange Fish Tunnel.
- In 2018/19 FY supply of borehole sources (Municipality, Turbine, Suurberg and Steengroef) were added. Raw water meter readings for the Orange Fish Tunnel were available for the 2019/20 FY.
- In 2020/21FY and now in 2021/22FY the Orange Fish Tunnel readings are not available.

The demographics for the Gariep area are as follows:

Table 16: Gariep Demographics

Total Population	Indigent Households	Length of Bulk lines	No. of Households
(People)	HH	Km	HH
29 633	2 842	216	8 308

4.4.2 Assumptions Made for the Gariep Area

The following assumptions were made for the Gariep region:

- Every household billed is in accordance with the tariffs supplied by JGDM.

- An indigent household receives a total of 6 kl per month is based on JGDM's indigent policy.
- The Flat Rate (Billed and Unmetered) Users for 2018/19 FY have been assumed to consume 30 kl per household, this is still applicable in the 2021/22FY. The total unmetered connections were assumed to be 883in the 2020/21FY.
- In the 2021/22FY, the calculation for the total water accounted for in Gariep's Benchleak, includes the Indigent consumption (Number of Indigents x 6 kl).
- In 2021/22FY actual meter readings at borehole were obtained for Steynsburg.
- Population figures were updated using the Stats SA guideline, to apply a growth rate of 1.35% from 2016 onwards until Stats SA release updated figures.
- Oviston and Venterstad had no working meters for the treated water, and a 10% escalation was applied onto the 2020/21FY's monthly treated volumes to determine the 2021/22FY volumes.
- The number of billed unmetered services connections (indicated on the input page in Benchleak) were determined by averaging the total flat rate consumption and dividing this by 30 kl. This approach was suggested by Sulene from JGDM for the FY2021/22
- A volume of 21 361.0066 kl was added to the treated volume to correct the treat volume.
- The running cost for the combined schemes is R 78 438 029.56 per annum.

The confidence level for the above mentioned is depicted in the table below:

Table 17: Confidence Level Estimate for Gariep

Item	Confidence Level	Confidence Interval	Task						
			Indigent Supply	Population Stats	Billing Volume	Running Costs	Meter Readings	WTW losses	Tariffs
1	Accurate	80%-100%		X					X
2	Minor Inaccuracies	60%-80%	X		X	X			
3	50% Estimated	40%-60%					X	X	
4	Significant Data Estimated	20%-40%							
5	All Data Estimated	0%-20%							

4.4.3 Results for the Gariep Area

The detailed bench-leak calculations for the area are provided in Annexure C, with the summarised results depicted in the tables below.

Table 18: Summary of Gariep

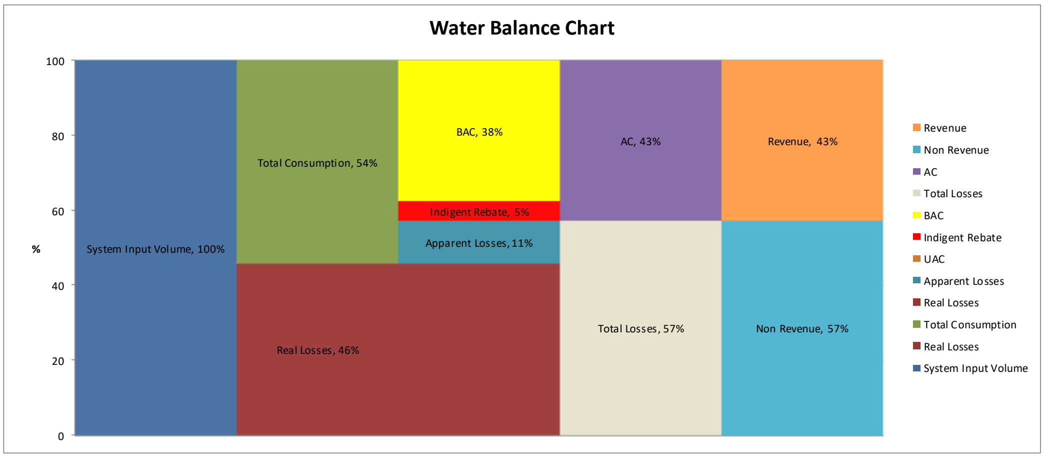
WATER LOSS ASSESSMENT:RESULTS SUMMARY

PROJECT:	JGDM ASSET MANAGEMENT
PROJECT NO:	1001550
CALCULATION METHOD:	WATER RESEARCH COUNCIL BENCHLE
CALCULATED BY:	M CHIRWA
DATE:	2022/11/01
CHECKED BY:	G PATON
DATE:	2022/11/01
COMMUNITY/TOWN	GARIEP
REVISION	4

