Assessing Water Conservation and Water Demand Management in the Mantsopa Local Municipality, Free State

Dissertation submitted in fulfillment of the requirements for the degree **MASTER OF PHILOSOPHY IN INTEGRATED WATER MANAGEMENT** at The Independent Institute of Education, IIE MSA.

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ABSTRACT

Water scarcity in South Africa poses critical challenges for economic growth, poverty alleviation, and overall socio-economic development. Effective strategies like water conservation and water demand management (WCWDM) are crucial to address water availability and water supply challenges. Municipalities in South Africa are grappling with challenges related to insufficient water supply, largely due to the inability of the local government to adequately meet the needs of the growing populations adequately. This predicament underscores the imperative for municipalities to adopt water conservation and water demand management strategies that will ensure water security across all dimensions including comprehensive availability, accessibility, and water quality. The study aims to investigate how the adoption of strategies for water conservation and water demand management could enhance Mantsopa Local Municipality's capacity to improve its service delivery responsibilities effectively. The study fulfils two main objectives to achieve this aim. The first objective was to understand how water conservation and water demand management is understood by participating Mantsopa Local Municipality officials. The second objective sought to identify challenges and opportunities for implementing water conservation and water demand management by the municipality.

The approach of the study is qualitative. The study used a purposive sampling method, for the collection of data. Semi-structured interviews were utilised to gather data from ten employees of the Mantsopa Local Municipality. A thematic approach was employed in the analysis of the qualitative data.

Five key findings are reported in the study. First, the study found that there exists a rich understanding of the critical role of water conservation and water demand management in effective water management among the municipality officials. Secondly, the study revealed that a systematic approach to combat water losses particularly to address climate change, population growth, and water scarcity is a necessity. Thirdly, the study found that the municipality is committed to the engagement of water conservation initiatives with the community through platforms such as Mayoral Imbizo and integrated development plans. Fourthly, the study further revealed that the municipality faces challenges of not having qualified personnel to

deal with issues of illegal connections, infrastructure maintenance, and insufficient water resources. Lastly, to address these challenges the municipality focuses on capacity building and adhering to the Municipality Staff Regulation Act, 2021 to significantly improve service delivery.

The study provided recommendations to the municipality on strategies for addressing and overcoming challenges for implementing water conservation and water demand management strategies and improving water service delivery.

DEDICATION

I dedicate this dissertation to my beloved wife, Lerato (Nunu), and daughter, Molemo (Momo). Your unwavering support, patience, and understanding throughout this journey have been my strength. It was not an easy path, but with your love and encouragement, I was able to persevere. Thank you for always being by my side.

I further dedicate this dissertation to my late grandmother (Mantilo) and my late mother (ManPonki). Their enduring love, wisdom and spirit continue to inspire and guide me.

DECLARATION BY STUDENT

I, **Kabelo Cornelius Phalole**, declare that this dissertation is my work, except where indicated in the text, and has not been submitted previously for assessment to any other university or institution for the purpose of obtaining a University degree.

Signature: 

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ALC	Active Leakage Control
CLPC	Closed Loop Pressure Control
COGTA	Cooperative Governance and Traditional Affairs
DMAs	District Metered Areas
DTIC	Department of Trade, Industry and Competition
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EPA	Environmental Protection Agency
FAVAD	Fixed and Variable Area Discharge
FMPC	Flow-Modulated Pressure Control
FOPC	Fixed Outlet Pressure Control
GWP	Global Water Partnership
IDP	Integrated Development Plan
ILI	Infrastructure Leakage Index
IRIS	Integrated Regulation Information System
IWA	International Water Association
MFMA	Municipal Finance Management
MIG	Municipal Infrastructure Grant
MIS	Municipal Infrastructure Service
MLM	Mantsopa Local Municipality
MSRA	Municipal Staff Regulation Act
NDP	National Development Plan

NPC	National Planning Commission
NRW	Non-Revenue Water
NWA	National Water Act
NWCWDMS	National Water Conservation and Water Demand Management Strategy
NWRS	National Water Resource Strategy
OECD	Organisation for Economic Cooperation and Development
PLC	Passive Leakage Control
PRVs	Pressure Reducing Valves
RBIG	Regional Bulk Infrastructure Grant
RSA	Republic of South Africa
SAHRC	South Africa Human Rights Commission
SALGA	South African Local Government Association
SANSA	South African National Space Agency
SDG	Sustainable Development Goal
SERI	Socio-Economic Rights Institute
Stats SA	Statistic South Africa
TMPC	Time-Modulated Pressure Control
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNWWD	United Nations World Water Development
WC	Water Conservation
WCWDM	Water Conservation and Water Demand Management
WDM	Water Demand Management
WSA	Water Services Act

WSAs	Water Services Authorities
WSDP	Water Services Development Plan
WSIG	Water Services Infrastructure Grant
WSP	Water Services Provider
WTP	Water Treatment Plant
WWC	World Water Council
WWTWs	Wastewater Treatment Works

CHAPTER 1: INTRODUCTION

1.1 Introduction

WCWDM is a global phenomenon that requires great attention from all states and strategies. The unavailability of sufficient water is a serious concern for most countries. Climate change, population growth and economic development are among the widely cited determinants of water shortage across the globe (Mukuhlani and Nyamupingidza, 2014; Murwirapachena, 2021). The study seeks to evaluate the effectiveness of WCWDM strategies within the jurisdiction of the Mantsopa Local Municipality and how these approaches could enhance the municipality's capacity to effectively improve its service delivery responsibilities. Additionally, the chapter will provide a background on the subject, a problem statement, research objectives, and research questions. Furthermore, the importance of the study will be covered to emphasise the potential benefits and the need for the Mantsopa Local Municipality to create communities that are water-sensitive and resilient and ensure sustainable and equitable water availability through integrated water planning and management. The structure of the study will also be outlined.

1.2 Background

The provision of water services at the local government level is governed by the Local Government: Municipal System Act, No. 32 of 2000 (RSA, 2000a), commonly called the Systems Act. This legislation emphasises the importance of equitable and accessible water-related services (Socio-Economic Rights Institute (SERI), 2020; Masiangoako, Khunou and Potter, 2022). Moreover, the Systems Act assigns municipalities the responsibility of realising Section 27 of the Constitution, which guarantees the right to access sufficient water for everyone (RSA, 1996). Specifically, Section 27(1)(b) of the Constitution enshrines this right, while Section 27(2) mandates the state to take reasonable legislative and other measures, within its available resources, to progressively release this right (Funke, Nortje, Findlater, Burns, Turton, Weaver and Hattingh, 2007).

The Systems Act is complemented by the Water Services Act (Act 108 of 1997) (WSA) (RSA, 1997), which serves as the primary legal framework governing the accessibility

and provision of water services, articulated in Section 3 of the Water Services Act. Another pivotal piece of legislation in South Africa that operationalise the constitutional right to water is the National Water Act (Act 36 of 1998) (NWA) (RSA, 1998a). This act was enacted to effect fundamental reforms in the regulation of water resources, including the repeal of certain laws and the handling of connected matters (Funke et al., 2007).

The collective framework compromising the Constitution, the NWA, the WSA, and the Municipal System Act establishes a shared obligation across all levels of government to cooperatively realise the right of access to water. However, it is the local municipality that bears the crucial responsibility of ensuring the delivery of water to communities (Madumo, 2015; Meissner, Steyn, Moyo, Shadung, Masangane, Nohayi and Jacobs-Mata, 2018; SERI, 2020).

As outlined in Act 108 of 1996, the Constitution of the Republic of South Africa, (RSA, 1996), local governments serve as the focal point for providing public services and spearheading efforts to alleviate poverty (Koma, 2010). South Africa's governmental structures work on a three-tiered system (national, provincial, and local) that functions interdependently. Local municipalities occupy the lowest tier of this system and possess the constitutional authority to manage the affairs of local communities in compliance with the relevant provincial and national legislation (Stats SA, 2017).

Additionally, Section 152 (1) of the Constitution outlines the local government objectives, including democratic governance, sustainable service delivery, social and economic progress, a safe environment and community participation in governance (RSA, 1996). These objectives underscore the multifaceted role of local government in fostering inclusive and sustainable development while involving communities in decision-making processes.

Furthermore, Koma (2010) elucidates the concept of local government as a distinct sphere of governance situated within communities, entrusted with the responsibility of serving and addressing the unique needs, interests, and expectations of communities. This perspective aligns with the findings of the Statistic South Africa Report 2017, which underscores the mandate of local government to develop and deliver municipal services while ensuring public satisfaction to improve the overall quality of life in local communities (Stats SA, 2017). Notably, local government in South Africa assumes a

pivotal role in advancing the development agenda set forth by the national government (Madumo, 2015). Furthermore, Meissner et al. (2018) underscore the important role of local government in advancing the development agenda in addressing water security issues, by highlighting the importance of communication, resource allocation, capacity building, and integrated planning in improving water security, which is an important aspect of the development.

Madumo (2015) and Meissner et al. (2018) underscore the importance of providing municipalities with the requisite support structures and fostering cooperation from the communities they serve to effectively achieve the outlined objectives. Additionally, the South Africa Human Rights Commission (SAHRC) report in 2014 reports on the provincial government's responsibility to offer support and oversee municipalities tasked with delivering water and sanitation services. Furthermore, Section 139 of the Constitution mandates provincial authorities to intervene in cases where municipalities fall short in fulfilling their constitutional and legal obligations to take corrective measures when necessary to ensure the effective delivery of services to communities.

The Department of Cooperative Governance and Traditional Affairs (COGTA), drawing its authority from Chapters 3 and 7 of the Constitution, assumes a critical oversight role concerning municipal service delivery performance. In addition, to its oversight functions, COGTA is tasked with formulating provincial policies and legislation and overseeing the implementation of key regulatory frameworks such as the Local Government Municipal System Act (Act 32 of 2000) (RSA, 2000a). These legislative instruments are pivotal in guiding how local municipalities administer services such as water and sanitation, thereby shaping the quality and accessibility of these essential services.

Moreover, COGTA is responsible for administering skills capacity programs aimed at enhancing the service delivery capabilities of municipalities (SAHRC, 2014). Conversely, the South African Local Government Association (SALGA), also mandated by the Constitution, serves as the supportive entity offering guidance and assistance to local governments. One of SALGA's initiatives, the Municipal Infrastructure Services (MISs), is designed to address the challenges municipalities face in delivering water and sanitation services by providing innovative solutions (SAHRC, 2014)

The 2017 report by Stats SA highlights that municipal services lack absolute definition, necessitating municipalities to adhere to various fundamental principles outlined in the White Paper on Local Government (RSA, 1998b) to guide service delivery. Improvement of municipal services is contingent upon adherence to the following core principles:

- **Accessibility:** Local municipalities must ensure that communities have access to a minimum level of service aligned with the Constitutional mandates.
- **Ease of Use:** Services should be user-friendly and convenient for community members.
- **Affordability:** Municipalities should strive to make services as economically accessible to residents.
- **Predetermined Standards:** Service must meet predetermined criteria, meaning it should be fit for their intended use, be provided promptly, ensure safety, and be available consistently (RSA, 1998b).

Legislative instruments oblige local governments to act a certain way to ensure water and sanitation services. In South Africa, the Constitution (Act 108 of 1996) assigns the responsibility of water and sanitation service provisioning and management to local governments (RSA, 1996). The NWA gives effect to the protection, use, development, conservation, management, and control of the country's water resources based on the principles of sustainability and equity (RSA, 1998a). The WSA addresses the provision of treated water, reticulation to consumers, and sanitation services, which are the legislative responsibilities of local governments (RSA, 1997). These legislative instruments outline the duties and powers of local governments in ensuring access to safe, clean water and sanitation services for their communities (Meissner et al., 2018)

Furthermore, the NWA, captures, defines, and addresses the various dimensions of water security such as basic water supply and sanitation, management of water quality and quantity, allocation of water for basic human needs and ecosystem requirements, and meeting international obligations in shared river basins (Funke, Nortje, Meissner, Steyn, Ntombela and Sakoane, 2018).

1.3 Problem Statement

Moglia, Cook, and Tapsuwan (2018) emphasise the necessity of WCWDM strategies, especially in developing nations like South Africa, where challenges such as climate change, aging infrastructure, and population growth threaten socio-economic development (DWAF, 2004a). Effective WCWDM strategies include protecting vulnerable water systems, reducing non-revenue water (NRW), and ensuring equitable water distribution (Sahin, Bertone and Beal, 2017; Funke et al., 2018).

The Cape Town Day Zero crisis (Shepherd, 2019) exemplifies the urgency of implementing proactive water management strategies. The Mantsopa Local Municipality IDP (2022) highlights ongoing challenges, including insufficient water supplies, aged infrastructure, and inconsistent water quality, necessitating a robust WCWDM approach.

Moglia et al. (2018) highlight the global impact of severe droughts on water security, with projections indicating a potential 40% deficit in global freshwater resources by 2030 (Koop, van Dorssen, and Brouwer, 2019). Moglia et al. (2018) stress the urgent need to address water scarcity exacerbated by anthropogenic climate change, which poses significant challenges to the development and prosperity of the country due to escalating human population and water contamination (Kaziboni, 2024). In developing nations like South Africa, water scarcity poses critical challenges for economic growth, poverty alleviation, and overall socio-economic development (DWAF, 2004a). The severe drought experienced by Cape Town in 2017/2018, leading to the fear of "Day Zero" when water supplies would run out, emphasised the necessity for behavioural changes, water conservation efforts, and effective water governance (Shepherd, 2019).

Effective strategies like WCWDM are crucial to address water availability challenges. Sahin, Bertone and Beal (2017) acknowledge the pivotal role of WCWDM techniques in enhancing regulations and planning to maximise water use and develop resilient water supply systems in the face of climate change. Such approaches cover the protection of vulnerable water systems, protection against floods and droughts, the sustainable development of water resources, and safeguarding access to water functions and services (Funke et al., 2018). Furthermore, these approaches encourage the adoption of sustainable water management practices and enhance the

capacity to adapt to heightened water sensitivity and responsiveness to water availability challenges. They address issues of water security by responding to the impacts of population growth, urbanisation, and climate change (Lindsay, Dean, and Supski, 2017).

WCWDM are related concepts that are essential to achieving a range of goals, including economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services, and political acceptability (DWAF, 2004b). Water conservation emphasises responsible water uses and the protection of resources. In contrast, water demand management focuses on reducing expected water consumption through organisational policies. Both concepts serve overlapping purposes and are essential for resolving water management challenges effectively (DWAF, 2004b).

Winmore, Desai, Beckedhal and Chemura (2016) emphasise that local municipalities are grappling with challenges related to unreliable water supply caused by various factors such as non-revenue water (NWR), aging infrastructure, climate change and further exacerbated by growing population. This predicament underscores the imperative for municipalities to adopt water management strategies that ensure water security across all dimensions, encompassing availability, accessibility, and water quality. Moreover, Winmore et al. (2016) stress the critical importance of municipalities maintaining contingency plans tailored to respond effectively to drought occurrences, thereby ensuring sustainable water service delivery and averting reactive responses. According to the Mantsopa Local Municipality IDP 2022, the municipality is currently facing similar challenges regarding insufficient water supplies exacerbated by increased community population, aged infrastructure including various installations like water purification plants, wastewater treatment plants, aged supply pipes, aged pump stations and control valve chambers, and inconsistent water quality due to lack of qualified process controllers (MLM, 2022). The municipality has implemented water restrictions since 2019 as a contingency plan following the municipal by-laws to manage the demand and usage of water resources which come with these challenges (MLM, 2022).

Given that water serves as the foundational element for community development, effective urban water management necessitates adoption of integrated approaches.

However, the water supply imbalances observed in local municipalities, as highlighted above, stem from various factors such as community expansion, population growth, NRW, aging infrastructure, poor water management and climate change. Identifying water resource augmentation measures is becoming increasingly costly (Moglia et al., 2018). Consequently, discussions about WCWDM must be prioritised in local municipalities to facilitate sustainable water service delivery.

1.4 Research Aim

The study aims to delve into how implementing WCWDM strategies could enhance the Mantsopa Local Municipality's capacity to effectively improve its service delivery responsibilities. The study further aims to explore the obstacles and prospects associated with the municipality's adoption of WCWDM strategies. To achieve this aim, a qualitative research approach was employed to examine various facets of WCWDM within the municipality.

1.5 Research Objectives

The study objectives are:

- To understand how WCWDM is understood by the Mantsopa Local Municipality officials.
- Identify challenges and opportunities for implementing WCWDM by the Mantsopa Local municipality.

1.6 Research Questions

The study aims to answer the following questions:

- How is WCWDM understood by the Mantsopa Local Municipality officials?
- What are the challenges and opportunities for implementing WCWDM by the Mantsopa Local Municipality?

1.7 Significance of the Study

The outcomes of this study hold significant potential benefits not only for the Mantsopa Local Municipality but also for its employees within the water services, technical, and finance departments. It is imperative to conduct such a study in the municipality as it battles with insufficient water supply to growing communities and increased water demand which it struggles to satisfy (MLM, 2022).

By outlining and providing recommendations on the requisite approaches for effective WCWDM, the study aims to enhance the delivery of water services within the municipality, specifically by addressing knowledge gaps such as lack of data on water usage, insufficient understanding of effective water conservation strategies, and limited technical capacity for water demand management. Additionally, the study seeks to shed light on under-utilised methods of WCWDM at the Mantsopa Local Municipality. Thus, this study offers practical and actionable insights to positively impact water management practices and service delivery within the Mantsopa Local Municipality.

1.8 Background to the Study Area

Municipalities within South Africa assume a pivotal function in advancing the developmental objectives set forth by the national government and fostering the cultivation of democratic principles throughout the nation (RSA, 1996). Essentially, the core responsibilities and duties of municipal governance revolve around establishing conducive conditions for the proficient and effective provision of services to communities within designated jurisdictions (RSA, 2000a). Overall, the South African municipal landscape encompasses a total of 278 municipalities, apportioned into 226 local municipalities, 44 district municipalities, and 8 metropolitan municipalities (Stats SA, 2016).

Mantsopa Local Municipality is situated in the eastern part of the Free State Province. Mantsopa constitutes the second-largest geographical area within the Thabo Mofutsanyana District, encompassing approximately 7% of the district's total population (MLM, 2022). The following towns are situated in the municipality: Ladybrand, Hobhouse, Tweespruit, Excelsior, and Thaba Patchoa (MLM, 2022).

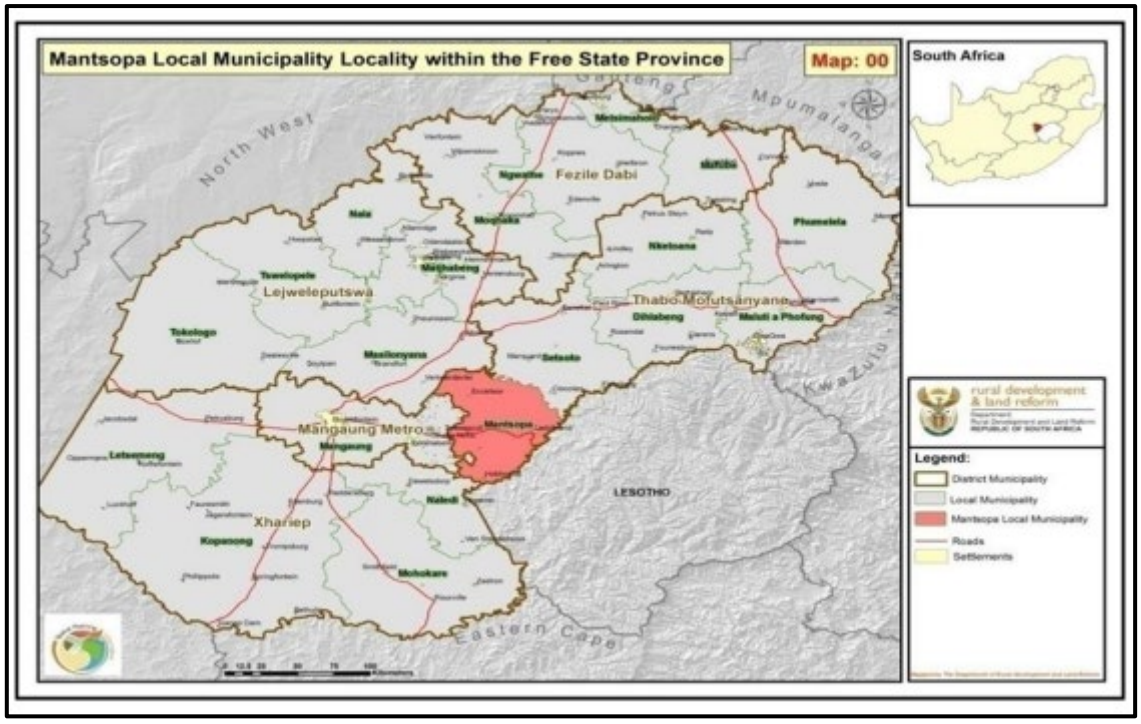

Figure 1.1: Mantsopa Local Municipality Locality (MLM, 2022).

According to findings by Bazaanah and Litabe (2023), the current conditions prevailing in Mantsopa underscore a significant need for more water provision, particularly in rural areas, water and sanitation are poorly served. Residents, including farm labourers and domestic water consumers, are compelled to cover extensive distances to access potable water sources. Moreover, the Municipality's capacity to supply bulk water remains notably deficient, with existing supply systems falling short of meeting demand. Additionally, the standards of water services need to be consistently upheld, with infrastructural facilities often failing to meet acceptable norms. Despite these challenges, Mantsopa municipality, as outlined in its Integrated Development Plan (IDP) 2022, asserts that it has made incremental progress in expanding water services to the community. The municipality has access to five distinct raw water sources, which are utilised across various waterworks and supply systems within the municipality. A comprehensive overview of the raw water resource status for the MLM is presented in **Table 1.1.**

Table 1.1: Mantsopa Local Municipality raw water resource status (MLM, 2022).

NAME OF WATER SUPPLY SYSTEM	SOURCE OF WATER	QUANTITY
Ladybrand	Caledon River Cathcart Dam Thomson Borehole	 1500000 m^3
Tweespruit	Lovedale Dam Boreholes	6500000 m^3 176100 m^3
Thaba Patchoa	Leeurivier River/ Amenia Dam	1588850 m^3
Excelsion	Dinana Spruit Balancing Dam Boreholes Bloemwater	 135000 m^3 150000 m^3
Hobhouse	Leeurivier River/ Amenia	1588850 m^3

Mantsopa's IDP identified several challenges confronting the municipality regarding the provision of water services (MLM, 2022):

- Insufficient raw water availability across all towns,
- Aging infrastructure encompassing treatment plants, supply pipes, pump stations, and control valve chambers,
- Shortage of qualified process controllers at treatment plants,
- Inconsistent water quality.

1.9 Structure of the Study

The study has five (5) chapters, each designed to contribute to the investigation and address the aim, objectives, and research questions.

Chapter One provides an overview of the study. It includes the research background, research problem, research aim, research objectives, and research questions. It further explains the significance of the study and the study area before outlining the background to the study area and the conclusion. Chapter Two provides consulted review of the literature about the research questions. The literature review will indicate that WCWDM is a management intervention between the legally responsible

government structures, through the Constitution of the Republic of South Africa (Act 108 of 1996), for the delivery of water services to the public. The literature will further draw attention to the challenges of implementing WCWDM practices within the local government. It will also include the laws and regulations governing South Africa's water resources usage and management practices. In addition, this chapter will outline the overview of South Africa's current water resources availability and effective ways to manage WCWDM.