SUMMARY OF SYSTEM

Water Distribution losses	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Estimated kl/year
Kilo litres Produced	315,466	316,128	315,668	329,814	320,752	344,250	348,574	307,981	339,946	341,843	316,449	308,488	3,905,359
Kilo litres Sold	150,735	129,058	136,658	137,421	133,590	114,295	97,043	230,222	115,778	135,241	126,758	162,356	1,669,155
Kilo litres lost in distribution	164,731	187,070	179,010	192,393	187,162	229,955	251,531	77,759	224,168	206,602	189,691	146,132	2,236,204
% lost during distribution	52.2	59.2	56.7	58.3	58.4	66.8	72.2	25.2	65.9	60.4	59.9	47.4	57.3%
Average cost in Rands	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36
Loss in Rand Value	R 2,694,999	R 3,060,465	R 2,928,604	R 3,147,549	R 3,061,970	R 3,762,064	R 4,115,050	R 1,272,139	R 3,667,384	R 3,380,009	R 3,103,345	R 2,390,720	R 36,584,297

Population with water supply - 2020 Esc @1.35%		29,417	people
Number of connections		8,745	connections
Indigent Population as per 2016 Survey		2,842	HH
Total number of Households served - 2020 Esc @1.35%		8,308	HH
Infrastructure Leakage Index		10.01	-



2013/2014 Total Loss Percentage: 57.1%

2014/2015 Total Loss Percentage: 49.8%

2015/2016 Total Loss Percentage: 29.4%

2016/2017 Total Loss Percentage: 53.3%

2017/2018 Total Loss Percentage: 38.6%

2018/2019 Total Loss Percentage: 41.8%

2019/2020 Total Loss Percentage: 51.6%

2020/2021 Total Loss Percentage: 53.4%

2021/2022 Total Loss Percentage:57.3%

Reason for Variance: It is recommended that a WCDM programme is implemented to identify where the system can be improved further. In 2021/22 FY the total losses have increased, but further improvements are required to reduce the amount of water loss in the system.

Infrastructure Leakage Index: The infrastructure leakage index of 10.01 which indicates a very poor efficiency in the management of the distribution system at the current pressure.

Table 19: Water Loss Figures for Gariep Annual System

Component	m3/year	m3/connection/day	% of System Input volume
Water Exported	0	not applicable	0.0
Authorised Consumption excluding exports	1,669,155	0.52	42.7
Apparent Losses	447,241	0.14	11.5
Actual Consumption excluding exports	2,116,396	0.66	54.2
Real Losses	1,788,963	0.56	45.8
System Input Volume	3,905,359	1.22	100.0

Table 19 (above) shows the actual water figures that can be attached to the water balance chart. The value of 45.8% real losses is higher than the previous FY value of 42.7%. Efforts should be made to reduce the number of losses. The total actual consumption of 54.2% indicates the system is providing atleast half the amount of its input volume to the end-consumer which is an indication that the operation of the system can be improved to a more acceptable standard. It should be noted that most of the supply is to rural area,

4.4.4 Recommendations for the Gariep Area

It is recommended that the following be done to improve the system:

- Acquire the correct pumping rates for the Boreholes.
- Implement bulk and zonal/village water meters.
- Separate the volumes for indigent populations, rural areas and urban areas. This will allow for a better idea on water usage and distribution.
- Ensure quality control during the monitoring process of activities such as water meter readings.
- Ensure constant monitoring of billing data.
- Implement a WCDMP.
- The number of household connections for the area must be clearly defined. If possible either a site investigation or review of “As-Built” drawings should be done to determine these values.
- Schematics need to be updated clearly indicating the current water sources utilised as per the Benchleak records or meter reading data provided, what source are now redundant, location and status of water meters (working or not working).
- Install more meters to reduce the number of billed unmetered (flat rate) users.
- All bulk meters should be calibrated to improve/ensure high confidence in their readings
- Verify water meter readings.

There is an ongoing programme to install district wide telemetry. Pre-paid meter installations have started at domestic and business consumers. However, there is still much of the recommended work to be implemented.

5 Development and Implementation of a WCDMP

In-line with the government legislature, "The Water Conservation and Demand Management National Strategy Framework", Aurecon has outlined a WCDMP for JGDM to implement over time to improve management of its water resources.

5.1 Proposed Methodology

The methodology focusses on the current situation holistically, then addressing the larger, regional problems first, before looking closer at zonal and end-user issues. Experience shows the easiest and biggest wins which contribute most to reducing water losses, are:

Big Win 1: Leaking infrastructure and irresponsible use of water at schools and municipal facilities.

Big Win 2: Leaking bulk infrastructure and wastage at the supply source

Big Win 3: Leaking infrastructure and plumbing fittings in low income and informal settlements.

Three implementation stages are proposed, each having a unique focus, namely:

- Stage 1 – "Immediate Implementation": Public awareness, management approaches and Big Win 1/2
- Stage 2 – "Major WCDMP Components": Zonal challenges and Big Win 1/2
- Stage 3 - "Minor WCDMP Components": End-user challenges and Big Win 3

Each stage builds on the results of the previous stage, as illustrated below:

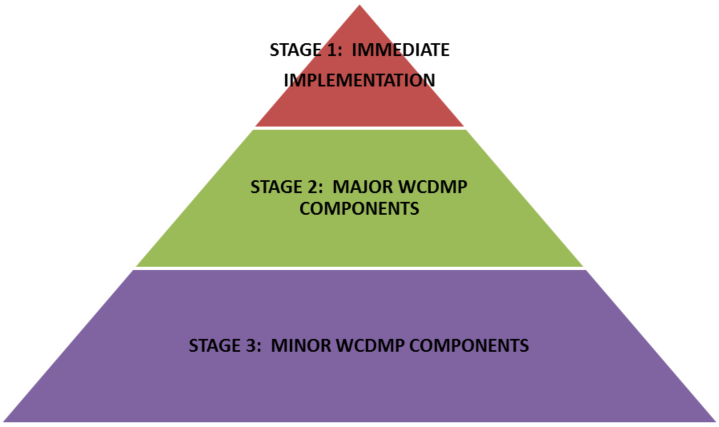


Figure 9: WCDMP Stages 1 - 3

For every stage mentioned above, the WCDMP needs to be implemented in different focus areas, each being interrelated and contributing to the overall success of the plan. These areas are:

- Financial: Water tariff structures, revenue collection methods and reporting on results
- Institutional: Management aspects of assets and policy developments
- Social: Community self-worth, sensitisation and involvement
- Technical: Maintenance of assets and improvement on infrastructure performance

5.1.1 Specific actions to be performed

Through the evaluation of the existing water supply arrangements, reporting structures and discussions with municipal officials, the following actions have been identified which needs to be incorporated within the WCDMP framework:

- Activity 1: Assess current bulk infrastructure supply arrangements and update asset register

- Activity 2: Training Programmes for staff members
- Activity 3: Monthly monitoring of readings
- Activity 4: Annual Assessment using Bench-leak and Financial Indicators
- Activity 5: Identify supply volumes and approved indigent population
- Activity 6: Subdivide existing network into manageable water demand and pressure zones.
- Activity 7: Each of the above zones needs to be separately metered for water balancing and identification of large water use (and water leak) areas.
- Activity 8: Prepare hydraulic models of the areas to provide accurate reflections of the operational scenario.
- Activity 9: Implementation and Integration of new infrastructure
- Activity 10: Constant Monitoring and Assessment

Details on the motivation for the above activities and what they should focus on, are provided in Annexure D.

Specific deliverables, based on the above Big Wins, Stages and specific Activities have been tabulated in Annexure E, for easy management and implementation by JGDM.

5.2 Proposed Implementation Timeline

While an implementation timeline is very much dependent on the available funds, resources and the successful implementation of the preceding stages, it is estimated the WCDMP can be implemented over an 8-year period. The duration of each stage would be as follows:

- Stage 1: 2 years
- Stage 2: 3 years
- Stage 3: 5 years

Each stage would overlap with the preceding stage by about 1 year to ensure the successful transition from one stage to the next.

The implementation timelines for the various stages and activities, are illustrated below:

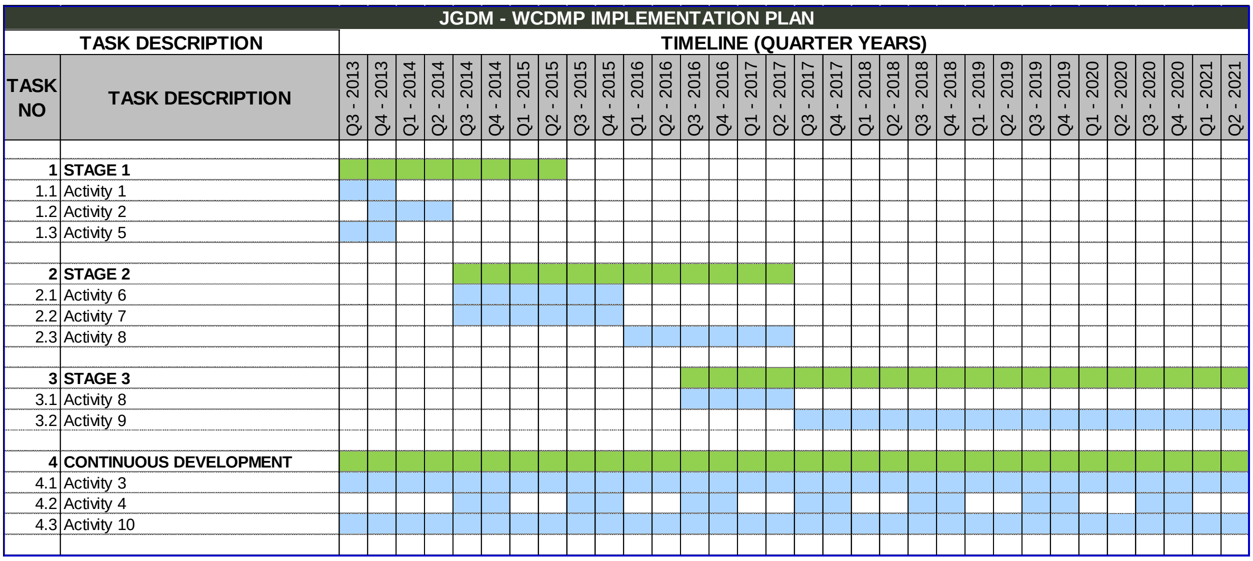


Figure 10: WCDMP Implementation Plan

The activities listed above are only some of the actions that could be considered per stage. For further detail, refer to Annexure E.

The implementation timeline and methodology for the WCDMP has not altered and it is recommended that it is followed in the upcoming financial year.

6 Actions Required

6.1 Improved Accuracy of Bulk Water Meter Readings

It has been mentioned in the report that water meter readings are of concern. Analysis of the system has only been conducted using Bulk water meters. The number of services for all local municipalities' connections is also not clearly defined.

Aurecon has informed JGDM of the concern to try and resolve the issues surrounding the billing data, water meters and household connections. The key outcomes were as follows:

- There is a problem with zonal water meter readers. In certain cases, meters are being read incorrectly or readings are being "forged" by the meter readers.
- The current billing system should be checked for accounts that no longer exist. An accurate number of metered household connections is required.
- Water meter billing codes must be accurately defined to enable accurate monitoring of indigent usage. A system that allows water to be categorized using different billing codes will enable usage to be more accurately defined.
- Bulk water meters are currently monitored by JGDM. JGDM has started replacing faulty bulk meters.
- The location of bulk water meters is critical. Aurecon can propose key areas where new water meters are required and JGDM can apply for funding to have these implemented.

The areas mentioned above are of a similar nature to the previous financial year. It is recommended that the system be re-analyzed to a more detailed level and a site survey conducted to ensure substantial improvement.

6.2 Appointment of PSP for WCDM

JGDM has appointed a PSP to implement the Water Conservation and Demand Management Plan but this initiative must be continued.

6.3 Implementation of Pilot Projects

Due to the scarcity of funding and high costs associated with the implementation of a district WCDMP, Aurecon has proposed that a pilot town be selected during the initial stages. This will allow for all shortfalls to be identified and corrected. The system can also be monitored to identify whether it will be feasible to implement across all towns.

It was decided that Jamestown be selected due to the systems complexity. If the project is viable for the most complex system, implementation for smaller systems will be easier.

The scope of the works will entail the following:

1. Identification of existing water meters and their current functionality.
2. Identifying of strategic areas that require water meters.
3. Installation of all Bulk meters identified in step 2.
4. Monitoring of bulk meters for a reasonable time frame.
5. Assessing of system functionality based on results from step 4.
6. Installation of zonal water meters identified in step 2.
7. Monitoring of bulk and zonal meters for a reasonable time frame.
8. Assessment of system using the DWS Blue Audit Format.
9. Assessing feasibility of full-scale implementation.

Funding has still not been obtained and therefore the project is on hold. It is envisaged that the project will require approximately 10 months to be completed.

7 Conclusion and Way Forward

The current status of the JGDM infrastructure requires attention. Although the unit cost of supply has decreased from R17.75 per kl to R16.36 per kl overall results show that the operation of the systems could be improved significantly through attention to the following:

1. Improved water meter readings.
2. Additional monitoring of consumers.
3. Illegal connections.
4. Checking wasteful use of water and leaks at reservoirs.
5. Monitoring of water loss influences such as household connections and indigent populations.
6. Regular billing.