The methodologies and techniques employed in the study are detailed in Chapter Three. It outlines the research methodology, encompassing the research philosophy, strategies, and design. Furthermore, the rationale for the research instruments, data analysis, and methods used to ensure the credibility of the study are explained. Lastly, the elimination of biases and the ethical considerations by the researcher are explained.

Chapter Four provides the study's findings and analysis. Chapter Five concludes the study with recommendations and a general conclusion.

1.10 Conclusion

This chapter highlight the critical significance of conserving water as a scarce resource, particularly given the challenges South Africa is currently experiencing due to water scarcity. Prioritising legislation and strategies related to WCWDM are essential to ensure the sustainable use of water resources and the provision of water services. Local governments, such as Mantsopa Local Municipality have a pivotal role in effectively implementing and monitoring these legislative measures and strategies. It is imperative to prioritise the development and enforcement of legislation and strategies focusing on WCWDM in response to South Africa's pressing water scarcity and major water services delivery challenges. Water security in South Africa is a crucial issue due to the current utilisation of water resources exceeding reliable yield, leading to potential water restrictions during drought (Meissner, 2015). Effective implementation and monitoring of these measures are key responsibilities of local governments like the Mantsopa Local Municipality. These actions are vital to ensure the sustainable use of water resources and mitigate the impacts of water scarcity.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Water resource management is a fundamental component of sustainable development, particularly in South Africa, where water scarcity and supply challenges persist due to climatic conditions, population growth, and infrastructure limitations (DWAF, 2004a). This literature review explores key aspects of water management strategies necessary for effective and sustainable use of water resources.

The review begins with an overview of water resource management, focusing on the South African water context, the challenges faced in ensuring reliable supply and strategic water management strategies (DWAF, 2004a). The concept of sustainable water management is then explored, emphasising the importance of balancing ecological sustainability with human consumption (Funke et al., 2018).

Adaptive water management is discussed as a dynamic approach to addressing the uncertainties in water resource planning and climate variability (Pahl-Wostl, Sendzimir, Jeffrey, Aerts, Berkamp and Cross, 2007). The legislative frameworks governing WCWDM in South Africa, including the National Water Act and Water Services Act, are also examined (DWAF, 2004b).

Furthermore, the literature defines WCWDM and highlights its fundamental principles, which include economic efficiency, social equity and environmental sustainability (Seago and McKenzie, 2007). Public perception and awareness of WCWDM play a crucial role in its success, as communities' attitudes and behaviours significantly impact water use efficiency (Sahin, Bertone, and Beal, 2017).

The review also delves into the technical components of WCWDM, including pressure management and NRW reduction strategies. Effective water loss management, such as proactive leak detection and infrastructure maintenance, is essential for optimising water use and minimising waste (McKenzie et al., 2012).

2.2 Water Resource Management

2.2.1 South Africa's Water Context

Water scarcity in South Africa is a complex challenge driven by limited water resources, increased climate variability, and historical inequalities in water access. Various studies highlight the extent of this scarcity, with the country's average annual rainfall at approximately 450mm, significantly lower than the global average of 860mm (Donnenfeld, Crooks and Hedden, 2018; Bhagwan, Wegelin, McKenzie and Wensley, 2014; Molobela and Sinha, 2011; Otieno and Ochieng, 2004; Basson, 2011; DWS, 2018). This substantial difference in rainfall underscores natural limitations and highlights the need for efficient water management strategies.

South Africa's ranking of 148 out of 180 countries concerning water availability in 2012 (NPC, 2011) underscores the severity of the issue. The National Development Plan (NDP) 2030 emphasises water's critical role in driving economic growth, poverty reduction and social equity (NPC, 2011). The plan envisions reliable, affordable access to safe water as a foundation for socio-economic development and well-being (Meissner, Funke, Nortje and Steyn, 2019; NPC, 2011).

However, achieving these objectives requires more than policy frameworks. The NPC emphasises the importance of effective water governance and strategic management, especially considering population growth and increasing demands on water resources (NPC, 2011). Moreover, Rabe, Maree, Ramano and Price (2012) argue that water is not merely a resource but a fundamental driver of prosperity and sustainability, directly influencing economic activities, public health, and environmental integrity.

Critically, Meissner et al. (2019) highlight the limitations of infrastructure-driven solutions, noting that South Africa's water resources have already been extensively developed, with most prime dam construction sites utilised. This insight points to the necessity of demand-side management strategies, improved governance and policy-driven innovation to secure the nation's water future.

2.2.2 Challenges of Water Supply in South Africa

The challenges surrounding municipal water supply in South Africa arise from a combination of historical inequalities, environmental pressures, and infrastructural

deficiencies. Rabe et al. (2012) highlight that the apartheid era left enduring disparities in access to water services, which persist today. These disparities, combined with prolonged drought conditions and limited water resources, create significant obstacles to sustainable water management (Warner and Meissner, 2021; Kaziboni, 2024).

Poor water governance and weak accountability mechanisms further hinder progress. Makaya, Rohse, Day, Vogel, Mehta, McEwen, Rangecroft, and van Loon (2020) emphasise that ineffective governance structures contribute to inefficiencies in water allocation and usage, a view supported by Adom and Simatele (2024). This mismanagement complicates achieving sustainable water management goals (Ruiters and Matji, 2015).

Rabe et al. (2012) also note that inadequate town planning exacerbates these issues. Uncoordinated urban development often overwhelms existing water infrastructure, leading to inefficient use of water resources. Rapid urbanisation and population growth, as reported by South African National Space Agency SANSA (2019) and DWS (2023), further intensify these challenges, placing immense pressure on water supply services and infrastructure. Aging infrastructure and insufficient maintenance have led to systemic inefficiencies, including significant leakages (Netshitanini, Adeeyo and Edokpayi, 2023).

Climate variability and unpredictable weather patterns add another layer of complexity to water resource management. Mukheibir and Sparks (2005) and Mishra, Kumar, Saraswat, Chakraborty and Gautam (2021) explain how rising temperatures and increased evaporation rates strain already limited water supplies.

The apartheid era policies (1948-1994) entrenched racial and economic disparities, leading to unequal access to water resources (Jacobs, du Plessis, Trollip and van Vuuren, 2014). Non-white communities were marginalised, with infrastructure development favouring the minority, impacting water access and distribution (Jegede and Shikwambane, 2021). While progress has been made since apartheid ended, Bazaanah and Mothapo (2023) argue that socioeconomic advancements have further increased water demand, stressing existing resources. Msibi and Dlamini (2011) emphasise that expanding water distribution networks without parallel improvements in treatment and pumping facilities exacerbates system inefficiencies.

Molobela and Sinha (2011) highlight the technical knowledge gaps within municipalities as a critical barrier to effective water management. Consequently, further exacerbated by a lack of technical knowledge in municipalities, which hinders effective decision-making and implementation of sustainable water management practices. Considering these challenges, there exists a significant discrepancy between water demand and supply, as depicted in **Figure 2.1** (Hedden and Cilliers, 2014).

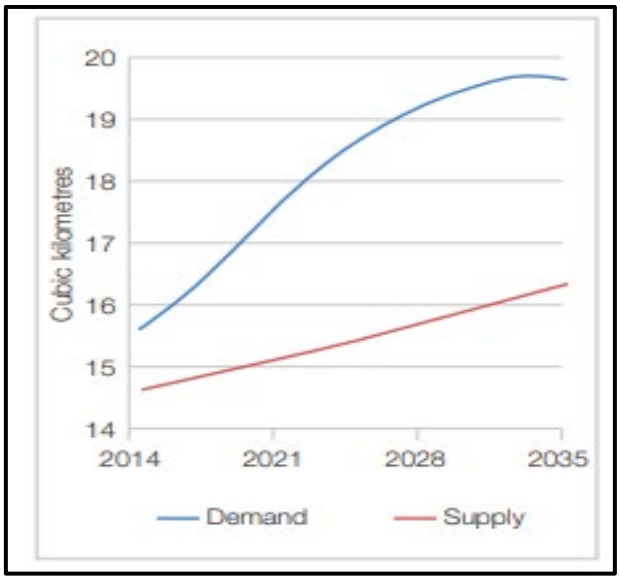

Figure 2.1: South Africa discrepancy between water demand and water supply (Hedden and Cilliers, 2014).

This discrepancy highlights the urgency of addressing these multifaceted issues to establish a more resilient and sustainable water management system in South Africa.

2.2.3 Strategic Water Management in South Africa

The "Closing the Gap scenario" presented by Donnenfeld et al. (2018:15) offers a valuable contribution to addressing South Africa's pressing water challenges. The model's optimism lies in its assertion that affordable and effective solutions can bridge the gap between water supply and demand. The emphasis on increasing treated wastewater effluent and expanding renewable groundwater withdrawals presents a forward-thinking approach to water security. However, while the model highlights viable interventions, it lacks a critical assessment of the infrastructural and financial

capacity required to implement these measures effectively, especially in rural areas with historically inadequate water infrastructure (Molobela and Sinha, 2011).

Regarding irrigation management, Crosby, de Lange, Stimie and van der Stoep, 2000) argue for a controlled approach to agricultural water use, emphasising that irrigation practices must not expand in parallel with agricultural growth. While the intention to curb excessive water use is commendable, the model underestimates the complexities of agricultural demand, particularly in regions reliant on intensive irrigation practices. Additional research, such as that by Meissner et al. (2019), emphasises the importance of balancing water conservation with food security, suggesting that reducing irrigation without alternative strategies could risk agricultural productivity.

The proposed water efficiency measures across municipalities, industries, and agriculture, as outlined by DWS (2016), align with global best practices for water conservation. However, a critique arises in the model's generalisation of these measures without addressing sector-specific challenges. For instance, older municipal systems often face severe water losses due to aging infrastructure, a challenge not fully addressed in the "Closing the Gap" scenario (Netshitanini, Adeeyo, and Edokpayi, 2023).

The model's prediction of increased renewable energy use and reduced water demand for coal-fired plants (Sparks, Madhlopa, Keen, Moorlach, Dane, Krog, and Dlamini, 2014) is well-aligned with sustainability goals. However, the feasibility of such a shift depends on significant investments in renewable infrastructure and policy support, aspects that require further exploration (DWS, 2023).

Finally, Jordaan, Ogundeji, Nyam, Llbury, Turton and van Coppenhagen, 2021) emphasise the importance of supply-side interventions through water resource reconciliation strategies. While the "Closing the Gap" scenario acknowledges these strategies, it does not sufficiently address the governance challenges, such as policy enforcement and corruption, that often impede effective implementation (Adom and Simatele, 2024). Moreover, the urgency highlighted by Donnenfeld et al. (2018) regarding timely intervention is critical, but the model could benefit from a clearer timeline and risk assessment.

According to Donnenfeld et al. (2018), the urgency of implementing sustainable water management policies cannot be overstated. The authors caution against delays,

arguing that South Africa cannot afford to reach a state of national panic similar to the ongoing energy crisis (Donnenfeld et al., 2018). Prompt intervention is crucial to prevent a potential water shortage and safeguard the long-term sustainability of water resources. Proactive measures, including policy reforms, infrastructural investment, and sustainable water management practices, are imperative to mitigate the risks associated with resource depletion and ensure equitable distribution (Sparks et al., 2014). Failure to act promptly may exacerbate existing challenges, compromising environmental health and socio-economic development.

In response to these challenges, the Department of Water Affairs and Forestry (2004) developed the National Water Conservation and Water Demand Management Strategy (NWCWDMS) to emphasise proactive and strategic water management policies aimed at safeguarding the nation's water security and preventing crises with far-reaching consequences (DWAF, 2004b). Similarly, the NWRS 2 and NWRS 3 emphasise the importance of fair and sustainable access to water resources, while also supporting socio-economic development and ecosystem sustainability for both current and future generations (DWA, 2013; DWS, 2023).

Numerous experts have noted that the effects of water mismanagement ripple across nearly every aspect of South African life. Given water's centrality to human security, these widespread consequences underscore the need for a paradigm shift toward sustainable water resource management and security (Meissner et al., 2019; Bischoff-Mattson, Maree, Vogel, Lynch, Olivier, and Terblanche, 2020; NPC, 2020). Mismanagement jeopardises water availability for basic needs and poses significant threats to agriculture, industry and overall community well-being.

Given the complex challenges inherent in South Africa's water management, a call for more assertive water policies becomes imperative. This includes the implementation of robust WCWDM measures (SALGA, 2008). However, while the emphasis on innovative technologies like desalination, smart irrigation, and water reuse presents a progressive outlook, it is essential to critically examine the practical limitations of these interventions (Al-Addous, Bdour, Alnaief, Rabaiah and Schweimanns, 2023). The financial feasibility and infrastructural readiness of many regions in South Africa, mainly rural areas, remain significant barriers to the widespread adoption of such advanced technologies (Molobela and Sinha, 2011).

Moreover, Donnenfeld et al. (2018) propose a comprehensive approach emphasising the diversification of water sources, yet their model may understate the socio-economic disparities influencing policy implementation. For instance, wealthier municipalities may be better positioned to adopt water efficiency technologies compared to under-resourced areas, exacerbating existing inequalities in water access (Meissner et al., 2019).

While the Department of Water and Sanitation (DWS, 2023) emphasises water conservation strategies to optimise resource use, the critique arises from the limited integration of long-term capacity building and community participation. Policies that focus primarily on technical solutions may overlook the need for public engagement and behavioural change, both critical for sustainable water management (DWS, 2016, Bischoff-Mattson, Maree, Vogel, Lynch, Olivier, and Terblanche, 2020).

Additionally, while the inclusion of renewable energy sources in water strategies, as noted by Al-Addous et al. (2023), aligns with sustainability goals, the critique lies in the reliance on high-cost infrastructure. Desalination, for example, has proven effective in regions like the Middle East but remains energy-intensive and costly, which could strain South Africa's already limited resources (Sparks et al., 2014).

2.3 Sustainable Water Management

In their 2014 study, Armitage, Fisher-Jeffes, Carden, Winter, Naidoo, Spiegel, Mauck, and Coulson (2014), emphasise the critical importance of sustainability in urban water management, especially in developing countries like South Africa. The challenges of climate-induced drought, water scarcity, and population growth demand urgent action to augment water resources and introduce new policies, such as water conservation and demand management (Rathnayaka, Malano and Arora, 2016). However, achieving sustainability in water management is not a one-size-fits-all concept but varies significantly across different countries and jurisdictions (Rathnayaka et al., 2016). This contextual variability highlights the need for tailored approaches to address local challenges effectively.

Sustainability in water management encompasses multiple dimensions that ensure water is available for both current and future generations (Carden and Armitage, 2013;

Emas, 2015; Rathnayaka et al., 2016; Pellicer-Martinez and Martinez-Paz, 2016; Brears, 2017). Central to this is the availability of sustainable water supplies that are vital not only for human consumption but also for the production of goods and services (Brears, 2017). In addition to ensuring sufficient water quantity, maintaining water quality is equally important to protect ecosystems (Leigh and Lee, 2019). These various facets of sustainability support the creation of environmentally responsible, safe, and prosperous societies (Rathnayaka et al., 2016).

Brears (2017) suggests that conflicts between the environmental, economic, and political pillars of sustainable development are less likely when sustainability receives focused attention. The integration of these three pillars: social, economic and environmental is essential for achieving sustainable water management (Rathnayaka et al., 2016). This comprehensive approach to sustainability is encapsulated in **Figure 2.2**, which visually represents the interplay between these critical pillars.

According to Adger, Hughes, Folke, Carpenter and Rockström (2005), the top of the triangle represents the social justice priorities, which asserts that water resources and cost should be equally distributed in urban water supply, through democratic decision-making processes. The bottom right point of the triangle depicts the economic water security through the efficient provision of adequate quantity and quality of urban water supply to support human needs (Gleick, 1998). The bottom left point of the triangle depicts the environmental agenda, which includes sustainability and renewability of freshwater stock and flows. Conflict between the three priority areas in sustainable urban water management is inevitable and continuous (Leigh and Lee, 2019).

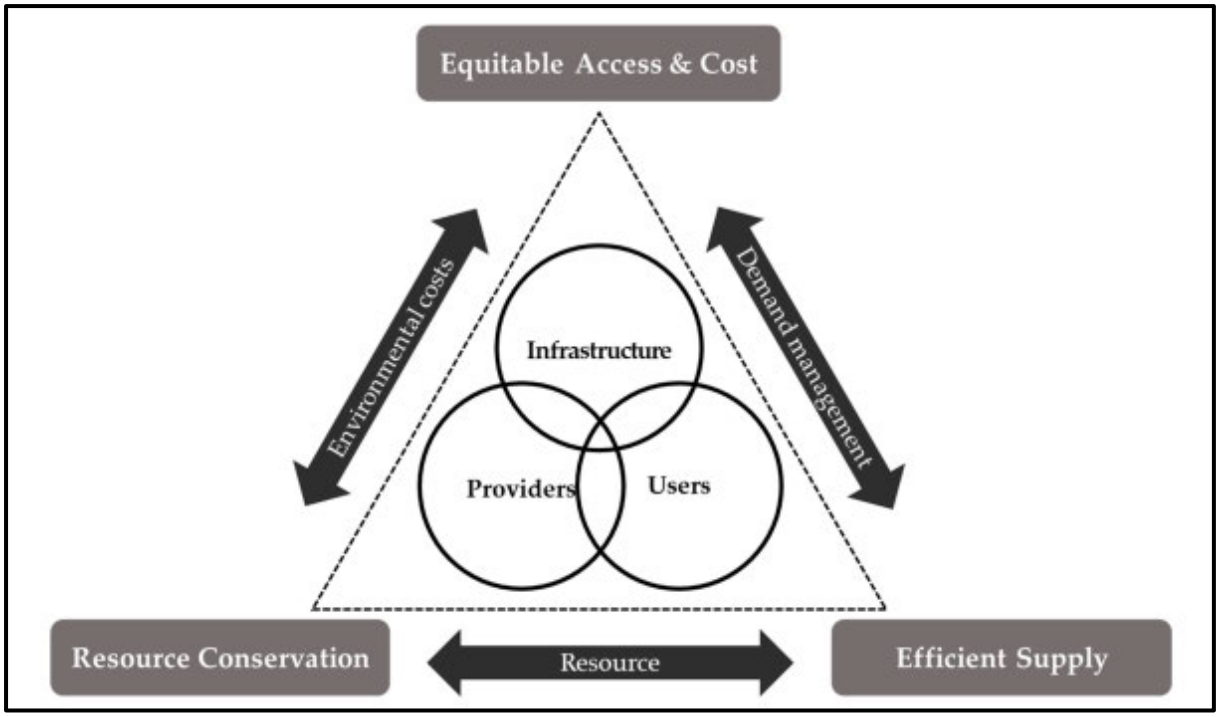

Figure 2.2: Sustainability pillars in urban water management (Leigh and Lee, 2019).

Given these challenges, Purvis, Mao, and Robinson (2019) argue for the need for an alternative, sustainable framework. Such a framework must find a balance between the social, economic, and environmental dimensions, addressing the complexities of urban water management while reconciling the inherent conflicts between these priorities.

2.4 Adaptive Water Management

Water management systems need to be equipped to respond to uncertain hydrological events (Rodina and Chan, 2019). This is evident to the Free State Province, where municipalities frequently experience severe droughts impacting negatively in the agricultural sector. These droughts from 1992/93; 1997/99; 2006/07 and 2015/18 impacted the three major maize-producing areas in the Free State, Bethlehem, Bothaville, and Bloemfontein, leading to significant water shortages. Such shortages have severely impacted water supply, food security, and highlighted challenges for local government water management systems in coping with hydrological uncertainties (Makuya, Tesfuhuney, Moeletsi and Bello, 2024; Ngaka, 2012; van Loon and Laaha, 2015).

This failure of major towns to respond to unexpected hydrological cycles emphasises the inability of local municipalities to manage uncertainty effectively. Transforming water governance paradigms and management practices is essential for resilience against unpredictable climate change stressors (Rodina and Chan, 2019). Policymakers at the municipal level must adapt to increasing variability in hydrological patterns and evolving behavioural dynamics. A paradigm shift from traditional concepts of stationarity towards integrative water resources management is crucial, emphasising the development of resilient municipal systems capable of withstanding future uncertainties (Rodina, 2019).

According to Urquiza and Billi (2020) resilient municipal water systems should be able to cope with and absorb disturbances while retaining their basic structure, functions, and identity. Resilience consists of four key dimensions, based on existing literature. The first dimension, redundancy, diversity, and flexibility, highlights how self-sufficient a municipal system is and how many tools it possesses to deal with unforeseen changes in the environment. A municipality can expand and absorb shocks effectively if versatile strategies are in place. High levels of self-transformation and capacity demonstrate the municipality's diversity and flexibility (Liu, Hull, Yang, Vina, Chen, Ouyang and Zhang, 2019).

The second dimension, connectivity, collaboration, and collective action, emphasises a municipality's capacity to promote interaction possibilities and diversify social and ecological resource interactions. Improved connectivity ensures sustainability and fair resource distribution by facilitating legislative changes to suit local conditions, in addition to improving resource access. Effective decision-making must be cooperative and inclusive for successful local governance (Siders, 2019).

The third dimension, social-ecological memory and learning, focuses on how the municipal system has adapted to environmental changes and the tactics developed in response. Collective knowledge from the environment and system is integrated into current strategies. Increased connectivity allows the community to share knowledge and social-ecological memory (Biggs, Schlüter, Schoon, Bohensky, Cundill, Dakos, and Leitch, 2012).

Lastly, the ability of the system to maintain its essential identity in the face of danger and to change into a more desired state when its original identity proves insufficient is

known as self-organisation and governance of system changes (Engle, 2011). According to Walker, Gunderson, Kinzig, Folke, Carpenter and Schultz (2006), this dimension guarantees the system's ability to adaptably manage change while preserving its core capabilities.

The ability of a system to resist, manage, and adjust to stresses that directly affect it from both the inside and the outside while maintaining its essential features and functions can be used to define resilience (Rodina and Chan, 2019; Rodina, 2019; Urquiza and Billi, 2020). Despite the importance of resilience principles such as flexibility, interconnectedness, and social learning, these concepts remain challenging to define and implement within local government water governance frameworks. This difficulty arises from a current lack of comprehensive understanding of how to enhance water resilience in an integrated manner that addresses the hydrologic, built, and social components of municipal water systems (Quay, 2020; Zhang and Li, 2021).

In urban water management, resilience is crucial for local governments. Recent research has highlighted how important governance is to the restoration of services after natural disasters like droughts and floods. Furthermore, reducing urban exposure, implementing multifunctional land use and combining upstream and downstream management techniques are examples of effective resilient water management measures relevant to municipalities (Shen, Yang, and Zhang, 2020; Wang and Liu, 2021).

Several perspectives on water governance are provided by Rodina and Chan (2019). At first, they define it as a blend of institutional frameworks and water management techniques used to address hydrological phenomena including droughts and floods. Furthermore, they characterise water governance as the political, organisational and administrative mechanisms that allow stakeholders to express their concerns and participate in the formulation and execution of policies. In this process, decision-makers within municipalities are held responsible for the provision of services and the management of water resources (Loseva, 2022; Akhmouch and Clavreul, 2016). For these reasons, water governance is regarded as an essential component in building resilience within local governments. To increase transformative potential and resilience to environmental changes, Rodina and Chan (2019) highlight the importance of adaptive governance and co-management in urban water systems. In

order to improve resilience through flexibility, participation and diversity, stakeholders and policymakers in local governments must use adaptive water management techniques, such as water conservation and water demand management (Mazibuko and Pegram, 2006; Pollard, Riddell, du Toit, Retief and Ison, 2023; Olley, Cvitanovic, Ginige and Bunt-MacRury, 2024).

2.5 Legislative Framework for Water Conservation and Water Demand Management

According to Ncube and Taigbenu (2019), Water Services Authorities (WSAs) are mandated to equitably distribute water. However, there exists an uneven distribution of water services among South African local governments because, numerous municipalities lack the necessary infrastructure to provide water services (Ncube and Taigbenu, 2019). The Constitution of the Republic of South Africa guarantees the right to adequate water, as articulated in Section 27(2), which mandates WSAs to adopt reasonable legislative and other measures to progressively realise this right (RSA, 1996). By constitutional provisions, the South African government has enacted numerous laws and policy frameworks to tackle water-related challenges (DWAF, 1997).

The Department of Water and Sanitation (DWS) oversees water distribution in South Africa. It further oversees the setting of national standards for water services, keeping an eye on how sound WSAs are performing, providing support to WSAs and stepping in when there are problems with the supply of water services. The NWA, WSA, the Municipal Systems Act (No. 32 of 2000), and the Municipal Structures Act (No. 117 of 1998) are some of the essential government legislations that control these activities (RSA, 1997; RSA, 1998a; RSA, 1998b; RSA, 2000a). An overview of different legislative frameworks is given in this section.

2.5.1 National Water Act (NWA) (Act 36 of 1998)

The National Water Act (NWA) adopts water conservation as a fundamental principle. Chapter 1 Section 2 of the National Water Act, No. 36 of 1998, outlines the Act's purpose, emphasising equity and sustainability in the protection, development,

conservation, management, and control of national water resources (RSA, 1998a). The Act further aims to eradicate racial and gender discrimination in water service provision, addressing historical injustices from the apartheid era (RSA, 1998a).

The NWA highlights the significance of strategic planning in water resource management, through the National Water Strategy and Catchment Management Strategy, as detailed in Chapters 2 and 3 of the Act (RSA, 1998a). These strategies ensure that important water resources are categorised and resource quality goals defined for each category, balancing the provision of basic human needs with the protection of aquatic ecosystems (Gildenhuys, 1997).

According to Seago (2016), the Act provides a legislative framework for improving the quality of both surface and groundwater resources while ensuring national water management reforms. The Act mandates municipalities to serve as Water Services Providers (WSPs) and requires them to develop policies that support water demand management, social and economic development, water resource protection, conservation and equitable access to water (RSA, 1998a). This legislative framework is particularly relevant to municipal governance, offering guidelines for effective WCWDM strategies.

2.5.2 Water Services Act (WSA) (Act 108 of 1997)

The primary goal of the Act is to provide support to municipalities in carrying out their water sector responsibilities (DWAF, 2005). It guarantees the Constitutional right to have access to sufficient water and a healthy environment, while also promoting equity and fairness in water service provision (RSA, 1997). The Act establishes several water institutions including Water Services Authorities (WSAs), Water Services Providers (WSPs), water services committees, and water boards (RSA, 1997).

Section 2(j) of the Act mandates equitable water service provision, emphasising the importance of water resource management and conservation (RSA, 1997). Key provisions of the Act include.

- Ensuring the right to access basic water supply and sanitation services.
- Requiring the preparation and compilation of a Water Services Development Plan (WSDP).

- Setting national standards and norms.
- Providing an information system.
- Establishing regulations (by-laws) for effective water supply by water institutions.
- Establishing water institutions such as WSAs, WSPs, water services committees, and water boards.
- Providing financial assistance provisions.
- Implementing a proper water audit process for monitoring effective water services.
- Promoting effective water resource management and conservation.

Section 4(2)(c)(vi) of the Act mandates water service providers, primarily municipalities, to include WCWDM strategies within their service delivery framework (RSA, 1997). As part of the government's poverty alleviation strategy, the Act guarantees free essential water to indigent households, ensuring no individual is deprived of access due to financial constraints (DWAF, 2005).

Furthermore, Section 12 mandates all water service establishments to repair significant leaks within 48 hours of detection to prevent NRW losses from leaks, illegal connections, and wastage (RSA, 1997). In cases where a WSAs fails to meet its obligations under the Act, the Minister of Water and Sanitation can intervene under Section 139 of the Constitution. If provincial intervention fails, the Minister may assume responsibility for the function (Malzbender, Earle, Deedat, Hollingworth and Mokorosi, 2019).

2.5.3 National Water Conservation and Water Demand Management Strategy

The National Water Conservation and Water Demand Management (NWCWDM) strategy was released by the former Department of Water Affairs and Forestry (DWAF) in 2004, serving as the foundational framework for implementing WCWDM measures in water resource management and water services provision in South Africa. The strategy outlines measures and interventions aimed at promoting and facilitating

increased competency in water use and reduction of water demand among water institutions and users.

The NWCWDM strategy is further complemented by sector-specific strategies tailored for three identified sectors: water services, agriculture, and industry, mining, and power generation (DWAF, 2004b). These strategies are designed to embed a culture of WCWDM among all water users and within all water management and services organisations, aligning with the principles established in the National Water Act (Act. 36 of 1998) and Water Services Act (Act 108 of 1997).

For local governments, the implementation of this strategy is crucial as municipalities play a direct role in water service delivery. Effective application of the strategy supports municipalities in ensuring water security, improving efficiency in water resource management, and fulfilling their legislative mandates (DWAF, 2004b). The objectives of the strategy are detailed in **Table 2.1**, emphasising equity, sustainability, and improved service delivery through effective WCWDM practices.

Table 2.1: The NWCWDM summarised objectives descriptions (DWAF, 2004b).

Objective(s)	Description of the objectives
Objective 1	WCWDM in attaining sustainable, efficient, and cost-effective water resource and water service management must be promoted and assured.
Objective 2	Ecology, the environment, and water resources must be preserved.
Objective 3	The creation of WCWDM culture in all water management and water services organisations must be prioritised.
Objective 4	Prioritise a WCWDM culture among all consumers and users of water resources.
Objective 5	Organisations providing water services and management must be supported in implementing WCWDM.
Objective 6	To encourage water institutions to provide sufficient capacity and resources for implementing WCWDM

Objective 7	Integrated planning must be embraced to encourage organisations to provide water management and water services.
Objective 8	International cooperation and engagements in the development of joint WC/WDM approaches should be encouraged amongst Southern African nations, particularly basin-sharing countries.

According to the DWS (DWA, 2013; DWS, 2023), the strategic objectives of WCWDM actions are outlined in Chapter 7 of the NWRS 2 and Chapter 4 of the NWRS 3. These objectives include ensuring the implementation of relevant and practical interventions across all sectors, establishing water allocation and use authorisation that embeds WCWDM principles, and strengthening compliance monitoring and enforcement mechanisms. These strategies are crucial for local government entities, which act as WSAs and WSPs, to implement sustainable water resource management practices effectively.

Local government must align their policies with the NWRS objectives by focusing on infrastructure development, leak detection, and repair as a central component on WCWDM (DWA, 2013). A significant aspect involves establishing institutional capacity with municipalities to regulate and manage WCWDM effectively, coupled with targeted education and awareness campaigns for the public (DWS, 2023).

The constraints and challenges affecting the successful implementation of WCWDM are also noted in the NWCWDM strategy, as well as the opportunities expected to be the driving factors. Moodley, Juggath, Vemblanathan, van Niekerk, Petersen, Baloyi, Pulles, Love, and Aspeling (2021) identify several key challenges.

- **Financial constraints:** The expenses of a project might not always be recovered, and the capital investment is not always accessible.
- **Institutional constraints:** The lack of collaboration among water supply chain stakeholders during project planning is the primary cause of this issue.
- **Limited awareness:** In the water supply sector, there is often a lack of awareness regarding the importance of WCWDM measures and the consequences of not adopting them.

- **Technical constraints:** The implementation of appropriate WCWDM implication is hindered by the absence of application-specific tools and recommendations.

Addressing these barriers requires local governments to adopt a multifaceted approach, including stakeholder collaboration, capacity building and securing financial resources. The alignment of the municipal policies with the NWRS can strengthen resilience against water scarcity and ensure sustainable water service delivery.

2.5.4 Municipal Structures Act (Act 117 of 1998)

The Municipal Structures Act intends to provide for the establishment of structures of the municipalities by the requirements relating to the categories and types of municipalities and their functions (RSA, 1998b). Essentially, there were three categories of municipalities that were established, namely metropolitan (Category A), local municipalities (Category B), and district municipalities (Category C) (RSA, 1996). The boundaries of the local and the district municipalities are determined by the Municipal Demarcation Act (RSA, 1998c) by the Demarcation Board. For progressive development and planning, this process considers the demographics, and social and economic characteristics of both structures. Furthermore, these boundaries are continually reviewed and assessed because over time some of these structures are amalgamated or split. While the metropolitan municipalities are located in large, densely populated areas, with strong, diverse, and complex economic backgrounds (Stats SA, 2017). The distribution of municipalities in South Africa is presented in **Table 2.2.**

Table 2.2: Municipal distribution in South Africa (Stats SA, 2017)

Province	Metro	District Municipality			Local Municipality				
Category	**A**	**C**	**C1**	**C2**	**B**	**B1**	**B2**	**B3**	**B4**
Western Cape	**1**	**5**	5		**24**	3	6	15	
Eastern Cape	**2**	**6**	1	5	**37**		3	19	15
Northern Cape		**5**	5		**27**	1	1	23	2
Free State	**1**	**4**	4		**19**	1	3	15	
KwaZulu-Natal	**1**	**10**		10	**50**	3	6	12	29
North West		**4**	2	2	**19**	4	1	9	5
Gauteng	**3**	**2**	2		**7**	2	4	1	
Mpumalanga		**3**	3		**18**	4	2	7	5
Limpopo		**5**	1	4	**25**	1	1	7	16
Total	**8**	**44**	**23**	**21**	**226**	**19**	**27**	**108**	**72**

The functions and responsibilities of different categories of municipalities are outlined in Chapter 5 of the Act. Concerning water services, it can also be noted a confusion is observed regarding water resource management as the act provides for a generalisation (RSA, 1998b). Section 84(b) of the Act highlights this point by stating that the "bulk supply" of water, which impacts a considerable number of municipalities within the district, becomes a District Municipal role (RSA, 1998b). Although the Municipal Structure Amendment Act (Act 33 of 2000) (RSA, 2000b) eliminated the term "bulk supply" from the legislation in Section 6, it still promotes a method that is in opposition to the integrated catchment approach, which holds that all issues pertaining to water should be managed on a catchment basis.

2.5.5 Municipal Systems Act (Act 32 of 2000)

The Municipal Systems Act (RSA, 2000a) provides a comprehensive framework for local government development, emphasising the importance of social and economic advancement through efficient service delivery. This legislative framework is particularly critical in the context of water services delivery, where municipalities are key drivers of ensuring equitable access and sustainable resource management (Dlamini and Reddy, 2018).

Chapter 4 of the Act underscores the significance of community participation in developmental regulation, highlighting the necessity for municipalities to create a governance culture that integrates both participatory and formal representative elements (RSA, 2000a). Effective community involvement ensures that developmental priorities reflect local needs, enhancing accountability and responsiveness within municipal governance (Ramodula and Govender, 2021). This participatory approach aligns with South Africa's broader constitutional commitments to democratic governance and citizen involvement in public administration.

A critical aspect of the Act is Chapter 5, which directly impacts water services management by mandating the adoption of Integrated Development Plans (IDPs) (RSA, 2000a). The Water Services Development Plan (WSDP) is a critical component of the IDP, as required by the Water Services Act (RSA, 1997). The inclusion of WSDPs within IDPs ensures a holistic planning process where water services

provision is integrated into broader developmental objectives, supporting sustainable growth and service delivery improvements (Dlamini and Reddy, 2018).

However, while the legislation provides a clear framework, the practical implementation often faces challenges at the local government level. These include capacity constraints, financial limitations, and inconsistent stakeholder engagement (Moodley et al., 2021). For example, many municipalities struggle with aligning IDPs with community expectations and available resources, leading to gaps in service delivery, especially in water services (van der Waldt, 2019).

Chapter 7 emphasises the importance of fostering a service-oriented administrative culture, focusing on community needs, staff accountability, and performance management (Ramodula and Govender, 2021). Principles of service delivery such as financial feasibility, environmental sustainability, and equitable access are fundamental to the effective management of municipal water resources (van der Waldt, 2019). Yet, municipalities often encounter difficulties in balancing these principles due to resource constraints and limited technical expertise (Moodley et al., 2021).

2.5.6 Municipal Finance Management Act (MFMA) (Act 56 of 2003)

The MFMA applies to all local governments, including all water services authorities. The goal of the act is to enhance budget and financial management practices by ensuring sustainable local government finances, thereby enhancing the capacity of municipalities to provide services to all stakeholders (RSA, 2003).

Water regulatory requirements place a strong importance on transparent financial reporting which adheres to generally accepted accounting principles as stated in Public Finance Management Act section 91(1)(b) (LHR, 2009).

2.6 Water Conservation and Water Demand Management

Water scarcity poses significant challenges for South African municipalities, particularly in rural areas where limited infrastructure and climate vulnerabilities exacerbate the issue. Kumari and Singh (2016) highlight that water resources are

often mismanaged, contaminated and depleted despite their fundamental value. This mismanagement persists in rural municipalities, where factors such as climate change, declining rainfall and groundwater depletion reduce water supply for domestic and industrial purposes. Shahangian, Tabesh, Yazdanpanah, Zobeidi, and Raoof (2022) emphasise the importance of water security for socio-economic development, as both rural and urban communities rely on consistent freshwater supplies.

Local governments, including rural and urban municipalities, are mandated to ensure water security under the National Water Act (RSA, 1998a) and the Water Services Act (RSA, 1997). However, limited financial resources, inadequate infrastructure maintenance, and capacity constraints often hinder municipalities' ability to meet water demand efficiently (Dlamini and Reddy, 2018). This results in inequitable access to water, particularly in marginalised rural areas, conflicting with constitutional mandates for basic water access and the principles of equitable service delivery (RSA, 1996).

Shahangian et al. (2022) argue that water conservation and demand management strategies are essential for sustainable rural and urban growth, requiring the preservation of ecosystem services and proactive resource management. Municipalities can play a critical role in implementing such strategies by integrating WCWDM principles into IDPs and WSDPs. The NWRS 2 and NWRS 3 further emphasise that effective water resource management and conservation are fundamental to sustainable service delivery (DWA, 2013; DWS, 2023).

However, achieving sustainable water management at the municipal level requires improved governance mechanisms. Municipalities often face challenges such as outdated infrastructure, illegal water connections and a lack of skilled personnel for water management (Moodley et al., 2021). The collaborative approach proposed by Wilgen and Wannenburgh (2016) stresses the need for interdisciplinary cooperation, involving municipal officials, community stakeholders, and environmental experts to address water shortages holistically.

Moreover, proactive policy enforcement, capacity-building initiatives, and community engagement are critical to enhancing water security. Local governments must adopt adaptive governance models that consider climate change projections and ensure equitable resource allocation across all regions (Akhmouch and Clavreul, 2016). This can be achieved through transparent decision-making processes, continuous

monitoring, and enhanced compliance with water conservation standards (RSA, 1998).

South Africa's bulk water delivery system plays a pivotal role in drought response, as it forms the backbone of water distribution for both urban and rural areas. However, recurring drought events have revealed systemic vulnerabilities in water management, leading to significant societal and economic consequences. Meissner and Jacobs-Mata (2016) criticise the government's reactive approach, highlighting how policies often prioritise corrective measures rather than proactive strategies aimed at long-term water security. This reactive stance is further complicated by infrastructure backlogs and data limitations, which impair the capacity of local governments to implement effective WCWDM strategies (Meissner and Jacobs-Mata, 2016).

A fundamental shift towards preventive strategies through WCWDM is essential for local governments to meet their constitutional obligations. WCWDM involves reducing water losses, promoting efficient water use and ensuring sustainable service delivery (Winmore, Sumaiya, Heinz, and Abel, 2016). These strategies not only contribute to social equity but also promote economic efficiency, environmental protection and political acceptability, aligning with the objectives of the NWA (RSA, 1998a).

Local municipalities are key players in balancing water supply and demand. The NWRS 2 emphasises the importance of integrating WCWDM into municipal water service planning, as mandated by the NWA (DWA, 2013). This strategy underscores the necessity for a balance between development, conservation, and sustainable management of water resources. However, the persistent challenges of infrastructure maintenance, non-revenue water losses, and limited technical expertise continue to undermine WCWDM efforts at the municipal level (Meissner and Jacobs-Mata, 2016).

For effective drought preparedness and long-term water sustainability, local government strategies must move beyond compliance-driven approaches to embrace a culture of proactive water stewardship (Meissner and Jacobs-Mata, 2016). This requires enhanced data management systems, regular infrastructure audits and capacity-building initiatives to empower municipal officials with the necessary skills for water resource management (Winmore et al., 2016). By adopting these measures, municipalities can significantly reduce water losses, ensure equitable access, and promote resilience against future hydrological uncertainties.

2.6.1 Definitions of Water Conservation and Water Demand Management.

2.6.1.1 Water Conservation

Water conservation is an old notion, that can be traced back to the 1960s when the idea of sustainable development was initiated. Likewise, Grima and Paine (1985) argue that even though the time, practices, and understanding of the phenomena have changed, however, the meaning and the core principles of water conservation are still understood the same way as at the time when water resource management was first studied. According to the NWRS 1, 2, and 3, water conservation is linked with saving and protecting water resources (DWAF, 2004b; DWA, 2013; DWS, 2023). This is also supported by Wegelin and Jacobs (2013). According to Mwiinga, Gumbo, and Mkoka (2008:2), WC is the "minimisation of water losses or wastage, the care and protection of water resources, and the efficient and effective use of water". This definition will be adopted for this study.

2.6.1.2 Water Demand Management

One of the major challenges facing local government is lack of efficient, effective, and sustainable management of limited water resources. Water demand outstripping water supply may result in problems with water supply. The situation is made worse by population expansion, growing urbanisation, droughts brought on by climate change, and rising temperatures (Stavenhagen, Buurman, and Tortajada, 2018). Water demand management has emerged as a key policy response to water scarcity and environmental sustainability (Willis, Stewart, Panuwatwanich, Williams, and Hollingsworths, 2011).

According to Mckenzie and Bhagwan (2015), in the context of South Africa which is considered a water-stressed country combined with matters such as low rainfall and high evaporation rates, these puts water scientists and water planners in a tricky situation of merging water demand and supply. Matose (2013:63) defines WDM as the "management of the total quantity of water abstracted from the source of supply using measures to control waste and undue consumption". Furthermore, Kumwenda

(2006:28) defines water demand management as the "development and implementation of strategies aimed at influencing demand, to achieve efficient and sustainable use of water". Both definitions are indicative of water demand management as being concerned with the protection of water resources and ensuring efficient water use through the usage of water-saving devices.

According to Wegelin and Jacobs (2013) and Matose (2013), the concept of water demand management stresses more on the socio-economic characteristics of water, where consumers are viewed as customers since they must pay for and account for all their water consumption. This notion creates a severe challenge for the underprivileged and marginalised in society.

2.6.2 Fundamental Principles of WCWDM

The principles of water conservation and water demand management are well-studied and documented (Mckenzie and Bhagwan, 2000; Mckenzie et al., 2012; Wegelin and Jacobs, 2013). These principles are underpinned by the notion of improving water use efficiency and promoting sustainable water use, and their successful implementation is intended to guarantee optimum long-term social and economic benefit for society while also being environmentally sustainable (DWAF, 2004b). In South Africa, water conservation and water demand management policies are underpinned by three main principles (DWAF, 2007; DWS, 2023):

- Water management and water services institutions must continually reduce leakage levels in water systems and promote water conservation and water demand management.
- Consumers should avoid wasting water.
- Water conservation and water demand management should be integral to the water resource and planning process.

It is significant to remember that the WCWDM principles call for the active involvement of every link in the water value chain, from the end user to the water institutions mandated with managing water resources (Busari and Mutamba, 2015). Additionally, Mohapatra and Mitchell (2009) suggest, that substantial backing from sound policies and governance is required for the principles to have a positive impact.

According to Busari and Mutamba (2015), several benefits and advantages can be derived from the successful application of the principles underpinning water conservation and water demand management. These benefits include ensuring efficient use of existing water supplies, promoting water leakage reduction, and equitable water use. Additionally, highlights the importance of reducing water loss and unnecessary development of large infrastructure to environmental quality. These benefits call for improved water management for the present opportunities, future use, water balance, and certainty in water demand forecast (Herbertson and Tate, 2001).

It is important to realise that WCWDM is a continuous process that ought to be a component of municipalities' water management procedures rather than a one-time event (Busari and Mutamba, 2015). Despite the numerous advantages of implementing WCWDM, there are also risks and challenges, that municipalities should take cognisance of. These challenges, according to Mohapatra and Mitchell (2009) and Mutamba and Busari (2012), include a lack of political support and leadership and, a lack of attitude and awareness towards WCWDM. Lastly, inadequate institutional capacity.

2.6.3 Drivers of Water Demand Management

According to Zamani, Monfared, Pour, and Moghadam (2019), rapid population growth exacerbates environmental changes and degradation, leading to declining natural water resources. Recent data indicates that South Africa’s urbanisation rate has been steadily increasing. In 2023, approximately 68.82% of the population resided in urban areas, up from 63.79% in 2013 (Statista, 2024). This upward trend suggests that NPC’s 2011 projection of 70% urbanisation by 203 remains plausible (NPC, 2011).

Furthermore, rapid population growth disrupts the earth's heat balance, causing increased use of fossil fuels, causing variable heat balance and climate change (Zamani et al., 2019). The main challenge includes over-exploitation of water resources, pollution of ground and surface water resources, access to services, health impact from inadequate sanitation facilities and contaminated drinking water supplies (Meissner et al., 2019)

Continued global temperature rise will have a negative impact on water resources availability and demand, affecting water resources (Zamani et al., 2019; Lampe and Reedy, 2013; Rodina and Chan, 2019). Lampe and Reedy (2013) highlight that unstable weather patterns due to climate change, may cause water scarcity and increased stress on ecohydrological systems like rivers, wetlands, and groundwater. Furthermore, Zamani et al. (2019) highlight that the widening gap between water resource availability and demand is putting pressure on the already stressed water resources, increasing uncertainty, and risking infrastructure. According to the report by Carden and Armitage (2013), municipalities are finding it difficult to keep pace with urbanisation, escalating competition for scarce resources and raising social tensions.

Sadoff and Muller (2009), note that in 1990 during the Second World Climate Conference, it was reported that once climate change begins, the water resources will be amongst the sectors that are most affected by this change. Additionally, it was predicted that only a few degrees Centigrade would see a significant change in precipitation, average river flow change, and water availability would decrease (Sadoff and Muller, 2009). The report by Sadoff and Muller (2009) suggests that it is necessary to look at climate change and its impact through different perspectives, including the physical, social, and economic.

2.6.3.1 The Physical Perspective

According to the United Nations Framework Convention on Climate Change (UNFCCC) (2016) report, the poorest and most vulnerable people are likely to be the ones most impacted by climate change, which poses the greatest threat to sustainable development. Moreover, the availability, accessibility, and demand for water are some of the current issues related to climate change, which could put further strain on already stressed ecosystems, biodiversity, and economic sectors (Meissner et al., 2019). However, Schulze (2012) argues that the impact of climate change on South Africa will not be entirely negative. While certain regions may experience detrimental effects such as prolonged droughts and floods, others could potentially benefit. This nuanced perspective highlights the complexity of climate dynamics. Rising temperatures, however, remains a significant concern, as they are projected to increase evaporation rates, which may critically influence surface water levels, runoff

patterns and ground water recharge (van Zyl, 2004). These effects underscore the necessity for effective monitoring and adaptive management strategies. Furthermore, Samir et al. (2017) highlights that rainfall intensity and duration are critical in sustaining groundwater reserves, pointing to the need for integrated approaches to water resource management to mitigate the uneven distribution of climate change effects.