Some assumptions had to be made because of incomplete information. To provide a more accurate reflection of the current water loss scenario, a more intense monitoring and evaluation regime should be implemented. The “Bench-Leak” model prepared as part of this study can be an effective tool to perform monthly monitoring.

As it stands, the current system analysis is high level and the outcomes could be affected by common inaccuracies. It is possible that external entities such as DWS will challenge the credibility of results due to the level of assumptions made. The accuracy of the analysis will be improved if more control measures are implemented.

Across all Local Municipalities, the following areas for improvement have been identified:

- Implement bulk and zonal/village water meters.
- Separate the volumes for indigent populations, rural areas and urban areas. This will allow for a better idea on water usage and distribution
- Ensure quality control during the monitoring process of activities such as water meter readings
- Ensure constant monitoring of billing data.
- Continue to implement a WCDMP.

Alleviating problems through the implementation of the WCDMP will aid the JGDM to improve their system. The plan is in accordance with governmental legislation and improving the system will ensure that scarce resources are protected.

By conforming to similar methods currently being implemented elsewhere (NMMM and Drakenstein LM), JGDM can improve revenue collection. These funds can be channelled to help in conserving water and ensuring sustainable use. Although the implementation requires significant time and effort, the long-term benefits are numerous, and the proposed plan will aid in helping JGDM achieve its long-term goals.

Appendix A
Source Information Narrative

- **Bulk water meter readings- Obtained from the JGDM**

  These readings were obtained directly from the JGDM. The Information contains the water meter readings for various meters within the different towns. A few readings were omitted as water meters were either broken or not in operation. Some of the information also contained errors regarding the readings.

- **Schematic diagrams of system layout- Obtained from the JGDM**

  Schematic diagrams of the system were provided by the JGDM. Information includes the basic operation and functioning of the system. Diagrams included the flow of water from the source to water treatment facilities, to water storage facilities and eventually to consumers. Additional information such as the location of water meters was also shown. The 2021/22FY schematics are being used for the 2021/22 FY for this interim report, despite the submission of the latest set of schematics. The new schematics will be used once approval of their use for 2021/22 FY is granted.

- **Bench-leak software - Obtained from the WRC**

  The Bench-leak software was obtained from the WRC. The software was developed to estimate water loss within the system as a percentage of the system volume input. Guidelines such as the BABE were used by the WRC in the formulation of the model. The model was adjusted to incorporate the needs of the client. Additional entries such as financial indicators were added to give a better overview of the system. Certain inputs are required and information regarding them may have to be assumed if the information is not readily available.

- **Econo-leak software- Obtained from the WRC**

  This information is of a similar nature to the bench-leak software. However, Econo-leak is a program which can evaluate the economic value of water leakage within a system and assessing the most cost-effective ways of mitigating such leakage.

  The basic principle involves monitoring areas along a pipeline and assessing the likelihood that a leak/pipe-burst will occur along its length. The cost of the Leakage within the system can then be determined using price indicators. In order to ensure an efficient system, the cost of maintenance and repairing of such leaks can be estimated and an informed decision regarding the necessary action to be implemented can be made. In some cases, it is cheaper for the leak to be unfixed due to the expensive costing of maintenance and repair. For an accurate assessment to be made of a system various factors need to be obtained such as water leakage rates, water leakage frequencies, marginal cost of water, costing of regular maintenance, duration of reported bursts and water loss data. Such information can only be considered reasonable if obtained over a period through regular monitoring and thus the Econo-leak tool can be useful once a system is in constant operation.

  For the purposes of the initial evaluation, it is therefore advisable to obtain a rough estimate of the efficiency of the system using the bench-leak model and thereafter implementing the Econo-leak model after sufficient accurate information has been gathered.

- **Asset register - Obtained from the GIS system**

  The asset register contains information regarding the layout and position of assets such as dams, boreholes, pipelines, water treatment facilities, water meters and reservoirs. The information was obtained from the “in house” GIS system.

- **JGDM Water Conservation & Demand Management Plan- Obtained from the DWS**

The WCDMP contains information for the district relating to demographics, water and sanitation needs, water conservation, water demand, initiatives, goals and high priority targets. The document outlines targets that need to be met within certain timeframes when implementing such strategies.

- **Community Survey 2016 - Obtained from JGDM & Aurecon**

  The survey contains all information relating to demographics and service delivery statistics. The data is the most recent available and is used to obtain population figures and indigent population statistics for the various towns and villages.

- **National Water Conservation and Demand Management Strategy- Obtained from DWS**

  This document contains information relating to the legislation for water conservation. Key plans and strategies are outlined to help municipalities develop strategies that will aid in sustainable water supply.

- **JGDM Profile- Obtained from COGTA**

  This document contains information relative to the demographics of the JGDM. Water supply and sanitation service supply statistics are also listed in the document.

Appendix B

Water Supply Schematics

Appendix C

Water loss calculation results for Local Municipalities

Appendix D
Specific JGDM improvement activities

1. **Assess current bulk infrastructure supply arrangements and update asset register**

   Some uncertainties exist with respect to the bulk infrastructure supply arrangements. Field investigations will be required to confirm the accuracy of data, after which the schematics can be updated.

2. **Training Programmes for staff members**

   Staff members responsible for meter readings, maintenance and general operation of systems should be equipped with the necessary skills. Programmes such as general procedures for carrying out the above-mentioned tasks should be introduced to all staff so that the correct procedures are implemented.

3. **Monthly monitoring of readings**

   The water meter readings should be monitored on a monthly basis. If large variations are found, inspections can be carried out to determine if water is being illegally usurped or if a pipeline has burst. Seasonal peaks for the region can also be monitored.

4. **Annual Assessment using Bench-leak and Financial Indicators**

   In addition to monthly monitoring, an annual audit should be conducted to assess whether the system is sustainable or not. Financial indicators can help determine whether the system is profitable, and Bench-leak can assess whether the water being lost is within a reasonable range. However, this can only be accurate if monthly monitoring and accurate information is available.

5. **Identify supply volumes and approved indigent population**

   To monitor the system, it is important to have an accurate assessment of the water balance. Therefore, it is recommended that supply volumes from the various sources be assessed. Pumping rates from the dams, weirs and boreholes should be accurately monitored. In addition to this, the cost of pumping from such sources should be assessed and the indigent population register should be updated. This will allow for the municipality to monitor the total cost of running the system and will include accountability for free water supply.

6. **Implementation and Integration of improved infrastructure**

   A replacement schedule for aged and leaking water meters and valves needs to be prepared. Software tools that allow for better monitoring should also be considered. Replacement of end user water meters should also be considered in the long term. Installation of pressure reducing valves and systems that are capable of monitoring end user usage more accurately can also be introduced.

7. **Constant Monitoring and Assessment**

   The system should be constantly monitored to ensure that it is as efficient as possible. If the system can be improved, then funding should be channelled to such avenues. Mechanisms such as the use of valve controls and pressure reducing valves can ensure a sufficient decrease in water loss. However, these can only be implemented after considerable time and the system needs to have basic infrastructure control mechanisms for effective usage. Therefore, the above-mentioned steps need to be implemented first, before considering advanced mechanisms.

Appendix E

WCDMP implementation stages and work description

STAGE 1: IMMEDIATE IMPLEMENTATION			
Item	**Assessment area/ Activity type**	**Sub-item**	**Works description**
1.1	Technical	1.1.1	Rapid assessment of bulk infrastructure's integrity and identify leaks.
		1.1.2	Inspect premises of large water users, schools, communal standpipes and municipality for leaks.
		1.1.3	Install bulk water meters at all bulk infrastructure components, where required, for system monitoring
		1.1.4	Monthly monitoring of bulk scheme to determine night-flows and quantify leaks (UAW)
		1.1.5	Repair leaks
1.2	Institutional	1.2.1	Determine what existing procedure is in place for leak reporting, repairs and detection.
1.3	Social	1.3.1	Engage large water users to make them aware of their large consumption, high water costs and advise them of ways to save water.
		1.3.2	Initiate public awareness campaign:
		1.3.2.1	Educational posters and information sessions at schools.
		1.3.2.2	Distribute pamphlets and brochures about household savings measures.
		1.3.2.3	Local radio station and newspaper articles/announcements.
1.4	Financial	1.4.1	Audit method by which water meter readings are taken and billings performed. Recommend adjustments/corrections to process.
		1.4.1.1	Only to be performed on a small test sample of the area.
		1.4.2	Obtain water consumption figures from treasury and identify large water users.
1.5	Future planning	1.5.1	Propose plan for roll-out of WCDMP, with milestones, deliverables and associated costs.