Lastly, according to the United Nations Development Programme Report (2008), climate change-related disasters affected 262 million people annually between 2000 and 2004, predominantly in developing countries. This highlights the severe socio-economic impacts of climate variability and the urgent need for robust water management strategies to mitigate these effects (UNDP, 2008)

2.6.3.2 The Social and Economic Perspective

Water is regarded as a social good that is essential to human well-being and is crucial for livelihoods and the environment. However, achieving water security is a prerequisite for economic progress (Meissner et al., 2019). Yet, according to the World Water Council and Organisation for Economic Co-operation and Development (WWC and OECD), (2015), this rhetoric is not matched by the actual priority it obtains on the political, economic, and environmental agenda, or by the allocations from financial institutions, municipal and national budgets, and investment programs.

The Global Water Partnership (GWP) (2012:3) notes that “water is not just part of the economy; it is embedded within the economy. Without it, the economy could not function”. Therefore, to achieve equitable and sustainable growth and development, it is necessary to integrate all areas of natural resource management (GWP 2012). Furthermore, Meissner et al. (2019) argue the importance of integrated water management as a foundational approach to achieving social inclusiveness, preserving biodiversity, and ensuring sustainable ecosystem services. This perspective underlines how fragmented management strategies may fall short in addressing the interconnected challenges posed by water resources management. Furthermore, Gulati, Jacobs, Jooste, Naidoo, and Fakir (2013) argue that a greater understanding of the complex interrelationships between food, energy, and water is necessary to secure a sustainable and safe future. The interdependence of these resources means that disruptions in the cost or availability of one can cascade into reduced production

efficiency and heightened demand for other, stressing the need for holistic management strategies to avoid resources conflict and inefficiencies (Gulati et al., 2013). Consequently, the interdependence of food, energy, and water makes it extremely vulnerable to environmental pressures and climate change. Effective water resource management necessitates a methodical approach capable of recognising and tackling the challenges and uncertainties linked with climate change (Sadoff and Muller, 2009). Thus, it is imperative to acknowledge water as a primary conduit through which climate change will affect development, and municipalities must integrate this recognition into their overarching planning and management frameworks. Moreover, Sadoff and Muller (2009) argue the critical importance of providing stakeholders and water users with pertinent information concerning the water challenges impacting their societies. Lastly, Meissner et al. (2019) argue that South Africa needs to invest in planning toward alternative water resources and a combination of centralised and decentralised treatment solutions.

2.6.4 Perceptions of Water Conservation and Water Demand Management

Freshwater resource availability has become the focal point of concern in the past years, especially in urban communities (Russell and Fielding, 2010). There is clear evidence that human activities such as pollution, increasing water demand exacerbated by population increase, economic development, and climatic change placed unmanageable stress on the water reserves (Singha and Eljamal, 2020). The statistic indicating that approximately 2.2 billion people lacked access to safely managed drinking water services as of 2022 underscores the global water access crisis, with significant implications for public health, economic stability, and social equity. The disproportionate burden faced by rural areas, where four out of five people lacked even basic sanitation services, further reveals deep-rooted disparities in infrastructure development and resource allocation (UNWWD, 2024). A critical issue in this context is the persistent gap between global commitments and on-the-ground realities. Despite the Sustainable Development Goal (SDG) 6, which aims to ensure universal access to clean water and sanitation by 2030, progress has been uneven (Arora and Mishra, 2022).

Addressing water security for future increasing human water demands poses a significant challenge for policymakers and water management practitioners while at the same time protecting the ecosystem (Fielding, Russell, Spinks, and Mankad, 2012). However, according to Fielding et al. (2012), managing water demand is a crucial component of future water security, which requires finding new water supplies and boosting the productivity of current water supplies to overcome this problem. For example, This is evident in the City of Cape Town in South Africa, which experienced the worst drought, leading to the City's announcement of a possible Day Zero in 2017 (Rodina and Chan, 2019) which, as a result, critical water conservation and water demand approaches to water management were introduced, ranging from restrictions on residential and commercial water usage, incentives for installing water-efficient appliances, information campaigns and per person water use targets (Fielding et al., 2012). These approaches combined led to a significant reduction in household water consumption and saw major changes in how local communities use and perceive water.

Additionally, Section 27(1)(b) of the Constitution states that everyone has the right to sufficient, affordable, and clean water for domestic use and hygienic purposes (RSA, 1996). In addition to helping to prevent sickness and providing high-quality water sustainably, municipalities need to maintain social order within their communities. As a result, South African communities residing in urban areas may experience problems with poor water management within households. However, Coetzee, Nell, and Bezuidenhout (2016), argue that for municipalities to resolve these water management issues in communities, it is essential for the municipalities to understand the beliefs, sources, and uses of water that are common amongst the communities. Indeed, municipalities must understand the psychological and socio-demographic factors that influence household owners' water usage to improve the efficiency of water conservation measures and the associated benefits to the environment (Addo, Thoms, and Parsons, 2018).

The relationship between people and water involves the perceptions and beliefs people have about water, together with their specific behaviour and consumption patterns and their participation towards available water. All of these play a role in the interaction between people and water (Coetzee et al., 2016). Furthermore, Russell and Fielding (2010) demonstrated that the perception of behavioural control over water

is a significant indicator of water conservation intentions and attitudes, beliefs and behaviour play a critical causative role in water conservation. These suggest that municipal water conservation initiatives should strive to win community support for water conservation strategies and offer ways to make and develop tactics that make it simple for individual community members to engage in water conservation practices. According to Thakur, Onwubu, Harris and Thakur (2022) communities will exercise water conservation if they are better aware of everyday water usage behaviours. Awareness is undeniably a crucial first step, as it can foster a sense of responsibility and provide the necessary knowledge to alter behaviour. However, while awareness is a crucial step, it may not be sufficient. A meta-analysis by Addo et al. (2018) suggests that understanding the psychological-social drivers of water use behaviour is essential for enhancing the effectiveness of water conservation strategies.

Furthermore, Singha and Eljamal (2020) state that education is essential. For communities to understand conservation practices, it requires learning more about how to use water and how that affects water supplies. Moreover, water demand management behaviours are explained and identified as curtailment and efficiency behaviours (Russell and Fielding, 2010; Singha and Eljamal, 2020). Russell and Fielding (2010) argue that individuals that practice curtailment behaviours do so to save water by implementing strategies that include but are not limited to washing only full loads of laundry, taking shorter showers, shutting off the water while brushing their teeth, replacing leaking pipes and taps, reusing grey water. While efficiency behaviour is observed as a one-time action that enables ongoing water saving, which includes the use of or installation of water-saving devices, installing rainwater harvesting tanks, and usage of effective cleaning households like washing machines and dishwashers and dual flush bathrooms. Most communities have false perceptions regarding how much water they should consume, thus leading to household water wastage. According to this perception, people are most likely to act reasonably and constructively towards practicing WCWDM if the municipality provides communication platforms within communities that will encourage people to use less water because this will allow them the ability to make clear commitments and assurance about what they are doing. This is supported by Singha and Eljamal (2020), who argue that communication and dialogue between municipalities and communities about water conservation will help communities feel responsible for their action towards water

usage. Furthermore, Thakur et al. (2022) suggest that the significant critical factor to water use behaviour is correct perceptions towards water consumption and usage.

2.6.5 Pressure Management of Water Supply Systems

Water resource availability is becoming increasingly critical on the global agenda due to worsening water scarcity and rapidly rising demands. Effective management of water losses is essential for the survival of humanity, as emphasised by Samir, Kansoh, Elbarki, and Fleifle (2017). Both urban and rural areas face significant challenges in securing water resources, which are exacerbated by population growth. This makes finding additional resources or expanding existing systems economically and physically demanding (Nazif, Karamouz, Tabesh, and Moridi, 2010). Water losses, including leaks, unauthorised usage, and under-registered meters, contribute significantly to the issue, sometimes accounting for over 70% of total water losses (van Zyl, 2004; van Zyl and Clayton, 2007; Samir et al., 2017).

Best practices indicate that managing pressure in water distribution systems is one of the most effective strategies for reducing leakage and ensuring sustainable water management (Samir et al., 2017). Benefits of pressure management include minimising undetectable leaks, reducing strain and breakage of pipes, lowering energy and water costs, enhancing water distribution management, prolonging pipe lifespan, and improving service delivery (Wegelin and McKenzie, 2002; Adedeji et al., 2017). Techniques for managing pressure include defining zone boundaries, using fixed outlet pressure control valves, and employing time-modulated and flow-modulated control valves. Pressure-reducing valves (PRVs) are particularly effective and widely used (McKenzie, 2014).

Nazif et al. (2010) propose non-structural solutions optimising water distribution systems. These solutions are cost-effective and do not require significant capital investment. Effective pressure management is complex and influenced by the system's physical characteristics and operational practices. Pressure is the primary driver of leakage; as pressure increases, leakage does as well (McKenzie, 2014). Various models, including the Fixed and Variable Area Discharge (FAVAD) model, explain the relationship between pressure and leakage rates (Samir et al., 2017).

Municipalities encounter several challenges in implementing pressure management, including high costs, a lack of specialised personnel, network complexity, aging infrastructure, and insufficient data (Samir et al., 2017). Comprehensive system evaluations, as suggested by Araujo, Ramos, and Coelho (2006), can enhance the performance of pressure management techniques. Effectively managing pressure variations can lead to significant reductions in NRW loss and improve customer satisfaction (Xu, Yang, Hughes, and Lechevallier, 2014).

Pressure management is crucial for balancing future water needs with available supplies, particularly in water-scarce regions such as South Africa. Despite its potential benefits, achieving manageable levels of water loss remains challenging (van Zyl, 2004). Studies have confirmed that PRVs can significantly reduce leakage flow rates in water distribution networks (Adedeji et al., 2017).

According to Mckenzie (2001); Wegelin and McKenzie (2002); Mckenzie, Wegelin and Meyer (2003); Mckenzie and Wegelin (2009); Adedeji et al. (2017), several methods for achieving pressure control include Fixed Outlet Pressure Control (FOPC), Time-Modulated Pressure Control (TMPC), Flow-Modulated Pressure Control (FMPC), Closed Loop Pressure Control (CLPC), Parameter-less P-Controller, and Optimization Techniques (Nazif et al., 2010).

The Khayelitsha Pressure Management Project in South Africa demonstrates the effectiveness of pressure management. By reducing excessive water pressure and fluctuations, the project achieved a 40% reduction in average daily flow and minimised minimum night flow (Mckenzie et al., 2003; Mckenzie and Wegelin, 2009; Mckenzie, 2014).

In summary, pressure management is essential for reducing leakage and the risk of pipe bursts (Mosetlhe, Hamam, Du, and Monacelli, 2021). It is a fundamental component of any leakage management strategy, offering municipalities significant water and financial savings (Samir et al., 2017). The various approaches to pressure management and their successful implementation highlight the substantial benefits that can exceed initial expectations (Mckenzie et al., 2007).

2.6.6 Non-Revenue Water (NRW)

Municipalities in South Africa face persistent challenges in managing water loss within their distribution networks, impacting their ability to meet consumer demands while maintaining affordable water tariffs. As highlighted by Frauendorfer and Liemberger (2010), NRW remains a significant issue, where substantial volumes of water fail to generate revenue due to physical losses, commercial losses, and unbilled authorised consumption. This situation not only stresses municipal finances but also affects water security and service delivery equity.

Physical losses, including leaks and overflows due to aging infrastructure and poor operational maintenance, are a major component of NRW (van den Berg, 2014; Rajasekhar, Ramana and Viswanadh, 2018). Addressing these physical losses requires targeted infrastructure rehabilitation, such as proactive leak detection and pressure management strategies (Farley and Liemberger, 2005). Notably, the NWRS 2 emphasises the importance of controlling such losses to meet South Africa's growing socio-economic demands (DWA, 2013).

Commercial losses, which stem from meter inaccuracies, data handling errors and unauthorised connections, also present significant challenges. These issues often result from weak billing and revenue management systems. Bhagwan et al. (2014) and McKenzie et al. (2012) identified poor planning, insufficient financial resources and a lack of skilled personnel as major barriers to effective NRW management in South Africa.

International case studies demonstrate that reducing NRW can lead to substantial benefits. For example, the Phnom Penh WSAs in Cambodia successfully reduced NRW through improved metering and operational efficiency (Biswas, 2009). Similarly, Kungwini West Local Municipality in South Africa achieved reductions through targeted conservation programs (Rabe, Maree, Ramono, and Price, 2012). These interventions underscore the importance of diagnostic evaluations and the implementation of sustainable NRW management practices (Farley and Liemberger, 2005).

Globally, NRW is estimated at 346 million cubic meters per day, with potential reductions capable of supplying water to millions of people (Liemberger and Wyatt, 2019). Within the South African context, NRW stood at 36.8% in 2012, with physical

leaks alone accounting for 25.4% (Bhagwan et al., 2014; McKenzie et al., 2012). Therefore, reducing NRW through effective strategies can significantly improve municipal revenue and water service reliability.

2.6.7 Water Loss Management: Leak Management in Water Supply Systems

The prosperity and welfare of societies hinge significantly on the availability of fresh water, making water loss from municipal networks a critical issue. According to Abd Rahman, Muhammad and Wan Mohtar (2018), recovering a portion of the lost water using water loss reduction techniques offers a more financially viable option than developing new water resources such as constructing dams, drilling wells, or desalinating seawater. This approach not only ensures the efficient use of existing resources but also supports decision-making and the implementation of effective water management strategies (Abd Rahman et al., 2018).

Van Duuren, Koschade, and Chapman (n.d.) highlight multiple benefits of a successful water loss reduction program for municipalities, including alleviating stress on water resources, mitigating environmental issues, saving energy in water treatment and pumping, increasing revenue, and improving public relations and network control. Thus, municipalities must identify factors contributing to leakages within their systems. Netshitanini et al. (2023) identify poor laying conditions, pressure surges, failing joints, material aging and working pressures as key causes of municipal water leakages.

For effective water loss management, Ahopelto and Vahala (2020) recommend dividing water networks into District Metered Areas (DMAs), where flow and pressure are monitored to identify leaks and other issues. Frauendorfer and Liemberger (2010) note that DMAs facilitate the determination of NRW, prioritise leak detection, and allow for the prompt identification of new pipe bursts.

The Environmental Protection Agency (EPA) (2016) reported that municipalities must ensure a sufficient water supply for all uses and should evaluate the feasibility of new sources while prioritising the economic management of existing resources (El-Zahab and Zayed, 2019). McKenzie (2014) further argues that understanding the types and sources of leakages, such as background leakage, burst leakage and internal plumbing leakage, is essential before implementing water demand management

programs. Background leakages are small and often undetectable, while burst leakages grow over time and can be economically repaired. Additionally, internal plumbing leakages within properties can significantly increase water consumption if unchecked (McKenzie, 2014).

Adedeji, Hamam, Abe, and Abu-Mohfouz (2017) warn that leaks at low pressures can introduce contaminants into the water distribution system. McKenzie (2014) indicates that many municipalities struggle to identify primary leak sources, leading to inefficient and costly interventions. Two main leakage control methods are Passive Leakage Control (PLC) and Active Leakage Control (ALC). PLC involves repairing reported leaks promptly, while ALC involves proactive detection and repair of unreported leaks using advanced technology and thorough investigation (McKenzie, 2014).

Furthermore, Winarni (2009) argues the importance of determining annual water losses as an indicator of the efficiency of the water distribution system. The International Water Association (IWA) developed the Infrastructure Leakage Index (ILI) to standardise water balance computations and identify real losses (Seago and McKenzie, 2007; Winarni, 2009; McKenzie et al., 2012). The ILI, which ranges from one (1) in well-managed systems to over one hundred (100) in poorly managed ones, provides a metric for comparing performance. McKenzie et al. (2012) report that South African municipalities have an average ILI of 6.8, indicating a performance that is better than many developing countries but worse than most industrialised nations.

Lastly, Fan, Zhang, and Yu (2021) highlight the importance of early leak detection to prevent significant water loss, infrastructure damage and environmental harm. Utilising advanced leak detection systems helps confirm leaks early, saving resources and preventing further damage. This comprehensive approach to managing water losses is vital for maintaining the sustainability and reliability of municipal water supplies (El-Zahab and Zayed, 2019).

2.7 Conclusion

This chapter undertook a comprehensive review of relevant literature concerning water conservation within the context of South Africa. It commenced by providing theoretical literature on water resource management and explored the concept of sustainability in

water management practices. Subsequently, it delved into discussions surrounding the notions of resilience and flexibility within water management frameworks. Furthermore, it reviewed the legislative frameworks governing both the South African local government and the water sector. The literature review revealed a multitude of factors influencing the implementation of water conservation and water demand management initiatives. These factors include attitudes and awareness levels, challenges about governance and leadership, the aging infrastructure, climate variability, and socio-demographic considerations. Despite encountering these challenges, the literature also presented various solutions available for the implementation of water conservation and water demand management strategies. There is no single intervention in water conservation and water demand management that can singularly address all the water scarcity challenges confronting South Africa. Given the country's uneven distribution of water resources and substantial climate variability, the need for prioritising water conservation and water demand management strategies and interventions remains a priority.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter provides an explanation of the research design, research philosophy, research strategy, population and sampling, data collection method, data analysis method, trustworthiness and ethical considerations and provides support for the methodology followed for this study. The chapter further explains the method used to analyse data collected for the study, ensuring that the results are valid, reliable, and meet the research objectives. The chapter introduces the research tool used for the investigation. The approach utilised to analyse data is also described. Finally, the ethical considerations addressed during the process are examined.

3.2 Research Design

According to Creswell (2009), research designs encompass the comprehensive plans and methodologies devised by researchers to conduct investigations, encompassing both overarching theoretical frameworks and specific methodologies for data collection and analysis. A clearly defined research design is crucial as it provides structure to the study and ensures methodological coherence, which enhances the validity and reliability of the findings (Kumar, 2011).

The design of a study delineates the strategies for both data collection and analysis, aiming to strike a balance between relevance to the research objectives and methodological efficiency (Kothari, 2004). Consequently, the research design serves as a manifestation of the researcher's conceptual framework, providing a structured blueprint that illustrates how all essential elements of the study interact to address the research inquiries (Asenahabi, 2019). In essence, it ensures that research endeavours are conducted efficiently, optimising the acquisition of maximum information while minimising expenditure in terms of labour, time, and resources (Kothari, 2004; Akhtar, 2016).

Research designs typically manifest in three primary forms: exploratory, descriptive, and explanatory, each tailored to suit the specific objectives and context of the study (Boru, 2018). Exploratory research was chosen for this study due to its suitability in investigating water conservation and demand management strategies within the

Mantsopa Local Municipality, a subject with limited pre-existing literature in the context of the Mantsopa Local Municipality and requiring a nuanced understanding of the local context. By adopting an exploratory approach, the study aimed to uncover new insights for further research, especially concerning service delivery improvements in the municipality. Exploratory research is particularly useful when investigating a phenomenon with limited existing knowledge, as it fosters the generation of new insights and hypotheses (Gray, 2014).

Gray (2014) and Akhtar (2016) characterise exploratory research as an approach aimed at uncovering fresh insights into novel or unfamiliar phenomena. Consequently, Gray (2014) and Saunders, Lewis, and Thornhill (2007) emphasise that exploratory research endeavours shed light on unexplored facets of a phenomenon by posing pertinent questions aligned with the research objectives. In contrast to structured inquiry, exploratory research demands adaptability and a readiness to alter course in response to emerging information (Saunders et al., 2007). Kumar (2011) and Gray (2014) further underscore the flexibility inherent in exploratory research, which allows for the adjustment of investigative direction without compromising adaptability.

Akhtar (2016) defines descriptive research as statistical inquiry utilised to discern and gather characteristic information regarding various subjects such as communities, groups, or individuals. Descriptive research provides a detailed portrayal of the phenomena under study, making it particularly useful for comparative analysis and pattern recognition (Kumar, 2011). Furthermore, Du Plooy-Cilliers, Davis, and Bezuidenhout (2014) perceive descriptive research, particularly within diverse sociocultural contexts, as an endeavour to compare attitudes toward significant issues. For instance, within the diverse sociocultural landscape of South Africa, this research design could be employed to delineate matters like the living conditions of individuals in rural areas characterised by distinct cultural paradigms, as well as issues like child abuse (du Plooy-Cilliers et al., 2014). In essence, this type of inquiry seeks to delineate social settings, structures, and occurrences observed by the researcher, endeavouring to provide characterisation. Additionally, such research aims to address questions about "what, who, where, how, and when" (Akhtar, 2016).

Explanatory research, as the term implies, aims to elucidate rather than simply delineate the subject under investigation (Given, 2008). Thus, whereas descriptive

research may address questions about "what," explanatory research endeavours to delve into the "why" and "how" aspects of the inquiry (Gray, 2014). Akhtar (2016) elaborates that this type of research is particularly suitable for studies exploring novel paradigms that have not been extensively examined before, as it seeks to delve into the underlying reasons behind phenomena. An essential characteristic highlighted by Akhtar (2016) is that explanatory research inherently incorporates a set of concepts guiding the researcher's pursuit of factual understanding.

3.2.1 Research Methodology

The research design approach is divided into three groups: quantitative, qualitative, and mixed methods research design. As shown in Figure 3.1 (Asenahabi, 2019), the researcher must decide on the most appropriate design that will benefit the type of research being undertaken.

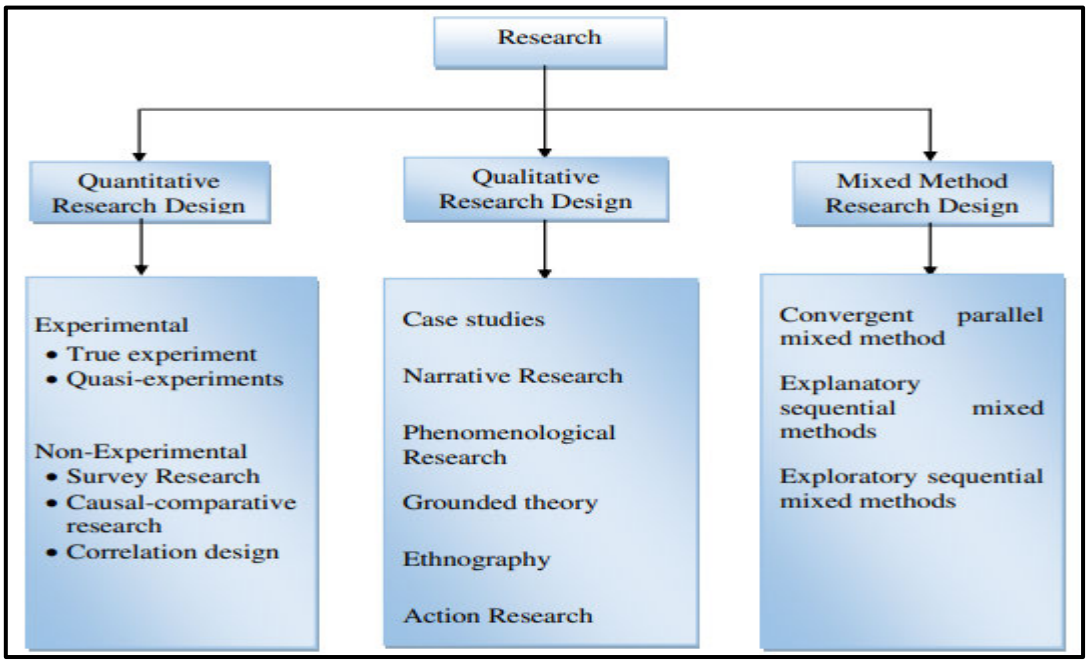

Figure 3.1: Summary of research design types (Asenahabi, 2019)

The qualitative technique was used in this study to enable a thorough analysis of the existing circumstances, gain insight into participants' daily experiences, and identify hidden meanings. This approach facilitated face-to-face interactions with participants, allowing the researcher to assess their decisions, actions, and opinions regarding water conservation and the municipality's management of water demand (Taherdoost,

2020). This study prioritised depth of understanding over generalisability, focusing on exploring the issue within its natural context (Dooly, Moore, and Vallejo, 2017). Gray (2014) emphasises that qualitative research provides a holistic perspective by engaging directly with individuals and communities.

By being attentive, suspending or bracketing preconceptions, and showing empathy for those being studied, the researcher gained a nuanced understanding of the organisational and community-specific context. This design aligns with a naturalistic approach, as described by Gray (2014). Furthermore, Babbie (2010) highlights that qualitative research allows researchers to observe social life in its natural setting, capturing detailed social processes more effectively when the researcher is intentional, prepared, and actively engaged in observation.

This study specifically adopted a cross-sectional design because it allows the researcher to capture data at a single point in time, providing a snapshot of the current situation within the Mantsopa Local Municipality (Saunders et al., 2007). This design was suitable as it facilitated the examination of water conservation and demand management strategies without the need for longitudinal data collection. According to Kumar (2011), cross-sectional designs are effective in studies aiming to understand prevailing conditions, as they offer a broad perspective of the research context and enable data collection from multiple participants simultaneously.

According to Asenahabi (2019), most qualitative research is inductive and built upon several key principles: the significance of the subject matter, the complexity and difficulty of quantifying variables, the social construction of reality, and the importance of insider perspectives. While acknowledging the inherent subjectivity, the methods employed in this study emphasised social justice and cultural diversity, ensuring a rich, up-to-date data set that offers deep insights.

3.3 Research Philosophy

Saunders et al. (2007) elucidate research philosophy as the framework concerning the generation and formation of knowledge, as illustrated in **Figure 3.2.** The metaphor of the research onion symbolises the research process, encompassing significant layers of inquiry. The initial layer represents the nature and evolution of knowledge available

to the researcher. Therefore, as outlined by Mukhles (2020) and Zukauskas, Vveinhardt, and Andriukaitiene (2018), there exist four principal paradigms of research philosophy that researchers may adopt: positivism, interpretivism, realism, and pragmatism.

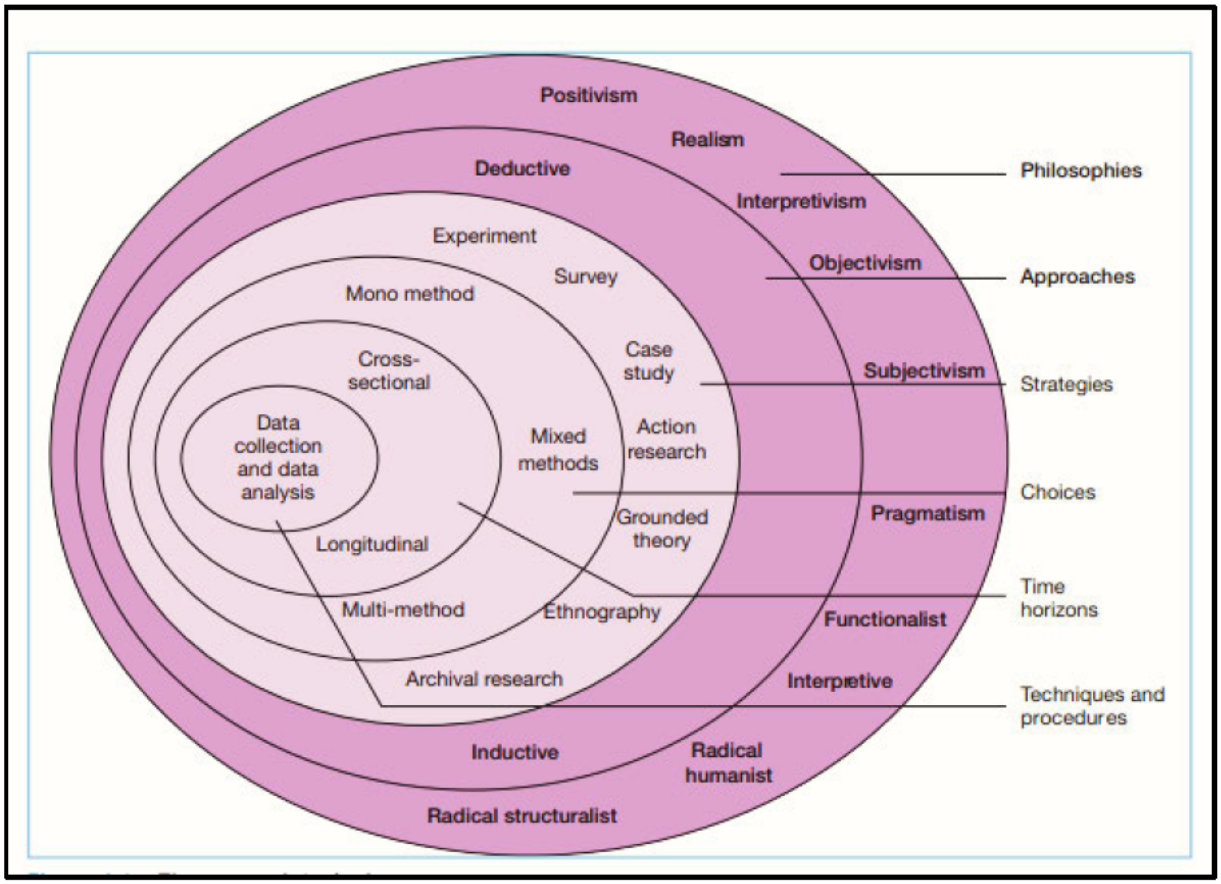

Figure 3.2: The research onion (Saunders et al., 2007)

Some academics believe the interpretivism research philosophy, which seeks to comprehend and explain social and human reality, is anti-positivist (Saunders et al., 2007; Gray, 2014; Mukhles, 2020). This philosophy looks for historically and culturally derived interpretations of social realities. Moreover, interpretivism holds that the facts of social science and natural research are distinct, calling for various methodological approaches (Gray, 2014). While social science realities study the behaviours of individual realities, natural science realities search for consistency in data collected to infer rules. The goal of the contemporary social study is to comprehend and provide an explanation for the reality of the organisation.

The interpretivism concept was used in this study to gather data, analyse it, and create social realities. The choice of interpretivism is particularly justified as it allows for a

deeper understanding of complex social dynamics, aligning with the study's objective to explore subjective experiences and meanings within the Mantsopa Local Municipality (Saunders et al., 2007; Gray, 2014). This philosophy is suitable when investigating human behaviour and social contexts where standardised measurements cannot capture the depth of meaning behind individual experiences (Du Plooy-Cilliers et al., 2014).

Du Plooy-Cilliers et al. (2014) describe this kind of technique as an inductive strategy, also known as the bottom-up approach. Saunders, et al. (2007) outlined the following types of inductive approaches: data display and analysis, template analysis, analytical induction, thematic analysis, discourse analysis and narrative analysis. The interpretivism approach was chosen for the study because it acknowledges the unique context of each organisation and the subjective nature of individual interpretations. This approach is particularly suitable when investigating social phenomena where multiple realities and perspectives exist (Saunders et al., 2007). Furthermore, it aligns with the study's aim of exploring the lived experiences and social contexts within the Mantsopa Local Municipality, which would be difficult to capture using positivist methods alone (Gray, 2014). By prioritising subjective meanings and contextual understanding, interpretivism ensures that findings reflect the nuances of the studied environment, making the research insights more authentic and contextually grounded (Mukhles, 2020).

3.4 Research Strategy

Various strategies are available for exploratory, descriptive, and explanatory research, providing the researcher with multiple methodological options. These strategies are not mutually exclusive; they can be integrated within a single study for enhanced comprehensiveness (Saunders et al., 2007). Core strategies include experiments, surveys, case studies, action research, grounded theory, ethnography, and archival research.

This study adopted the case study strategy, leveraging a range of accessible information sources. The case study strategy is particularly suitable as it incorporates multiple sources of evidence, such as participant recordings, visual documents, interviews, and observations (Saunders et al., 2007). To achieve a detailed

understanding of water conservation and demand management in the Mantsopa Local Municipality, this study employed interviews as a primary method. Interviews are highly effective in qualitative research as they allow for an in-depth exploration of participants' attitudes, behaviours, and experiences (Bryman, 2012).

To collect primary data, semi-structured interviews were conducted with employees of the Mantsopa Local Municipality. This approach provides structured guidance while allowing flexibility for participants to elaborate on their experiences (Creswell, 2009). Such a method ensures the collection of consistent, reliable, and trustworthy qualitative data. Face-to-face interviews were specifically chosen to facilitate direct interaction and reduce miscommunication (Opdenakker, 2006).

Kumar (2011) argues that the case study strategy excels in examining interactional dynamics, providing a holistic understanding of processes without quantification. Yin (2018) further stresses the importance of context, noting that distinguishing the phenomenon under study from its context can be challenging in case study research. Furthermore, Kumar (2011) highlights the flexible and unrestricted nature of data collection and analysis in case study strategies, making them ideal for investigating unique cases where the goal is to gain a holistic and comprehensive understanding rather than generalise findings to an entire population.

3.5 Population and Sampling

The sample selection was accomplished through the purposive sampling technique, which enabled the researcher to choose participants based on their specific experiences, distinctive qualities and expertise related to the subject under investigation (Creswell, 2012; Etikan, Musa, and Alkassim, 2018). This approach ensured that the selected participants possessed relevant insights critical to the research focus, enhancing the quality and depth of data collected. Using this technique, the researcher identified and selected various participants with pertinent knowledge concerning WCWDM within Mantsopa Municipality, ensuring a focused exploration of the research topic.

A carefully chosen sample ensures the manageability of data collection while still capturing sufficient diversity to address the research questions effectively (Saunders

et al., 2007). Sampling is particularly important when the population is large or difficult to access entirely, making it a practical and resource-efficient strategy (Martinez-Mesa, Gonzalez-Chica, Daquia, Bonamigo and Bastos, 2016).

The sample size of ten (10) research participants was determined by the need for data saturation, where further data collection was unlikely to yield new insights (Guest, Bunce, and Johnson, 2006). These participants were drawn from seven municipal departments, representing the entire population relevant to the research focus within the Mantsopa Local Municipality. The choice of ten participants across all key departments ensured adequate representation while maintaining manageability for in-depth qualitative data collection. Majid (2018) defines the population of interest as the group or organisation that the researcher intends to examine and from which the sample elements of the study will be drawn. Additionally, Du Plooy-Cilliers et al. (2014) describe the population as the whole set of individuals or entities from whom information is needed for the research objectives.

The selected sample and data drawn were likely to generate a strong, rich, and deep level of knowledge rather than a generalisation (Gray, 2014). A smaller, carefully chosen sample size allowed for detailed exploration of participant perspectives, which is appropriate for qualitative research focused on understanding context-specific phenomena.

According to Martinez-Mesa, Gonzalez-Chica, Daquia, Bonamigo and Bastos (2016) and Majid (2018), sampling is a method or approach for selecting components from a population of interest. According to Majid (2018), a sufficient sample is a statistical representation of the target population large enough to address the study questions effectively.

When gathering data for study questions where it is impractical for the researcher to collect data from the entire population, Saunders et al. (2007) stress the importance of selecting a sample. Whether data collection involves interviews, questionnaires, observations, or other methods, this step is crucial. Babbie (2010) explains that two main sampling techniques are available: probability and non-probability sampling. Non-probability sampling is utilised when it is challenging to identify the entire study population and gain access to it (Du Plooy-Cilliers et al., 2014). Scholars like Babbie (2010) and Kumar (2011) describe this technique as involving selecting samples from

the population in a manner that does not adhere to the principles of probability theory. This sampling approach provides the researcher with information-rich case studies through which research questions are explored (Saunders et al., 2007). Furthermore, non-probability sampling offers various alternative techniques for the researcher to select samples based on their judgment without random selection of participants (Du Plooy-Cilliers et al., 2014).

3.6 Data Collection Method

This study is qualitative, where the researcher conducted one-on-one interviews with the participants using open-ended questioning techniques to allow them to freely share their experiences without being limited by the researcher's viewpoint or previous research findings (Creswell, 2012). The responses obtained from these interviews constitute the primary source of data collection for this study. According to Gray (2014), an interview is a verbal exchange in which the researcher (interviewer) seeks to comprehend and obtain information from the participants (interviewee). This data collection method enabled the researcher to gather valid and reliable data relevant to this study's questions and objectives (Saunders et al., 2007).

For exploratory studies like this one, Gray (2014) underscores the importance of interviews, emphasising the following points:

- Interviews aim to comprehend the lived experiences of respondents and the meanings they attribute to those experiences.
- They provide respondents with an opportunity for reflection on events, often without needing to document their responses due to the confidentiality of the information shared.
- Interviews allow for clarity and follow-up on questions, fostering a deeper understanding.
- By making questions explicit, interviews encourage more comprehensive responses.

Moreover, there are several types of interviews that the researcher can utilise in addressing the aims and objectives of this study. According to Gray (2014), the following types of interviews can be explored by the researcher:

- Structured interviews.
- Semi-structured interviews.
- Non-directive interviews.
- Focused interviews.
- Informal conversational interviews.
- Problem-centred interviews.

This study employed a semi-structured interview format to facilitate the researcher's thorough understanding of the phenomena under investigation. This approach allowed the researcher to delve deeper into participants' thoughts and opinions by posing follow-up questions, thus enabling the generation of reliable, comparable qualitative data. To facilitate that the participants are comfortable before the interviews commenced, a deliberately informal approach was adopted. The interviews were delivered in both Sesotho and English to ensure a comprehensive understanding of the WCWDM concept. A total of ten interviews were conducted in one week at the Mantsopa Local Municipality, and each interview lasting approximately 45 minutes. Throughout the interviews, detailed notes were taken, and permission was requested for audio recording to ensure the accurate capture of all information without omissions. The audio recording consent form is given in **Appendix D**. All interviews were conducted at the participants' respective offices to maintain a familiar and comfortable environment, minimising potential response bias that could arise from an unfamiliar setting. The interview schedule consisted of four sections and a total number of twenty-one questions in an attempt to answer the research questions. The semi-structured interview schedule used to collect qualitative data from the participants is given in **Appendix E**.

3.7 Data Analysis Method

After collecting data, the next phase of the study involved processing and analysing the collected information. Data analysis, as defined by Kothari (2004), involves the computation of specific measures aimed at identifying relationships between groups of data. This study employed a manual thematic analysis approach, a widely used method for qualitative data analysis, particularly suited for textual data such as interview transcripts (Lakens, 2022). Thematic analysis was selected due to its capacity to identify recurring patterns, themes, and ideas across the data set, facilitating a comprehensive understanding of participants' perspectives.

A key motivation for choosing thematic analysis is its adaptability and theoretical flexibility, as it is not restricted to a specific epistemological framework (Braun and Clarke, 2012; Maguire and Delahunt, 2017; Lochmiller, 2021). This versatility allowed the researcher to explore the data inductively, letting the themes emerge organically rather than being pre-determined. Lochmiller (2021) highlight that thematic analysis is particularly valuable in interview-based research, as it provides a systematic process for synthesising and describing participants' recollections while exploring new theoretical insights. Furthermore, Braun and Clarke (2012) argue that thematic analysis is both accessible and flexible, making it an ideal choice for qualitative research where the goal is to interpret subjective data and connect it to broader conceptual issues.

To ensure a comprehensive analysis, the collected audio data was transcribed and subsequently coded into thematic categories. The transcription process involved reproducing audio recordings as written documents using the exact language spoken by participants, as recommended by Sargeant (2015). While transcription is time-consuming, often requiring six to ten hours per hour of audio (Sargeant, 2015), the researcher minimised delays by transcribing audio data promptly after each interview. To streamline the process, only sections directly relevant to the research questions were transcribed, aligning with Watkins (2017) suggestion of selective transcription.

Although various technological tools and software can assist with transcription and data management, they do not inherently perform the analytical process (Sapat, Schwartz, Esnard and Sewordor, 2017). These tools primarily aid in organising and handling data more efficiently rather than interpreting it. Computer packages were not

used, as the collected data was manageable enough for direct manual thematic analysis.

3.8 Trustworthiness

The researcher employed alternative research criteria to assess the trustworthiness or credibility of this study's findings rather than relying solely on statistical measures (Du Plooy-Cilliers et al., 2014). Trustworthiness, as defined by Cloutier and Ravasi (2021:114), refers to "the degree to which the reader can assess whether the researchers have been honest in how the research has been carried out and reasonable in the conclusions they make". Although subjective, trustworthiness reflects a shared reality between the author and the reader, facilitating mutual understanding in the research process (Stahl and King, 2020).

Ensuring uniformity and standardisation in qualitative research is challenging due to the flexible and evolving nature of qualitative methodologies. The research questions are often explored through multiple methods and processes. To address this complexity, criteria such as credibility, transferability, dependability, and confirmability are commonly used as indicators of trustworthiness (Kumar, 2011; Du Plooy-Cilliers et al., 2014; Johnson, Adkins, and Chauvin, 2020; Cloutier and Ravasi, 2021; Stahl and King, 2020).

Credibility was prioritised by adapting the four trustworthiness criteria to ensure the accuracy and integrity of this study's findings. Biases and confounding factors were actively managed throughout this study, as recommended by Stahl and King (2020). This precaution was particularly important in preventing participants from providing responses influenced by authority figures, a phenomenon described by Swanson (2015). To mitigate this, participants were assured of anonymity and informed that the findings would be used exclusively for academic purposes.

Connelly (2016) asserts that credibility requires iterative questioning and re-examination of data. Therefore, credibility was further strengthened by employing established research methods (Solberg, Raastad, Angeltveit and Paulse, 2016). The purposive sampling approach also enhanced credibility by selecting participants with

specific, relevant experiences, ensuring the collected data were representative and meaningful for this study.

Transferability, defined as the extent to which qualitative findings can be applied to various contexts or populations, was ensured by providing a detailed description of the study's setup and procedures (Moon, Brewer, Januchowski-Hartley, Adams, and Blackman, 2016). Transferability relies heavily on the reader's ability to determine applicability to other contexts (Trochim, 2020). Descriptive data was included to allow external audiences to assess the generalisability of the findings to different settings.

Dependability, which aligns closely with reliability in quantitative research, was addressed by ensuring the data's stability over time and across varying conditions (Polit and Beck, 2014). Dependability focuses on consistency, particularly whether the analytical procedures align with the chosen research design (Korstjens and Moser, 2018). To establish dependability, an inquiry audit was conducted, verifying the congruence between the findings and the data collected.

Confirmability, akin to objectivity in quantitative research, ensured that the study's findings reflect the participants' experiences rather than researcher bias (Polit and Beck, 2014). Confirmability was achieved through rigorous techniques such as verification, triangulation, and peer review (Johnson et al., 2020). Moon et al. (2016) emphasise that confirmability guarantees participant driven results, minimising subjective interference. To further ensure confirmability, the following strategies were employed (Korstjens and Moser, 2018):

- **Audit Trail:** Comprehensive documentation of the research process, including data collection, analysis, and interpretation.
- **Reflexivity:** The researcher critically examined their positionality and potential biases, considering their background and how it might influence various stages of the research, from topic selection to data interpretation and presentation of results.

3.9 Ethical Considerations

Ethics is defined by Du Plooy-Cilliers et al. (2014) as the moral or professional code of conduct that establishes expectations for the behaviour and attitude of researchers.

It suggests that it is crucial to be a person of integrity who can be relied upon to uphold moral standards in the context of life in general. According to Saunders et al. (2007), ethics in the context of research refers to how suitably a researcher behaves about the rights of people who are either the topic of the study or are impacted by it. As a result, it's critical to safeguard research subjects by applying the proper ethical guidelines (Arifin, 2018). permission to conduct the study, informed consent, protection of participant confidentiality and anonymity, and no harm to participants is the primary ethical consideration underlying this research endeavour.

3.9.1 Informed Consent

Informed consent is explained as a formal agreement between the researcher and the participant that outlines the reason for data collection and use of the information, how long will it be used, how long it will be protected, with whom will data be shared, and how the participant can withdraw from the research (Dankar, Gergely, Malin, Badji, Dankar and Shuaib, 2020). The participants were given a consent form to fill out and sign, indicating their voluntary consent to participate in the study. The participant consent form is attached as **Appendix C**. Participants were also informed of their rights before signing the consent form. Participants were further told of the study's objectives, their freedom to withdraw from it, and how long the findings would be retained and shared.

3.9.2 Ensuring “no harm” to Participants

Du Plooy-Cilliers et al. (2014) contend that researchers are obligated to avoid causing harm to participants, a principle upheld across various disciplines. However, within the realm of social science, this concept becomes intricate, as harm can manifest in diverse forms such as psychological, social, physical, and legal, as noted by Du Plooy-Cilliers et al. (2014). The researcher implemented rigorous measures to ensure participants did not experience any adverse effects due to their involvement in this study. These measures included obtaining informed consent where participants were clearly briefed about the purpose, process, and their rights to withdraw from the study at any time without facing consequences. Confidentiality and anonymity were strictly maintained by anonymising participant data and securely storing all records to prevent

unauthorised access. Furthermore, attention was given to creating safe and suitable environments for participants by conducting interviews at their offices, a familiar setting where they felt secure and comfortable. Rigorous efforts were undertaken to minimise any potential risks or disadvantages for the participants during the study, including avoiding any sensitive questioning that could lead to emotional distress and ensuring open communication channels for participants to raise concerns at any stage of the research process.

3.9.3 Protection of Participant Confidentiality and Anonymity

As per Du Plooy-Cilliers et al. (2014), anonymity in research denotes a situation where the researcher cannot link a participant's identity to their responses during the research process, thus remaining unaware of their identity. On the other hand, confidentiality implies that the researcher is cognisant of the participant's identity but commits to keeping this information confidential and not disclosing it to any third party. In this study, participants selected for participation will remain anonymous to readers. The data collected for this study was stored on an external disk, and securely kept in a safe. To protect the participants' identities, pseudonyms were used in presenting the study's findings, ensuring that participants were not identifiable.

3.9.4 Authorisation to Perform the Study

Before commencing the study, authorisation was sought from the Mantsopa Local Municipality to conduct research involving its employees. Additionally, the University granted ethical approval to conduct this study. A letter of authorisation from the Mantsopa Local Municipality and the ethical approval from the University are a necessary component of this study and are included as **Appendix B** and **Appendix A**, respectively.

3.10 Conclusion

This chapter provided a thorough understanding of the research methodology used for this study. It detailed the research methodology, including the research philosophy, strategies, and design. The study findings were investigated using a qualitative

research approach. Interviews, featuring semi-structured open-ended questions in **Appendix E**, served as the primary research instrument. Sampling strategies were deliberated upon, with the researcher opting for purposive sampling to elicit detailed and comprehensive information from participants. Thematic analysis was employed to analyse the data obtained from the interviews. Ethical considerations were carefully deliberated and adhered to, ensuring the protection of individuals' rights throughout the research process.