STAGE 2: IMPLEMENT MAJOR WCDMP COMPONENTS			
Item	**Assessment area/ Activity type**	**Sub-item**	**Works description**
2.1	Technical	2.1.1	Identify water demand zones
		2.1.1.1	Develop zones and install zonal water meters
		2.1.2	Identify pressure zones
		2.1.2.1	Install pressure reducing valves or similar
		2.1.3	Develop and implement monitoring system for bulk water supply and distribution to demand zones.
		2.1.3.1	Perform water balancing on demand zone level to determine large water use areas.
		2.1.3.2	Monthly monitoring of bulk scheme to quantify leaks and night-flows.
		2.1.3.3	Monthly monitoring of implemented zones for large water uses and leaks, including night-flows.
		2.1.3.4	Pressure management, particularly to reduce night flows.
		2.1.4	Leak detection in large water-use areas.
		2.1.5	Repair of communal standpipes.
		2.1.6	Install prepaid water meters at standpipes in smaller villages
		2.1.7	Rapid assessment of infrastructure integrity, identify and repair leaks.
		2.1.7.1	This can assist in updating and refining the existing asset register to improve O&M service delivery
		2.1.8	Evaluate water re-use potential
2.2	Institutional	2.2.1	Draft policy in support of WCDMP section of bylaws requiring the use of water efficient fittings.
		2.2.2	Define responsibilities between WSA and WSP.
		2.2.3	Expand O&M team with focus on water infrastructure and the maintenance thereof.
		2.2.4	Refinement of and improvement on existing leak reporting framework
2.3	Social	2.3.1	Policing of large water users
		2.3.2	Continue with public awareness campaign:
		2.3.2.1	Informative billing.
		2.3.2.2	Pamphlets and brochures on household savings measures.
		2.3.2.3	Local radio station and newspaper articles/announcements.
		2.3.3	Assign "caretakers" at each village responsible for leak detection and reporting.
		2.3.4	Implement a "Private Homes Programme"
		2.3.4.1	Identify problematic consumption via LM records and zonal water meters

STAGE 2: IMPLEMENT MAJOR WCDMP COMPONENTS			
Item	**Assessment area/ Activity type**	**Sub-item**	**Works description**
		2.3.4.2	Arrange ward meetings for affected households via ward councilors
		2.3.4.3	Establish reasons for wastage at these meetings
		2.3.4.4	Report findings to LM and PSC for further action.
		2.3.5	Tele-call centre to target consumers with high water consumption.
2.4	Financial	2.4.1	Revise water tariffs with "penalty" bracket for high users.
		2.4.2	Implement adjustments to revenue collection method, based on Stage 1 findings.
2.5	Future planning	2.5.1	Compile Stage 2 close-out report, which will be used for inception of Stage 3

STAGE 3: IMPLEMENT MINOR WCDMP COMPONENTS			
Item	**Assessment area/ Activity type**	**Sub-item**	**Works description**
3.1	Technical	3.1.1	Monthly monitoring of implemented zones for large water uses and leaks, including night-flows.
		3.1.2	Install water meters at each erf.
		3.1.3	Repair leaks at low-income areas.
		3.1.4	Prepaid water meters at all stands.
		3.1.5	Develop hydraulic model of network, up to end-user level, and monitor water uses.
		3.1.6	Evaluate each water demand zone to identify high water use areas and address to rectify.
		3.1.7	Construct water re-use infrastructure (E.g. Irrigation of public open spaces with TSE)
3.2	Institutional	3.2.1	Assign a dedicated leak detection and repair team.
		3.2.2	Policing of implemented regulations, tariffs and large water users.
3.3	Social	3.3.1	Continue with Stage 2 interactions.
		3.3.2	Offer free leak repair service
		3.3.3	Replace traditional plumbing fittings with low-flow fittings. (Free of charge to consumer).
3.4	Financial	3.4.1	Adjustment to water tariff structure to improve revenue collection.
		3.4.2	Perform water audit to determine the efficiency of implemented revenue collection method. Recommend and implement changes if required.
3.5	Future planning	3.5.1	Compile Stage 3 close-out report, which will be used to understand, maintain and refine the newly implemented WCDMP

Appendix F
Calculation Methodology

The general calculation methodology is shown below. The figures come from the 2015/16 financial year.

In the case where values were found to be outliers in comparison to other data, or in the instance that a reading was unavailable, the following procedure was used to determine a calculated estimate within a reasonable range:

1. <u>Estimating a monthly reading using an average</u>

$$Calculated\ Volume = \frac{Sum\ of\ volumes\ for\ other\ months}{total\ number\ of\ months}$$

An example of this is indicated for the Billed Volume reading in the Senqu LM for May 16:

$$Calculated\ Estimate =$$

$$\frac{3809 + 3895 + 3969 + 3784 + 3784 + 4044 + 3712 + 3207 + 4096 + 3112 + 2963}{11}$$

$$= 3\ 670\ Kilo\ litres$$

Readings for other months were obtained in the same manner.