Chapter 4 will delve into the findings of this study, providing detailed discussions and interpretations of the findings.

CHAPTER 4: RESULTS, DISCUSSION, AND INTERPRETATION OF FINDINGS

4.1 Introduction

The findings from the qualitative data, collected and examined following the research methodology described in the previous chapter, are presented. These findings aim to address the research questions and achieve two study objectives. The first objective was to understand how water conservation and water demand management are understood by the Mantsopa Local Municipality officials. Lastly, to identify challenges and opportunities for implementing water conservation and water demand management by the municipality.

Semi-structured interviews were used as the research instrument to achieve these objectives. To evaluate the effects of WCWDM within the municipality, data were collected from ten employees of the Mantsopa Local Municipality. The study used a purposive sampling method, to facilitate the interviews. The research instrument consisted of four thematic areas with twenty-one (21) semi-structured questions (**Appendix D**).

4.2 Presentation, Analysis and Discussion of the Results

This section outlines, evaluates, and interprets the results of the participant interviews conducted in the Mantsopa Local Municipality. The focus was on employees in the Water and Sanitation Unit since they had the knowledge and experience to provide informed comments because of their direct involvement with water service issues. The study attempted to get answers from eleven individuals, but in the end, it only managed to get ten, yielding a 91% response rate. A saturation was achieved with 10 municipal employees with diverse designations, qualifications, ages, and experience levels, who participated in this study. This rate is considered acceptable and is expected to produce informative data to improve the study's discussion and recommendations. The process for responding to questions was explained to the respondents, and all ethical issues, such as getting informed consent before the interview were conducted. To protect participant confidentiality and anonymity, which safeguards against exploitation and harm (Surmiak, 2018), respondents are identified numerically from

Respondent 1 to Respondent 10. The findings are organised thematically and were analysed manually, with each theme evaluated for its relevance to the research objectives, specifically assessing the impacts, challenges and opportunities of WCWDM within the municipality.

4.2.1 Gender of Participants

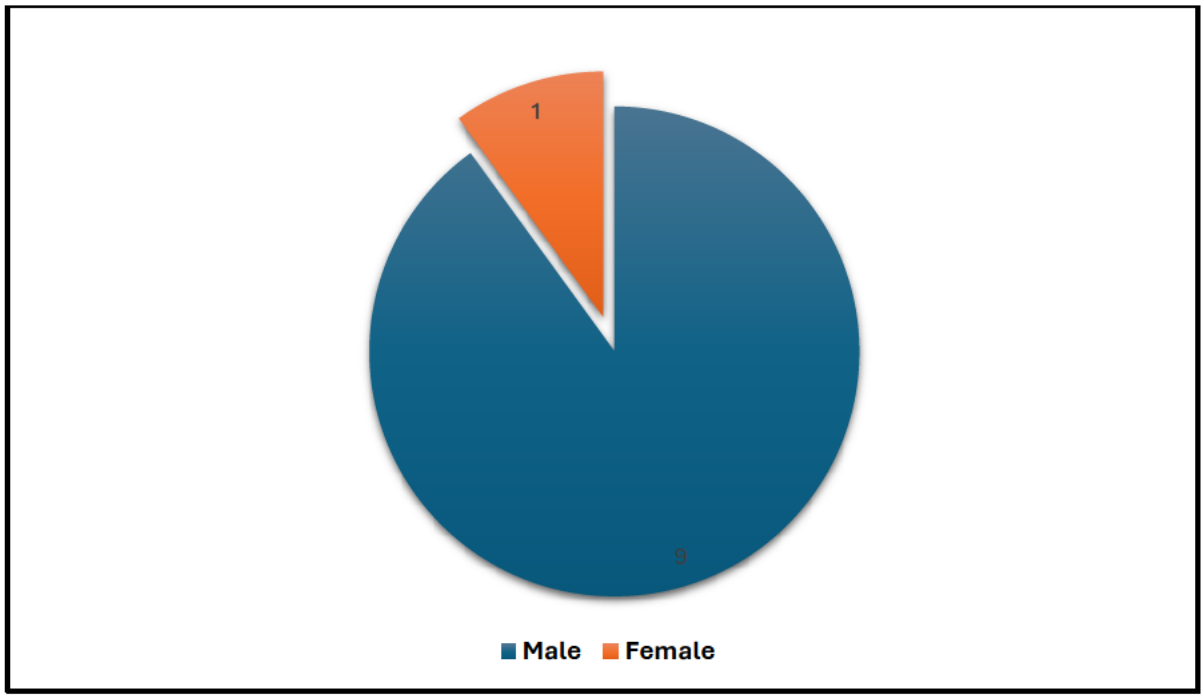

Figure 4.1: Gender of participants

Figure 4.1 presents an overview of the gender distribution of participants, which shows that 1 of the participants was female and 9 of the participants were male. Since gender balance was not achieved, these gender statistics point to a slightly biased in favour of men. This discrepancy suggests that more men than women have been appointed in the Mantsopa Local Municipality water conservation and water demand management.

4.2.2 Age Group of Participants

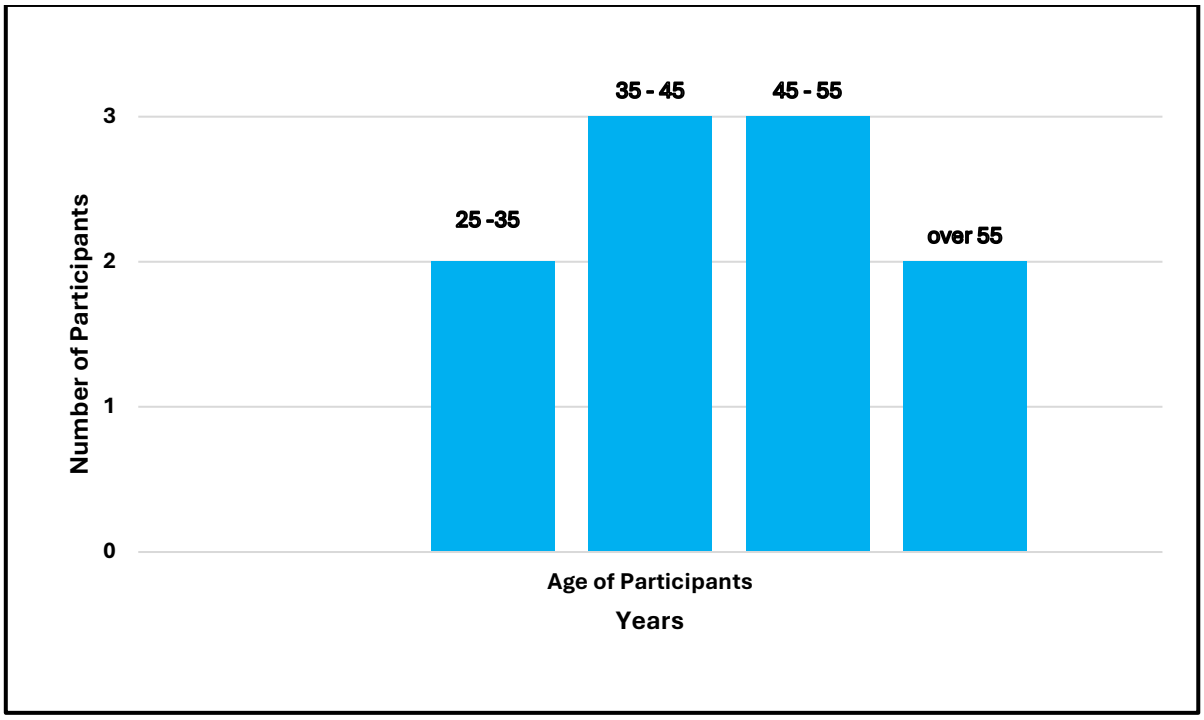

Figure 4.2: Age group of participants

Figure 4.2 presents the age group of the participants that participated in this study involved in WCWDM at the Mantsopa Local Municipality. The age distribution was between 25 – 35 years (2 participants), 36 – 45 years (3 participants), while 46 – 55 years (3 participants) and lastly above 55 years (2 participants). This presents a valuable insight into the potential benefits of having a mix of age groups within the workforce at the Mantsopa Local Municipality. This age distribution spans four different age groups, ensuring a mix of perspectives and experiences (Parsons, 2015). Younger employees (25-35 years) bring fresh ideas and innovative approaches to water management, while older employees (above 55 years) contribute with extensive experience and knowledge in water management (Galia and Zenou, 2013). This assertion may inadvertently stereotype these groups. Although age can influence perspective and capabilities, individual contributions are shaped by a multitude of factors, including education, training, organisational culture and exposure to contemporary practices (Galia and Zenou, 2013). However, with six (6) of employees falling between the 35 – 55 years range, this brings a balance of both experience and knowledge. This age group bridges the gap between the young and the old employees (Galia and Zenou, 2013). The presence of older employees alongside the young

employees, presents an advantage for the promotion of institutional knowledge transfer, through mentoring and training, ensuring that valuable knowledge and practices are passed down and retained within the municipality (Mahadeo, Soobaroyen and Hanuman, 2012).

4.2.3 Participants' Level of Education

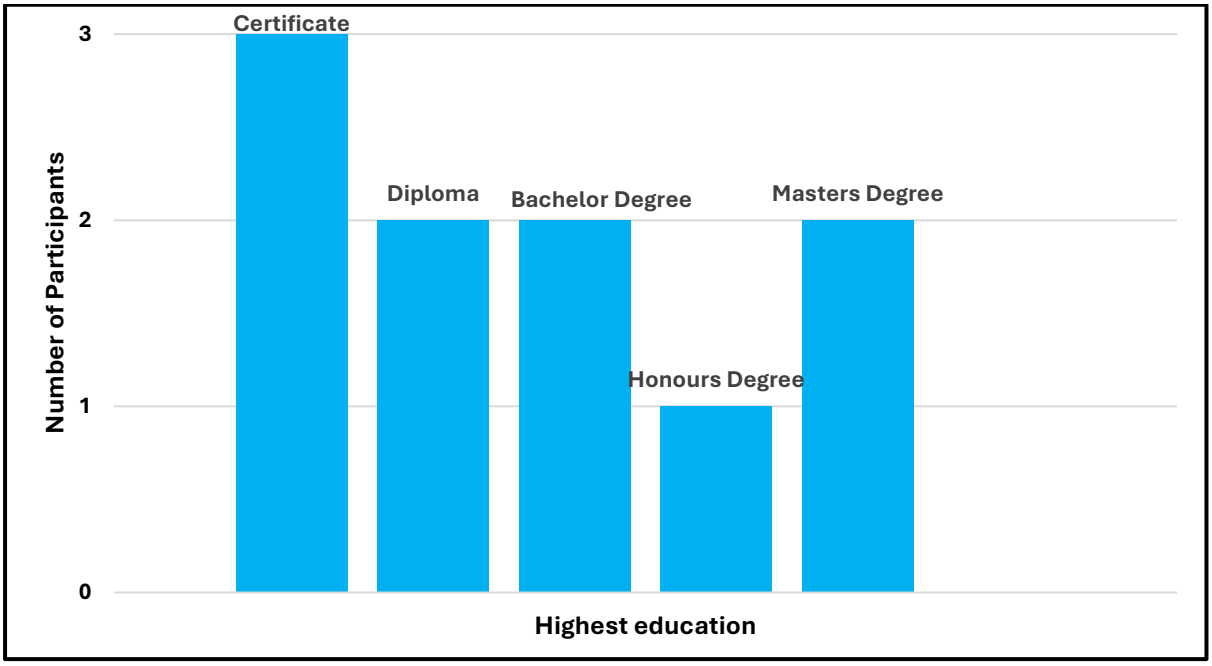

Figure 4.3: Participants' level of education

Figure 4.3 illustrates the highest education level of the participants. Majority of participants hold certificates (3 participants), Diplomas (2 participants), Bachelors degree (2 participants), Masters degree (2 participants) and lastly, Honours degree (1 participant). This variety of educational qualifications ensures a range of perspectives and skills (Galia and Zenou, 2013). The employees with certificates bring practical technical hands-on experience. This ensures that practical solutions are implemented, while higher degrees, Diplomas: in analytical Chemistry and Building & Civil Engineering, Bachelor: in education and Environmental Management, Honours: in integrated water management and Masters degree: Business Administration and Governance & Political Studies, contributes theoretical knowledge and advanced problem-solving skills. However, this assertion overlooks the overlap that often exists between employees with certificates and degrees (Galia and Zenou, 2013). Practical

experience is not limited to employees with lower qualifications and theoretical knowledge can also be found among those with certificates who have undergone specialised training or have gained substantial experience in the field (Ng and Feldman, 2009).

Moreover, while it is logical to expect degrees in Environmental and Integrated water management to enhance water management strategies, it may not always follow that a degree in unrelated fields, such as Education contributes equivalently to WCWDM (Mahadeo et al., 2012). However, continuous professional development is critical to keep all the employees, regardless of their qualifications, up to date with advancements in water management technologies and practices (Allen, Eby, O'Brien and Lentz, 2008).

4.2.4 Number of years worked at the Mantsopa Local Municipality

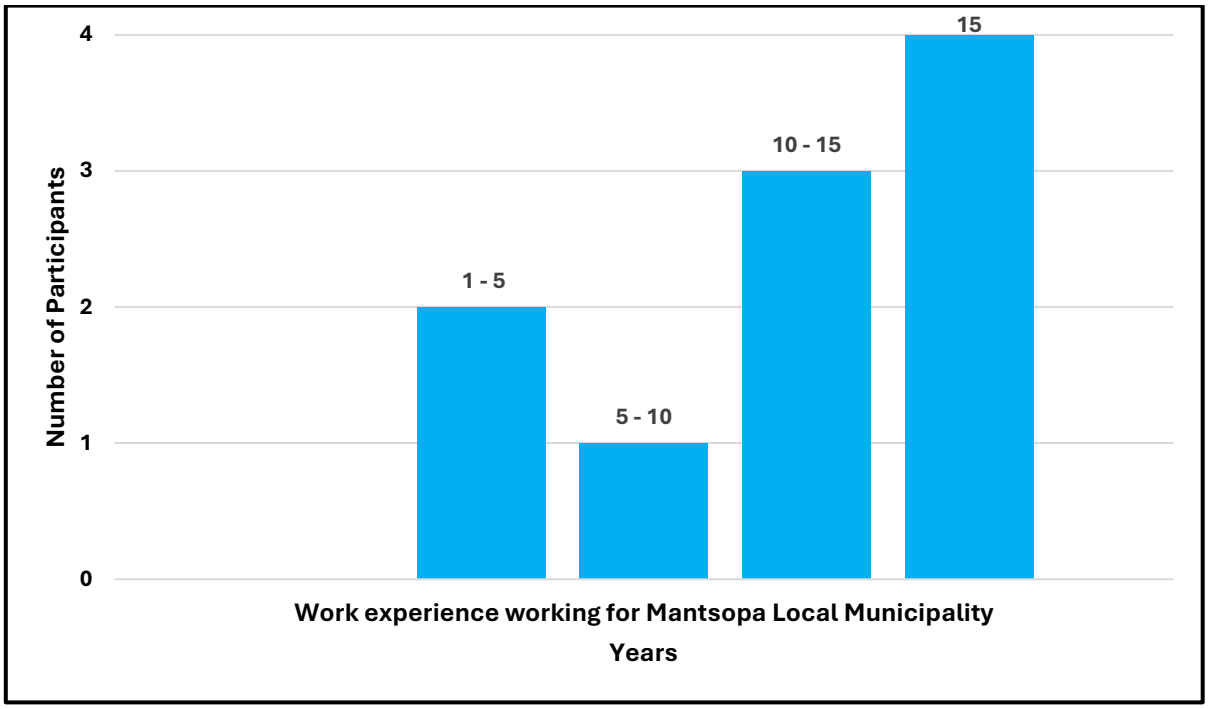

Figure 4.4: Number of years worked at the Mantsopa Local Municipality

Figure 4.4 illustrates the number of years worked at the Mantsopa Local Municipality. This figure indicated that eight (8) of employees have been employed in the municipality for more than five years, while two (2) have been employed there for less than five years. This suggests stable and experienced employees, which can facilitate

mentoring and knowledge transfer. However, this assumes that all long serving employees are equally equipped and willing to mentor other, which may not always be the case (Allen et al., 2008). Effective mentoring depends not only on the experience of employees but also their interpersonal skills, willingness, and organisational support systems in place to foster such relationships (Allen et al., 2004). However, while experienced employees bring institutional knowledge, they may also be resistant to change or less adaptable to innovative approaches compared to newer employees (Parsons, 2015).

4.2.5 Experience in Water Conservation and Water Demand Management

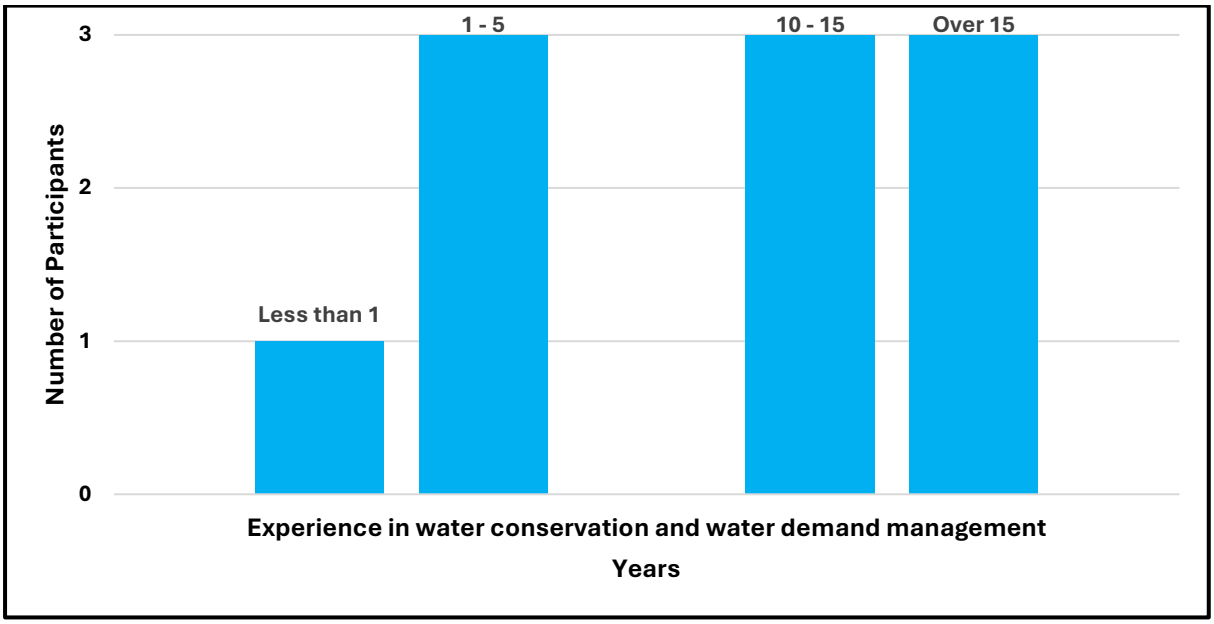

Figure 3.5: Experience in water conservation and water demand management

Figure 4.5 shows that four (4) of participants have less than 5 years of experience in water conservation and water demand management, whereas the majority of the participants, six (6) have experience in water conservation and water demand management. This suggest that the organisation might benefit from having officials with a lot of experience in water conservation and water demand management, by ensuring the transfer of valuable knowledge and practices to newer employees with less than 5 years of experience. However, this assumes that all experienced employees are effective mentors, and that knowledge transfer occurs seamlessly.

Research indicates that successful knowledge transfer requires structured mentoring programs, organisational support, and a culture that encourages collaboration and learning (Sokoh and Okolie, 2021). Lastly, Ng and Feldman (2009) cautions that, experience alone does not guarantee expertise or effectiveness if it is not relevant to the tasks at hand.

4.3 Results from the Participants

The presentation of the findings corresponds with the objectives of the study. A manual thematic method is used to analyse the qualitative data collected from participants. As a result, every objective relates to a different research theme. Some themes have subthemes, or central concepts, that are used to elaborate and explain them further. A summary of qualitative results is in **Table 4.1.**

Table 3.1: Summary of qualitative results

Theme	Subtheme
1. Understanding and knowledge of water conservation and water demand management.	
2. Importance and relevance of ring-fencing water revenue to ensure sustainable water service delivery.	
3. Practices of water conservation and water demand management at the Mantsopa Local Municipality	3.1 Public awareness. 3.2 Public forums and consultations. 3.3 Water restrictions. 3.4 By-laws. 3.5 Prepaid meters. 3.6 Other municipal practices.

4. Challenges for implementing water conservation and water demand management by the Mantsopa Local Municipality.	4.1 Lack of competent personnel and capacity building. 4.2 Illegal connections. 4.3 Budget constraint. 4.4 Lack of maintenance. 4.5 Non-enforcement of by-laws. 4.6 Lack of public engagement. 4.7 Silos within municipal departments. 4.8 Lack of raw water resources. 4.9 Non-payment of water services.
5. Opportunities for implementing water conservation and water demand management by the Mantsopa Local Municipality.	5.1 Capacity building and training. 5.2 Public engagement and education campaigns. 5.3 Infrastructure maintenance. 5.4 Addressing illegal connections. 5.5 Water meters. 5.6 Improved raw water resource management. 5.7 Policy development.

4.3.1 Theme 1: Understanding and knowledge of water conservation and water demand management

This theme is linked to the first objective of the study, which sought to establish how the Mantsopa Local Municipality officials understand WCWDM. Participants were asked to provide their understanding of the WCWDM concept. The national WCWDM strategy identifies fundamental steps to be taken in promoting water use efficiency,

that are aligned with the National Water Act (Act 36 of 1998) (RSA, 1998a; DWAF, 2004b). The Act put emphasis on the effective management of the water resources. The Water Services Act (Act 108 of 1997) requires that water services providers to provide measures to promote water conservation and water demand management (RSA,1997). Therefore, it was important to evaluate how well the Mantsopa Local Municipality officials understood the concept. From the data collected, most participants revealed that the concept of water conservation and water demand management is a broad perspective strategy to addressing challenges of water scarcity and ensuring sustainable service delivery. Other participants highlighted the importance of municipal educational initiatives in promoting water-saving practices and further highlighted the impact of climate change and population growth on water demand. Thus, the efficient use and highlighting minimisation of water loss and the protection of water resources is a key aspect of WCWDM.

Participant 1 emphasised the distinction between the two concepts, noting that while water conservation is about saving water, water demand management focuses on using water efficiently, incorporating strategies and plans that are measurable.

Expanding on this, Participant 2 described water conservation as "*the minimisation of water loss from the treatment plant to the end user*". The participant highlighted the importance of managing water loss to meet demand effectively. This underscores that addressing water loss is key to meeting the demand effectively.

Participant 3 provided a practical example, citing the municipality's WCWDM project, which introduced prepaid meters to address revenue collection challenges. "*This initiative aimed to conserve water due to high water losses within the municipality*". The participant pointed out that "*70-80% of the water is unaccounted for, raising concerns about whether it reaches the end user. The focus, therefore, is on saving water for future use and enhancing revenue collection*". This example provided by the participant, illustrates systematic inefficiencies and the need for targeted interventions.

Participant 4 emphasised the importance of balancing water conservation with demand. The participant stressed the need to save available water while managing consumption to ensure sustainable service delivery, which is crucial for municipalities.

Participant 6 underscored the need for efficient systems to reduce water wastage, particularly in urban areas. The participant highlighted the importance of conservative

systems that minimise unnecessary spillages, aligning water management practices with community needs.

Finally, Participant 7 raised concerns about water scarcity, exacerbated by climate change and population growth. The participant discussed various water-saving methodologies, such as rainwater harvesting and greywater reuse, as well as the importance of educating communities about efficient water use. The participant recommended simple practices like watering plants in the early morning or late afternoon to avoid wastage.

The insights gathered from participants highlight a solid understanding of water conservation (WC) and water demand management (WDM) as critical components of sustainable water resource management. Participant perspectives align on the principle that WC focuses on reducing water loss and preserving resources for future use, while WDM emphasises the efficient utilisation of available water through measurable strategies. This alignment reinforces the definitions provided by Mwiinga et al. (2008:2), who define WC as the “minimisation of water losses or wastage, the care and protection of water resources, and the efficient and effective use of water”, and Matose (2013:63), who defines WDM as the “management of the total quantity of water abstracted from the source of supply using measures to control waste and undue consumption”.

The participants' emphasis on a systematic approach to addressing water loss resonates with Kumwenda’s (2006:28) view that WDM involves “the development and implementation of strategies aimed at influencing demand to achieve efficient and sustainable use of water”. These perspectives collectively underscore the importance of integrating WC and WDM practices into municipal frameworks to enhance the protection and optimal use of water resources.

A recurring theme in the participants’ feedback is the interplay between WCWDM practices and broader socio-environmental challenges such as climate change, population growth, and water scarcity. This is consistent with literature emphasising that sustainable water management must account for external pressures and incorporate adaptive strategies (Pahl-Wostl et al., 2021). The participants’ recognition of strategies such as rainwater harvesting, and greywater reuse demonstrates an awareness of proactive measures municipalities can adopt to mitigate future water

shortages. However, while these suggestions are valuable, the data lacks on the feasibility and cost-effectiveness of these interventions, which are critical for implementation.

Further revelation is that although participants offer valuable theoretical and anecdotal insights, there is limited quantified data to substantiate their claims. For instance, the mention of significant water losses within the municipality is not accompanied by detailed metrics, which would have strengthened these findings. According to Gleick (1998), robust water management strategies require empirical data to identify inefficiencies and measure the impact of proposed interventions.

Moreover, while participants highlight urban challenges, such as high water losses and inefficient systems, rural considerations are notably absent. This omission risks neglecting the unique water management needs of rural communities, which often face distinct challenges such as limited infrastructure and resource accessibility (Makaya et al., 2020).

As Kariuki and Reddy (2017) argue, effective water management necessitates strong institutional frameworks and governance mechanisms to support the implementation of sustainable practices. The participants' focus on technical and community-based solutions could be expanded to include discussions on regulatory frameworks, enforcement mechanisms, and funding models for WCWDM initiatives.

The participants' perspectives provide a robust conceptual foundation for understanding WCWDM and align with established definitions in the literature. Their emphasis on sustainable practices and adaptive strategies is commendable. However, the data could be strengthened through greater integration of empirical evidence and consideration of diverse municipal contexts.

4.3.2 Theme 2: Importance and relevance of ring-fencing water revenue to ensure sustainable water service delivery

This theme aimed to examine how the concept of ring-fencing water sales revenue in municipalities can contribute to ensuring a consistent and reliable water supply for communities, thereby promoting sustainable water management practices and enhancing the financial stability of municipal water services. Ruiters and Amadi-

Echendu (2022) argue that achieving effective and sustainable water supply systems, with acceptable levels of assurance, quality, and accessibility, requires substantial financial resources for capital investment, operation, maintenance, and distribution. While there is support for ring-fencing water sales revenue as a strategy to improve financial management and sustainability, participants argued the necessity for accurate metering, robust internal controls and sufficient financial resources to ensure the successful implementation of this approach within the municipality.

The discussions surrounding ring-fencing for water sales revenue in the municipality reflect a blend of concern and optimism from the participants. Participant 4 pointed out that "*the municipality is not currently practicing ring-fencing for water sales, as evidenced by the significant mismatch between revenue collected and the associated expenditures*". This disparity raises doubts about the feasibility of implementing ring-fencing without resolving these issues. The participant emphasised that "*the success of ring-fencing would largely depend on the proper functioning of municipal meters, which would allow for accurate comparisons between revenue and expenses. However, the lack of monitoring over budget policies and metering further complicates efforts to establish a sustainable ring-fencing approach*".

Building on this, Participant 3 highlighted that "*the municipality relies heavily on provincial grants, which are allocated for specific service delivery purposes and cannot be redirected to other needs*. *In an attempt to explore new financial strategies, the municipality introduced prepaid meters to assess their impact on water management without disrupting service delivery. The initiative aimed to uncover financial benefits and enhance the monitoring of water consumption. Additionally, the program sought to encourage water conservation by making consumers more aware of their usage through the prepaid system*".

Despite these efforts, the majority of participants expressed optimism about the potential advantages of ring-fencing. Participant 5 argued that "*implementing ring-fencing would allow the municipality to allocate a dedicated budget for water conservation and demand management programs. This could also extend to educational initiatives targeting the community*". However, they cautioned that "*the effectiveness of ring-fencing would rely heavily on the presence of strong internal controls to ensure that revenue generated from water sales is appropriately used for*

water management purposes. This financial stability would allow the municipality to secure necessary resources for infrastructure maintenance, including the purchase of water treatment chemicals and materials for repairing leaks".

Participant 6 further elaborated on the benefits of ring-fencing, stating that it would support the implementation of water management systems like prepaid meters, allowing for more precise control over water usage from abstraction to consumption. However, they acknowledged that the municipality is not yet practicing ring-fencing, as evidenced by the misalignment between water sales revenue and actual consumption. "*The current revenue is insufficient to cover the full costs of water management, including purification, distribution, and infrastructure upkeep*".

While acknowledging the potential of ring-fencing, Participant 7 warned that its implementation could be challenging due to the municipality's financial constraints. The participant emphasised that "*successful implementation would require sufficient capital to invest in water conservation and demand management initiatives*". Despite these obstacles, Participant 7 still expressed support for the concept of ring-fencing as a long-term solution.

Lastly, Participant 8 echoed the benefits of ring-fencing, suggesting that it would enable the municipality to take a more progressive approach to water management, ensuring a consistent and reliable water supply. The participant also emphasised that "*ring-fencing would empower the municipal water division to sustain its operations, particularly in procuring essential water treatment chemicals and maintaining water infrastructure. This, in turn, would play a critical role in ensuring the municipality's ability to maintain continuous service delivery*".

The participants' insights into the potential benefits and challenges of ring-fencing water sales in the municipality provide a nuanced understanding of its financial implications. They highlighted the absence of ring-fencing practices, pointing out a significant gap between the revenue generated from water sales and the costs associated with water management. This discrepancy underscores a critical challenge for the municipality, the reliance on provincial grants. These grants are often earmarked for specific service delivery initiatives, limiting the municipality's financial flexibility and its ability to allocate funds to areas such as WCWDM.

This challenge is consistent with broader findings in water governance literature, where financial constraints are frequently identified as a barrier to effective water management (Glasser and Wright, 2020). In the absence of ring-fencing, municipalities may struggle to secure the necessary capital for long-term water infrastructure and management strategies, potentially jeopardising the sustainability of water supply service delivery (Agrawal, De Tommasi and Lyons, 2022). Ring-fencing, or setting aside a portion of the revenue from water sales for dedicated purposes, is viewed as a promising solution to this issue. By ensuring that funds generated from water sales are specifically allocated to WCWDM initiatives, the municipality could improve its financial stability and secure the resources needed for effective water management (Agrawal et al., 2022).

However, while ring-fencing presents clear advantages, participants also noted its potential challenges. For instance, the municipality's financial flexibility could be further constrained by the need to adhere to rigid budgetary allocations. In the South African context, where municipalities face diverse and often urgent needs across various service delivery sectors, strict allocation of funds to one area could lead to imbalances in addressing other essential services (Akinboade et al.,2014). Therefore, careful consideration would be required to ensure that ring-fencing water sales does not inadvertently limit the municipality's ability to respond to other pressing needs.

Furthermore, the successful implementation of ring-fencing requires a well-established financial and governance framework to monitor and manage these funds effectively (Thusi and Selepe, 2023). According to Thusi and Selepe (2023), water management initiatives require not only financial resources but also transparent governance mechanisms to ensure that funds are spent efficiently. The municipality would need to implement robust financial controls and oversight to ensure that ring-fenced funds are used exclusively for water-related initiatives, without diversion to other projects. This is particularly important in light of the often limited institutional capacity within municipalities to manage large-scale water conservation and demand management projects (Makaya et al., 2020).

The participants' insights underscore the potential benefits of ring-fencing water sales as a means to secure dedicated funding for WCWDM initiatives. However, the feasibility of this approach is contingent upon overcoming financial constraints,

ensuring that ring-fencing does not limit overall budgetary flexibility and implementing strong governance and financial oversight mechanisms.

4.3.3 Theme 3: Practices of water conservation and water demand management at the Mantsopa Local Municipality

The theme practices of water conservation and water demand management at the Mantsopa Local Municipality, covers the approaches that the municipality employs to manage and conserve water resources. This includes the measures taken to reduce water consumption, improve the efficiency of water use, ensure sustainable and reliable water supply, and address the challenges related to water scarcity. The theme also explores how the municipality engages with the community, implements policies, and utilises technologies, such as metering systems, to promote water conservation and demand management within the local community. The participants have highlighted that the municipality utilises various approaches to foster participation and collaboration with the community for water conservation and demand management. The following approaches were cited by the majority of the participants.

4.3.3.1 Public awareness

Participant 3 reflected on the municipality's approach to installing prepaid water meters, recalling the early stages of the project in 2019. The participant highlighted the importance of community involvement, noting that "*the municipality could not simply enter people's properties and replace existing meters without first establishing a proper process. To facilitate this, the municipality organised public hearings and community meetings to engage residents, ensuring their participation and understanding of the project*".

Participant 6 emphasised the municipality's efforts to promote water conservation through continuous community engagement. The participant explained that "*the Speaker's office makes public announcements and participates in community meetings, especially during the dry season, to encourage water-saving practices. This ongoing engagement has helped the community gradually adopt a culture of water conservation. While some residents may occasionally overlook minor issues like a*

leaking pipe, many others, mindful of the need to conserve water, actively report such problems through the hotline system".

Participant 7 further supported the importance of community education, discussing the role of the municipality's environmental awareness and educational program. "*This program addresses various topics, including water usage, and serves as a platform for encouraging the community to save water. Through this initiative, the municipality can engage directly with residents on important water-related issues, fostering greater awareness and responsibility in water conservation*".

4.3.3.2 Public forums and consultations

Participant 3 discussed the municipality's efforts to keep the community informed through the Mayoral imbizo, a platform where all municipal services are presented and scrutinised by the public. "*This includes detailed reporting on water services, where the municipality communicates its expenditure, water consumption expectations, and projected revenue. This platform allows for transparency and encourages the community to engage with the municipality on water usage*".

Additionally, Participant 3 mentioned the importance of the Integrated Development Plan (IDP) rotational meetings held across the municipality's towns. "*These meetings serve as an opportunity to educate the community, emphasising the importance of water conservation and encouraging a culture of saving water*".

Participant 5 noted the municipality's regular ward meetings, facilitated by ward councillors. "*These meetings provide a vital platform for raising awareness about water conservation, especially during dry seasons when rainfall is scarce, and the municipality faces drought conditions. Councillors play a key role in communicating the importance of water-saving practices to residents during these critical periods*".

Participant 6 further elaborated on the role of councillors as the primary link between the municipality and the community. The participant cited an example involving the frequent bursts of the main pipeline from the Genoa Water Purification Plant. "*Councillors take proactive measures by informing the community about the pipeline's condition during ward meetings. This communication ensures that residents are aware of potential issues before they occur, rather than waiting for the pipeline to fail again.*

This approach helps the community stay informed and prepared for water service interruptions".

4.3.3.3 Water restrictions

Participant 3 emphasised the municipality's efforts to manage water levels in its reservoirs to maintain an adequate supply amid ongoing water misuse. The participant highlighted the goal of ensuring continuous water availability throughout the day, but due to the scarcity of water, restrictions have been put in place in an attempt to control and limit consumption. "*For example, in areas such as Tweespruit, water is supplied from 6 a.m. to 12 p.m., and again from 6 p.m. to around 9 or 10 p.m. These restrictions are an essential attempt to ensure the integrity of the system. It is one of the water demand managements measures the municipality is undertaking".*

Participant 6 discussed the legal framework guiding water restrictions, noting that these restrictions are enforced based on existing by-laws. While some of these by-laws have been brought before the council for formal adoption, others continue to be enforced even without formal approval. "*To conserve limited resources, the municipality rations water supply to different areas of the community for set hours each day. However, due to capacity constraints, the water restrictions are not always implemented as planned, which presents challenges in effective water management*."

Participant 7 added that the municipality follows a valve management schedule with specific time frames for shutting off water to various parts of the towns. "*This scheduling is part of the broader effort to manage water distribution and ensure equitable access despite the constraints on water supply.*"

4.3.3.4 By-laws

Participant 3 outlined the process of addressing water service challenges that stem from all water users misuse or mismanagement. "*We advised the council that the administration had identified the need to incorporate specific restrictions into municipal bylaws and policies to regulate consumer behaviour. These restrictions aim to address the root causes of water service issues and promote responsible water usage*".

Once the proposed measures were developed, Participant 3 emphasised the importance of community involvement through a public participation process. "*This step ensures that the community has a voice in decisions that directly affect them. It also provides an opportunity to inform and educate residents about the details of the proposed bylaws and policies, fostering understanding and support*". After receiving input and approval from the community, "*the administration returns to the council to finalise the adoption of the proposed restrictions into law*". Participant 3 further noted that these measures only become law after formal adoption by the council, highlighting the procedural steps necessary for implementing such restrictions and bylaws within the municipality.

4.3.3.5 Prepaid meters

Participant 3 highlighted the ongoing efforts of the municipality to address water losses that are unaccounted for, which have been a recurring issue in their financial statements year after year. "*In response, the municipality passed a resolution in 2019 to install prepaid water meters. The primary objective of this initiative is to reduce water wastage and losses*". Participant 3 emphasised that people tend to be more mindful of their water usage when they are required to pay for it, which in turn promotes water conservation and water use efficiency. "*This prepaid meter installation project is ongoing and has already been implemented in several areas, including Ladybrand, portions of Manyatseng, Hobhouse, and part of Tweespruit. The municipality plans to expand the project to cover the entire Excelsior and complete installations in all towns by 2025, to have prepaid water meters in every household*".

Participant 6 argued that "*the installation of prepaid meters in select areas across five towns, including Hobhouse and Ladybrand, has led to significant cost savings. These savings demonstrate the effectiveness of the initiative in managing water resources more efficiently and reducing unnecessary water expenditure*".

4.3.3.6 Other Municipal practices

Participant 6 highlighted the municipality's use of a cellphone hotline service to quickly address community complaints related to leaking pipes and toilets, sewage blockages,

and manhole overflows. In addition to this, a dedicated maintenance team is always on standby to respond to these complaints and carry out routine preventative maintenance, ensuring timely repairs and upkeep.

Participant 6 also discussed past initiatives designed to promote water conservation, such as the Water Leakage Soldiers program. "*This program was aimed to train consumers in leak detection and repair, and the trained individuals would then help fix leaks within the community*". Another initiative included an internship program that provided technical training to enhance the municipality's capacity for water management. However, both programs were discontinued due to funding constraints.

Participant 4 noted an initiative from the municipality that dedicates the month of September to water conservation efforts. During this time, the municipality distributes brochures in schools, workplaces, and through councillors, raising awareness about water-saving practices.

Participant 7 mentioned the municipality's efforts to reduce water losses by detecting leaks within its infrastructure. "*The municipality is also working to refurbish its aging infrastructure to improve water retention and prevent losses. Additionally, despite the responsibility for fixing leaks within individual yards typically falling on the community, the municipality has stepped in to assist in these repairs, recognising that water loss is a collective problem. Furthermore, in collaboration with other stakeholders, the municipality has provided schools with water tankers for gardening purposes, encouraging the use of harvested rainwater as part of their conservation efforts*."

The municipality's emphasis on community engagement in water conservation initiatives demonstrates a commitment to fostering public involvement in managing water supply service delivery. Their efforts to install prepaid meters, which require public hearings and community consultations, exemplify a proactive approach to ensuring that communities are well-informed about the importance of water conservation and the benefits of the new system. This is consistent with literature highlighting the role of community engagement in successful water management, as it ensures that local communities are not only aware of but also invested in the sustainable use of water resources (SERI, 2020).

The municipality's use of platforms such as the Mayoral Imbizo and IDP rotational meetings to promote water conservation efforts further strengthens this engagement.

These meetings provide a forum for dialogue, ensuring that residents have a voice in decision-making processes and are kept informed about ongoing initiatives. According to Winmore et al. (2016) participatory governance in water management enhances community buy-in, making conservation efforts more likely to succeed. These platforms serve to build trust and transparency between the municipality and the public, which is essential for the long-term success of water management strategies.

However, the municipality faces significant challenges in monitoring the effectiveness of water restrictions. While restrictions have been implemented to address the ongoing water scarcity, they have not been officially approved and monitoring mechanisms are hindered by capacity constraints. This lack of formal approval and inadequate monitoring systems are problematic, as the absence of official mandates and effective oversight can undermine the enforcement of restrictions. According to Adom and Simatele (2021) successful water management requires both clear policies and the institutional capacity to implement them. Without these, the municipality may struggle to control water consumption patterns effectively, risking continued overuse of water resources.

Moreover, the municipality's collaborative initiatives with stakeholders, such as providing schools with water tankers and promoting the use of harvested rainwater for gardening, are commendable and reflect an innovative approach to water conservation. These initiatives not only contribute to immediate water savings but also encourage sustainable practices within the community, which is crucial for long-term water management. As Bischoff-Mattson et al. (2020) suggest, integrating rainwater harvesting and local-level conservation practices into broader water management strategies can significantly enhance the sustainability of water resources. However, for these initiatives to have a lasting impact, the municipality will need to ensure that they are adequately resourced and maintained, as short-term efforts can sometimes be undermined by lack of follow-up support (SAHRC, 2014).

The municipality's focus on community engagement, the use of public forums, and its collaborative efforts with stakeholders are positive steps towards fostering sustainable water management. However, challenges remain in terms of monitoring and enforcing water restrictions due to capacity limitations.

4.3.4 Theme 4: Challenges for implementing water conservation and water demand management by the Mantsopa Local Municipality

Theme 4 is linked to the second objective of the study. This objective sought to establish the key challenges preventing the municipality from practicing water conservation and water demand to ensure that efficient and sustainable water supply. Thus, the participants were asked for their opinions on what they think are the critical key factors of inefficient practices of water conservation within the municipality. Nine (9) main key challenges emerged from the participant's responses. These challenges were: lack of competent personnel and capacity building, illegal connections, budget constraints, lack of maintenance, non-enforcement of bylaws, lack of public engagement, silos with municipal departments, lack of raw water resources, and non-payments of water services. The obtained response from the participants now follows.

4.3.4.1 Lack of competent personnel and capacity building

Participant 3 observed that the municipality faces a significant challenge due to the lack of qualified personnel to manage water issues effectively. "*This shortage hampers the correct implementation of water conservation and demand management measures, creating a considerable gap that adversely affects the municipality. As a result, the municipality often finds itself in a position where it must outsource essential water-related services*".

Participant 5 argued that "*there is an urgent need to capacitate current municipal employees. It is crucial to have skilled workers at water treatment plants who are well-trained and knowledgeable about cleaning water to provide communities with safe and drinkable water that is free from bacteria*".

Participant 6 also noted that many individuals have gained their skills through work experience rather than formal training, further highlighting the inadequacies in the training and qualification of personnel.

Participant 7 added that "*within the municipality, there is a noticeable shortage of human resources, making it difficult to ensure that the water sector has the necessary professionals to effectively manage and operate the water services department. While*

competent professionals exist, the failure to recruit an adequate number leads to challenges in responding effectively to water management issues".

4.3.4.2 Illegal connections

Participant 3 argued that illegal connections pose a significant challenge to the municipality. Despite this, "*there is a policy in the revenue division that specifically addresses cutoffs and penalties for any instances of illegal water usage*".

Participant 5 added that, unfortunately, the municipality currently lacks the systems necessary to effectively manage and address illegal water use.

4.3.4.3 Budget constraints

Participant 3 argued that the municipality's limited budget allocated for water conservation and issues related to safe, efficient water use results in a reactive approach. This means that the municipality only responds to water issues as they arise, rather than proactively addressing them in advance.

Participant 5 observed that another significant challenge exacerbating the situation is the insufficient budget to recruit qualified water professionals. This shortage of resources hampers the municipality's ability to prioritise and effectively manage water conservation and demand management, leaving it unable to adequately tackle the challenges of NRW losses.

4.3.4.4 Lack of maintenance

Participant 5 argued that "*the municipality's water infrastructure is deteriorating because of a lack of maintenance. For example, many boreholes are not functioning due to insufficient upkeep. It is common to find that only three out of ten boreholes are working properly, and in the worst cases, only two may be operational*".

4.3.4.5 Non-enforcement of by-laws

Participant 5 noted that the municipal bylaws are not being implemented due to the municipality's lack of capacity. Specifically, there are no peace officers available to monitor and enforce these bylaws.

Participant 6 argued that while the bylaws exist, they are not implemented as expected. "*The absence of officials on the ground to enforce these regulations undermines their effectiveness. Simply having bylaws in place is insufficient if there is no mechanism to enforce them*".

4.3.4.6 Lack of public engagement

Participant 6 argued that there exists a significant gap between the community and the municipality, which often results in the community abusing water resources. This gap is largely due to the lack of public engagement from the municipality, which has led to communities being uninformed about the conservation practices that the municipality is proposing or implementing.

Participant 7 observed that "*the absence of public engagement and educational awareness regarding water management and conservation practices has left certain sections of the community unaware of the importance of saving water. For instance, some community members continue to water their lawns during the day, demonstrating a lack of understanding of proper water management. There is a pressing need for increased awareness and education efforts in this area*".

4.3.4.7 Silos within municipal departments

Participant 6 highlighted the significant challenge posed by municipal departments operating in silos. In particular, the participant emphasised the need for collaboration between the water and sewage departments. This cooperation is essential for both departments to effectively detect and address existing challenges. For instance, "*there are instances where the sewage night flow is high, but this critical information is not communicated to the water department for further investigation*". According to Participant 6, conservation efforts must begin with improved communication and collaboration between these departments.

4.3.4.8 Lack of raw water resources

Participant 6 highlighted a significant challenge faced by the municipality: the lack of reserve capacity for raw water. The participant pointed out that "*the rivers surrounding the municipality do not have any synergy or interlinking systems in place to ensure a consistent supply of water. This issue becomes particularly noticeable during the dry season when rainfall is limited. Consequently, the municipality is compelled to impose water restrictions due to the insufficient availability of source water*".

4.3.4.9 Non-payments of water services

Participant 4 observed a notable challenge in water conservation efforts, stating that some households do not save water because they do not pay for water services, believing instead that water is a gift from God. "*This belief complicates the municipality's ability to identify which households are registered with the indigent register, hindering the enforcement of the Credit Control and Debt Policy. In informal settlements, residents, especially those in extensions, primarily access their water through common public taps or from a shared water tanker. This situation further discourages them from conserving water, as they do not bear the financial responsibility for its use*".