2. <u>Unavailable water meter readings across a plant</u>

For readings that were unavailable it was assumed that the losses across a plant will be calculated using values from other plants within the region. In general cases, water losses across a plant are plant specific and losses are dependent on numerous variables. Therefore, water losses are different for each plant depending on age, capacity and plant design. Within the Joe Gqabi District Municipality, it was found that for plants purifying less than 10 000 kl/month a loss of about 5% was applicable. For plants purifying quantities between 50 000 and 100 000 kl/month, a loss of about 20% was applicable.

$$Calculated\ Estimate = ((100\% - \%\ loss) * Raw\ value)$$

An example of this is indicated for the Dec 2015 reading in the Maletswai LM for Jamestown:

$$Calculated\ Estimate = ((100\% - 20\%) * 43471)$$

$$= (80\% * (43471)$$

$$= 34\ 777\ Kilo\ litres$$

Therefore, loss across plant: $\%loss = \frac{43471-(34777)}{43471} * 100 = 20\%$

Readings for other months were obtained in the same manner.

3. <u>Water supplied to Indigent Households</u>

All Indigent households were assumed to receive 6 kilolitres of water per month.

An example of this is indicated for the Elundini LM:

$$Total\ Supply = number\ of\ indigent\ housholds *\ 6kl$$

$$= 1\ 568 * 6$$

$$= 9408\ kl/month$$

$$= 112\ 896\ kl/year$$

Readings for other Local Municipalities were obtained in the same manner.

4. Running Costs for Each Municipality

The Total running costs for water supply was calculated for the entire District municipality. It was assumed that this figure can be divided to each local Municipality relative to the length of pipeline infrastructure. Therefore:

$$Total\ Cost\ of\ Water\ Supply = R\ 150\ 117\ 578.51$$

$$Length\ of\ Elundini\ Pipeline = 155\ km$$

$$Length\ of\ Maletswai\ Pipeline = 107\ km$$

$$Length\ of\ Senqu\ Pipeline = 248\ km$$

$$Length\ of\ Gariep\ Pipeline = 212\ km$$

$$Total\ Length\ of\ Pipeline = 722\ km$$

$$Cost\ of\ water\ supply\ for\ LM = \left(\frac{Length\ of\ LM\ pipeline}{Total\ \ Length\ of\ pipeline} * 100\right) * Total\ cost\ of\ water\ supply$$

$$Cost\ of\ water\ supply\ for\ Elundini = \left(\frac{155}{722} * 100\%\right) * R\ 150\ 117\ 578.51 = R\ 32\ 227\ 457.99$$

$$Cost\ of\ water\ supply\ for\ Maletswai = \left(\frac{107}{722} * 100\%\right) * R\ 150\ 117\ 578.51 = R\ 22\ 247\ 341.97$$

$$Cost\ of\ water\ supply\ for\ Senqu = \left(\frac{248}{722} * 100\%\right) * R\ 150\ 117\ 578.51 = R\ 51\ 563\ 932.78$$

$$Cost\ of\ water\ supply\ for\ Gariep = \left(\frac{212}{722} * 100\%\right) * R\ 150\ 117\ 578.51 = R\ 44\ 078\ 845.77$$

5. Costing for Water Supply per kilolitre

The costing of water supply from abstraction till end user was calculated as follows:

$$Costing\ per\ kl = \frac{Total\ Cost\ of\ water\ supply}{Total\ kilolitres\ purified}$$

$$Costing\ per\ kl = \frac{R\ 150\ 117\ 578.51}{kl\ from\ Elundini + kl\ from\ Maletswai + kl\ from\ Senqu + kl\ from\ Gariep}$$

$$Costing\ per\ kl = \frac{R\ 150\ 117\ 578.51}{1\ 008\ 124.80 + 6\ 435\ 027.00 + 3\ 990\ 974.45 + 3\ 337\ 950}$$

$$Costing\ per\ kl = \frac{R\ 150\ 117\ 578.51}{14\ 772\ 076.25\ kl} = R\ 10.16\ per\ kl$$

6. Household Connections

If the number of household connections for an area seemed unreasonable, it was assumed based on the population figures and an average number of people per household. The connections for Elundini and Senqu were assumed using the following method.

$$Calculated\ Estimate = \frac{total\ population\ being\ served}{no. of\ people\ per\ household}$$

An example of this is indicated for the Elundini LM:

$$Calculated\ Estimate = \frac{111\ 429}{7} \quad = 15\ 918$$

In diversity there is beauty and there is strength.

MAYA ANGELOU

Document prepared by:
Zutari (Pty) Ltd
Reg No 1977/003711/07
Riverwalk Office Park
41 Matroosberg Road
Ashlea Gardens
Extension 6
Pretoria
South Africa
PO Box 74381
Lynnwood Ridge
0040

T +27 11 214 4500
F +27 86 556 0521
E tshwane@zutari.com

ZUTARI
IMPACT. ENGINEERED.