The municipality faces significant challenges in its water management and conservation efforts, many of which are rooted in systemic and operational issues. A primary concern is the lack of qualified personnel, which limits the municipality's capacity to address water-related problems effectively. This aligns with findings from Nama, Daweti, Lourens and Chikukwa (2022), who underscores that skilled human resources are critical for implementing and maintaining sustainable water management practices. Without adequately trained staff, the municipality may struggle to develop and enforce policies, conduct repairs, and engage in proactive planning.

Illegal water connections present another critical challenge, despite existing policies aimed at curbing unauthorised usage. The persistence of this challenge suggests gaps in enforcement and monitoring, which are often exacerbated by limited institutional capacity (Adom and Simatele, 2024). According to Adom and Simatele (2021), municipalities must not only establish policies but also ensure they are supported by

robust enforcement mechanisms to deter illegal activities effectively. The failure to address illegal connections undermines water conservation efforts and places additional strain on already scarce resources.

The lack of infrastructure maintenance further compounds the municipality's water management challenges. Poorly maintained infrastructure can lead to leaks, inefficiencies, and higher rates of water loss, which directly impact service delivery. Fan et al. (2021) highlights that aging or neglected water infrastructure is a major barrier to effective water management, particularly in resource-constrained municipalities. Addressing this issue requires consistent investment in maintenance and upgrading systems to reduce water wastage and improve reliability (Ruiters and Amadi-Echendu, 2022).

Another critical challenge is the seasonal unavailability of water resources, particularly during the winter months when rainfall is limited. This scarcity disrupts service delivery and increases the municipality's reliance on alternative sources, which are often costly and unsustainable. According to Savenije and van der Zaag (2002), the seasonal variability of water resources necessitates the adoption of adaptive management strategies, such as rainwater harvesting, improved storage systems, and demand management practices. The lack of such strategies in the municipality indicates a missed opportunity to mitigate the effects of seasonal water shortages.

The municipality's water management challenges, including a lack of qualified personnel, illegal connections, inadequate infrastructure maintenance, and seasonal water scarcity, are interrelated and require a comprehensive approach to address.

4.3.5 Theme 5: Opportunities for improved water conservation and water demand management by the Mantsopa Local Municipality

Participants also provided opportunities that the municipality may consider for promoting water conservation and water demand management. This is linked to the study's second objective, which sought to provide opportunities for the municipality to implement water conservation and water demand management. The participants cited the following opportunities.

4.3.5.1 Capacity building and training

Participant 3 highlighted the importance of the Municipal Staff Regulation Act of 2021, a national document that mandates municipalities to fill positions with individuals who possess the requisite qualifications. This regulation aims to ensure that municipalities employ qualified professionals who have a thorough understanding of their roles, facilitating the provision of efficient and effective services.

In line with this, Participant 8 recommended that the maintenance team undergo trade testing, and that process controllers should be formally registered. The participant emphasised that the priority should be on enrolling these essential workers in short courses to advance their skills. Additionally, it would be essential to evaluate how skill development opportunities are allocated to employees.

Participant 6 noted that providing formal training for technical officials is crucial for enhancing their professional development. The participant believes this approach would effectively combine theoretical knowledge with academic knowledge, enabling officials to address municipal water management challenges more effectively.

4.3.5.2 Public engagement and education campaigns

Participant 3 highlighted the importance of communicating with communities during consultation meetings, emphasising that water is a scarce resource. The participant noted the necessity of launching additional campaigns aimed at both communities and schools to promote water conservation. These campaigns are intended to help prevent further misuse of water services and encourage responsible usage.

Participant 8 recommended enhancing community participation, as they frequently receive numerous complaints from each ward, particularly from high-lying areas that are predominantly informal settlements. These complaints often revolve around water shortages and the lack of visibility of municipal officials to assist.

Participant 6 further noted that the municipality should facilitate consumer workshops to raise awareness about water consumption. These workshops would serve as a platform to educate the community on efficient water usage practices during both peak and off-peak hours.

In addition, Participant 5 recommended educating communities on critical issues such as global warming and the scarcity of water resources, highlighting that water conservation is the most effective approach to prevent water misuse.

4.3.5.3 Infrastructure maintenance

Participant 3 observed that the municipality receives annual grants for the implementation of water service projects. The participant highlighted the importance of prioritising the maintenance of infrastructure, particularly the main pipes from water treatment plants, which are old and frequently burst. Additionally, Participant 3 pointed out that the pump stations need upgrades, stating that addressing these issues will help accommodate growing communities and alleviate pressure on the existing water infrastructure.

In line with this, Participant 6 recommended that dams must be designed with sufficient capacity to meet the required water storage needs. The participants also suggested that the purification plant should be upgraded to include modern technology and increased pumping capacity to cater to increased demand and support economic activities.

4.3.5.4 Addressing illegal connections

Participant 3 recommended that the municipality should implement existing policies that address and regulate the mismanagement and misuse of services, including illegal connections, and ensure their enforcement. The participant highlighted that the revenue policy outlines measures for addressing illegal connections, which include disconnections and penalties for offenders.

Participant 6 observed that illegal water use occurs in both formal residences and informal settlements. The participant emphasised the necessity of installing prepaid or conventional meters in formal residences to monitor water consumption effectively. In contrast, the participant suggested that in informal settlements, communal taps or water tankers could be provided to prevent illegal connections.

4.3.5.5 Water meters

Participant 3 highlighted that the municipality is embarking on a project to install prepaid meters to address NRW. The participant pointed out that there is also an opportunity for the municipality to incorporate smart meters, which will be able to detect leaks and identify their exact locations. This technology can further assist in combating illegal connections, as these smart devices can identify where there is misuse of water.

Building on this, Participant 6 noted the importance of identifying leaks, particularly in the main bulk water lines. The participant emphasised that the municipality should invest in leak detection equipment to ensure timely identification and response to leaks. This investment could be integrated with a centralised telemetry system for the water division.

Additionally, Participant 5 recommended that zonal smart meters should be installed to accurately monitor water consumption in each zone. This would enable the comparison of water usage across different areas, allowing for prompt action in response to significant variations. Implementing this system could also enhance revenue collection for the municipality.

4.3.5.6 Improved raw water resource management

Participant 3 recommended conducting a study to determine the availability of raw water resources, noting that the growing population has put a strain on the water infrastructure. The participant expressed that this study would assist in determining future water demand.

Building on this, Participant 9 highlighted the need to explore alternative sources, such as boreholes, where possible. The participant emphasised the necessity of constructing new water infrastructure, as the municipality currently lacks adequate facilities. Participant 9 underscored the importance of managing the limited resources effectively.

Participant 8 observed that there are plans to construct three additional reservoirs to alleviate the water supply problem, particularly in high-lying areas that struggle to receive adequate water due to high demand within the low laying areas communities.

Furthermore, Participant 6 highlighted that it is essential to expand reservoir capacities to meet the needs of growing communities. They pointed out that while an additional 20,000 households have been constructed, the number of water reservoirs has remained unchanged despite the increased demand. Participant 6 stressed that the expansion of water storage capacity must align with the development of new sites and the increased availability of raw water resources.

Lastly, Participant 10 recommended that a future water demand analysis be conducted, considering scenarios of peak and off-peak water usage while incorporating population growth rates. The participant suggested utilising municipal population statistics and spatial planning to ensure accurate forecasting and planning.

4.3.5.7 Policy development

Participant 6 recommended that a policy should be developed to address seasonal water consumption patterns, particularly during the summer and winter periods, as well as during times of water use restrictions. The participant emphasised that public awareness of this policy is essential to ensure effective implementation with community support. The proposed policy could encompass measures such as valve restrictions, designated restriction zones, and strategies to mitigate water loss.

In addition, Participant 2 argued that a policy needs to be developed regarding road construction. The participant noted that the design of roads should allow for water flow through channels, serving as conduits to direct water to raw water reserves.

The municipality's recognition of the need for capacity building and training reflects a progressive approach to improving water management and service delivery. The adoption of the Municipal Staff Regulation Act of 2021 underscores this commitment, as it aims to ensure that qualified professionals are employed to strengthen municipal operations. This aligns with literature emphasising the importance of skilled personnel in enhancing water governance. For instance, Ng and Feldman (2009) highlight that capacity building and training are foundational for effective water resource

management, enabling municipalities to implement sustainable practices and respond to emerging challenges.

The municipality's focus on installing prepaid meters is a practical step towards addressing NRW and improving revenue collection. By reducing water losses and ensuring accurate billing, prepaid meters can mitigate financial shortfalls and enhance the municipality's ability to invest in water infrastructure. Ncube and Taigbenu (2019) supports this approach, noting that technological interventions, such as metering systems, play a critical role in reducing NRW and promoting efficient water use. However, the success of this initiative depends on community acceptance and engagement, as public resistance to prepaid systems can hinder their effectiveness Bazaanah and Litabe (2023).

Policy development is another area of focus for the municipality, particularly in addressing water consumption patterns and seasonal fluctuations. Seasonal variability in water availability, especially during periods of low rainfall, poses significant challenges to consistent service delivery. Savenije and Van der Zaag (2002) argue that adaptive policy frameworks are essential for managing such fluctuations, as they enable municipalities to balance supply and demand more effectively. Developing robust policies that incorporate demand management strategies, such as water restrictions and incentives for conservation, can help the municipality mitigate the impacts of seasonal water shortages.

Despite these positive steps, challenges remain in the implementation and enforcement of these initiatives. The successful adoption of capacity-building programs, prepaid meters, and adaptive policies requires strong governance, adequate funding, and sustained political will. According to Ruiters and Amandi-Echendu (2022), resource-constrained municipalities often face difficulties in maintaining momentum for long-term reforms. To address these challenges, the municipality should prioritise stakeholder engagement, secure funding for its initiatives, and establish clear accountability mechanisms to ensure that policies and interventions are effectively implemented.

The municipality's efforts to improve water management through capacity building, technological interventions, and policy development demonstrate a commitment to addressing its challenges.

4.4 Conclusion

This chapter presented and expanded on the findings emanating from the interviews that were conducted to address the research objectives of the study to assess the Mantsopa Local Municipality water conservation efforts and effective management of water demand to ensure sustainable water supply. The results gathered through semi-structured interviews were presented, discussed, and analysed.

The insights gathered from the participants provided a rich understanding of the critical roles of WC and WDM in effective water management. There is a consensus among participants highlighting the necessity of a systematic approach to combat water loss, especially in the context of addressing climate change, population growth, and water scarcity. Moreover, the municipality has shown commitment to engagement in water conservation initiatives with residents through public consultation on platforms such as Mayoral Imbizo and the IDP. However, the municipality faces challenges of qualified personnel to deal with issues of illegal connections, infrastructure maintenance, and insufficient water resources. Recognising these challenges, the municipality focuses on capacity building and adhering to the Municipal Staff Regulation Act 2021. By adhering to this Act, the municipality aims to significantly improve service delivery.

The next chapter (Chapter 5) concludes the study and provides recommendations for improved water conservation and water demand management in the Mantsopa Local Municipality.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter aims to cover the results of the study. The chapter is represented in six sections. The first section contributes to the study summary. The second section discusses the findings from the literature, followed by the third section which discusses the primary research findings. Furthermore, the recommendations of the whole study are then discussed. This chapter further discusses the area of future research, followed by the conclusion.

5.2 Summary

The previous chapter presented and discussed the results of the study. This chapter concludes the study, giving recommendations and identifying areas of future research. It is important to remember that this study aimed to delve into how the implementation of WCWDM strategies could enhance the Mantsopa Local Municipality's capacity to improve its service delivery responsibilities effectively.

To achieve this aim, the study was set to fulfil the two main objectives. The first objective was to understand how water conservation and water demand management are understood by participating Mantsopa Local Municipality officials. While, the second objective, sought to identify challenges and opportunities for implementing water conservation and water demand management.

To achieve the aim and outlined objectives, the study adopted a qualitative approach for data collection, analysis, and discussion. The qualitative data were collected through semi-structured interviews, in which participants were purposively selected. A saturation was achieved with 10 municipal employees with diverse designations, qualifications, ages, and experience levels, who participated in this study. The thematic approach was then used to analyse the qualitative data manually. Microsoft Excel program was used to plot graphs of qualitative data (Findings).

5.3 Results from the Literature Review

The findings from the literature review revealed that effective and sustainable water management practices are paramount to ensuring that the objectives of the local government are achieved. Furthermore, different literature reviews agree and recognise that the role of water is pivotal to economic growth, poverty eradication, and reduction of inequality within the local government sphere. Meissner et al. (2019) argue that organisations need a paradigm shift towards sustainable water resource management and water security. This includes the implementation of robust water conservation and water demand management practices (SALGA, 2008), which are designed to promote the culture of water conservation and water demand management amongst all water users. The literature also outlines a wide variety of water conservation and water demand management approaches that are critical to effectively managing and conserving water resources. These approaches include technical interventions, financial interventions, institutional measures, and behavioural change (Rabe et al., 2012).

Wegelin and Jacobs (2013) present a comprehensive argument highlighting the multifaceted challenges of implementing WCWDM. Their assertion that there is no "one-size-fits-all" solution resonates with the complex socio-economic and political realities of water management in diverse municipalities. For instance, resource constraints, governance inefficiencies, and a lack of stakeholder alignment often exacerbate water management challenges (Akhmouch and Clavreul, 2016). The lack of funding for strategy development and the absence of robust data for decision-making, as noted by Wegelin and Jacobs (2013), emphasise systemic weaknesses within municipal governance structures. These issues, compounded by high vacancy rates and political indifference, create significant barriers to the effective implementation of WCWDM strategies. Their critique is particularly relevant in a South African context, where service delivery protests and public dissatisfaction often highlight the fragility of municipal governance (Akinboade, Mokwena and Kinfack, 2014).

The challenges identified by McKenzie and Wegelin (2009) and McKenzie et al. (2012) further elaborate on the operational and institutional difficulties faced by municipalities. The poor maintenance of water reticulation systems, both pre- and post-intervention, underscores the need for sustained investment and technical expertise. Additionally,

consumer apathy and the lack of standardised free basic water allocations impede efforts to benchmark water losses and manage resources efficiently. Moreover, socio-economic disparities in unmetered informal settlements highlight significant challenges, as these areas generate no revenue from the water supplied, posing financial sustainability issues for municipalities (Muller, 2008). The absence of legal enforcement mechanisms further hinders efforts to promote accountability and ensure payment compliance, a concern echoed by other researchers examining the limitations of municipal governance (Funke et al., 2007).

While both Wegelin and Jacobs (2013) and McKenzie et al. (2012) offer critical insights, it is important to note that the degree to which these challenges manifest may vary across municipalities. Some municipalities may struggle more with high vacancy rates, while others face greater difficulties in securing political support or addressing operational inefficiencies (Thusi and Selepe, 2023). These variances highlight the need for a nuanced understanding of local contexts when developing WCWDM strategies.

In conclusion, addressing the challenges identified requires a tailored, context-specific approach that integrates robust data collection, institutional capacity building, community engagement, and political commitment. The insights provided by McKenzie and Wegelin (2009), and McKenzie et al. (2012), Wegelin and Jacobs (2013), complemented by findings from Muller (2008), Akhmouch and Clavreul (2016) and others, are invaluable for informing policy and practice in WCWDM, particularly in South Africa.

5.4 Findings from the Primary Research

The aim of the first objective sought to understand how WCWDM is understood by the participating Mantsopa Local Municipality officials. The study found that there is a comprehensive understanding of WCWDM within the municipality. WC was found to be focused on minimising water loss and wastage, while WDM was found to be highlighting the efficient and effective use of water resources. Furthermore, the definitions of WC and WDM that are outlined in Chapter 2 of the study, including those by Kumwenda (2006), Mwiinga et al. (2008), Matose (2013), and those of the municipality are found to be aligned. These definitions reiterate the need for

sustainable water management and long-term social and economic benefits for municipal water users. Moreover, officials with expertise in WCWDM implement proactive strategies to ensure water availability. These strategies include adherence to policies that are aligned with national strategies and legislative frameworks, ensuring regulatory compliance.

The findings from the research reveal that the municipality employs several strategies to reduce water consumption, enhance water use efficiency, and ensure a sustainable water supply. These strategies include public awareness, public forums and consultations, water restrictions, the bylaws, and the installation of prepaid meters. These approaches are aligned with existing literature, which emphasises the importance of both community engagement and regulatory measures in water management.

For instance, Sershen, Rodda, Stenstrom, Schmidt, Dent, Bux, Hanke, Buckley and Fennemore (2016) supports the role of public awareness in shaping water use behaviour, highlighting how educational campaigns contribute to more efficient water use and improve water security. Similarly, Boakye and Akpor (2012) argue the significance of public forums and consultations in creating a participatory framework nationally and locally amongst all water users and provides access to relevant information on water resource management. These consultations ensure that communities are involved in decision-making processes, fostering a sense of ownership and responsibility.

Further reinforcing these strategies, Jacobs, du Plessis, Nel, Gugushe and Levin (2020) provide insights into the effectiveness of water restrictions, particularly during drought. On the regulatory front, Department of Trade, Industry and Competition (DTIC) (2021) further argue how by-laws play a crucial role in promoting sustainable water management and ensuring compliance with water management policies. Finally, the installation of prepaid meters is explored by Heymans, Eales and Franceys (2014), who examine their impact on household water consumption, their financial viability and affordability. This strategy is shown to reduce water use by making consumers more conscious of their consumption patterns. Consequently, this strategy needs to take priority in water sector policies and regulatory frameworks (Heymans et al., 2014).

Furthermore, this study found that the municipality's inability to allocate sufficient financial resources, such as ring-fencing revenue from water sales, prevents the promotion, maintenance, and implementation of sustainable water management strategies. The NWRS 2 further notes that effective financial planning is essential, but many municipalities are failing to ring-fence water revenues, leading to inefficient revenue collection (DWA, 2013).

Moreover, the study revealed that a lack of systems and strict internal control has resulted in a mismatch between water sales revenue and the actual consumption of water. This is further argued by Ruiters and Amadi-Echendu (2022) that the lack of internal control and the absence of effective governance structures to manage water infrastructure in the municipalities remains a distant goal for full cost recovery from the tariffs.

Regarding objective 2, which sought to identify challenges and opportunities for implementing WCWDM. The findings revealed that the following challenges are the determinants of ineffective sustainable water supply: lack of competent personnel and capacity building, illegal connections, budget constraints, lack of maintenance, non-enforcement of bylaws, lack of public engagement, silos within municipal departments, lack of raw water resources and non-payments of water services. These challenges are aligned with existing literature, which indicates that these challenges facing WCWDM are multidimensional and require coordinated interventions across multiple municipal departments and governance levels,

The study revealed that the municipality has a shortage of professionals to adequately manage water treatment and supply, which has resulted in the dependency on outsourcing services and inefficient water management practices. Glasser and Wright (2020) support the finding that this challenge leads to reliance on the outsourcing of critical functions.

Furthermore, the study revealed that communities in informal settlements and townships do not pay for water services and are not appreciative of water-saving technologies. However, it was revealed that most people in the suburbs do not share the same sentiment. This is supported by Hara, Ncube and Sibanda (2021) who found that middle-class residents tend to pay for water services, while the informal settlement residents often resist. The main reason for the former not to pay for water services

was that they believed water was a gift from God. This perception is highlighted in Muller (2020) particularly where informal settlement residents view water as a natural resource that should be free, which contributes to non-payment and irresponsible water use.

Despite the policies in place, there is a lack of systems to manage and curb irresponsible water use, through illegal connections. This is further exacerbated by the budget constraints that directly contribute to the municipal inability to maintain the water services infrastructure. Ruiters (2013) further argue that limited financial resources directly impact the ability of the municipality to maintain and upgrade the aging water infrastructure. Similarly, Couvelis and van Zyl (2012) argues that illegal water connection contributes to unaccounted water losses in South African municipalities.

Furthermore, the study revealed that the municipal by-laws are not implemented as expected as the municipality does not have the capacity on the ground to enforce these by-laws. Additionally, the lack of public engagement between the municipality and the community puts pressure on the limited resources as the residents continue to misuse water. Elazegui (2002) argue that without strict enforcement on water usage, the municipal effort on water conversation strategies tends to falter, as residents lack both accountability and awareness.

Moreover, the study revealed that there exists a misalignment in the cross-departmental coordination within the municipality for successful WCWDM. This is further argued by Scott and Gong (2021), noting that siloed departments within the municipality hinder effective coordination of water conservation strategies.

About the opportunities for implementing WCWDM. The findings revealed that the following opportunities are likely to improve water service delivery and customer satisfaction: capacity building and training, public engagement and education campaigns, improved infrastructure maintenance, addressing the illegal connections, installation of prepaid and smart meters, improved raw water source management, and policy development. The study found that implementing the Municipal Staff Regulation Act (2021) which aims to standardise the appointment of staff to key positions within the municipality, can help the municipality to ensure that key positions are filled with suitably qualified personnel and further providing formal training to

existing staff, further mandating the registration of process controllers on the Integrated Regulatory Information System (IRIS) with Department of Water and Sanitation, for classification. Furthermore, it was revealed that prioritising the old infrastructure maintenance and upgrading of water treatment plants has the potential for the municipality to meet the increasing demand of growing communities and prevent frequent water supply failures. This approach is highlighted in the NWRS 2 (DWA, 2013) that old and outdated infrastructure significantly contributes to water losses and affects service delivery.

5.5 Recommendations

The following recommendations are made to the Mantsopa Local Municipality on ways of overcoming challenges for implementing WCWDM strategies and improving water service delivery. These recommendations emanate from the study and literature review:

- Implement the Municipal Staff Regulation Act 2021 (MSRA, 2021), to ensure that key positions within the municipality are filled by individuals with required qualifications to enhance efficient service delivery. Nengwekhulu (2009) argues that human resources (HR) are critical for training and retaining skilled employees to ensure sustainable service delivery. Training of process controllers and classification by the DWS should be prioritised to ensure that the water value chain is not compromised (i.e. all processes involved in ensuring that water is not contaminated through all stages from wastewater effluent discharge into water resources to water treatment and transportation, storage, and consumption by end users). Classification of process controllers is outlined in the regulations relating to compulsory national standards and measures to conserve water under the Water Services Act (1997) (RSA, 1997; DWS, 2015). Additionally, the maintenance team should get formal trade testing to upgrade their skill and regular evaluations should be conducted to identify skill development opportunities for employees. According to Mafunisa and Xaba (2008) and Kariuki and Reddy (2017) capacity building, ongoing training, monitoring and evaluation, and development initiatives are critical to enhancing the technical and managerial capacity of municipal employees and further

ensuring that employees adhere to ethical standards and municipal regulations, promoting good governance and accountability.

- Improve education, public engagement, and awareness-raising campaigns to promote WCWDM by hosting regular workshops to inform residents about practices for water during peak and off-peak periods. This can raise awareness and prevent water misuse. Furthermore, improve on communication channels between residents and municipality, particularly areas of high lying areas, by increasing the visibility of municipal officials to address water-related issues. Additionally, it is recommended that the municipality host tour guides to their water treatment plant (WTP) and water resources collection, to sensitise the communities and schools to their critical state of water shortage, particularly during the winter periods when rainfall is limited. These tours should focus on educating the public about water scarcity and promoting efficient water use. According to Sershen et al. (2016), public awareness campaigns support the role communities play in shaping water use behaviour and contributing to more efficient water use.

- Promote awareness of illegal connections, by first ensuring that the communities understand the consequences of illegal connections and the penalties thereof. Furthermore, strengthen the enforcement of penalties for illegal connections and misuse of water. The municipality can invest in a “did you know” pamphlet or on social media platforms, that are issued weekly or monthly to raise awareness. According to Addo et al. (2018), the municipality needs to understand the beliefs, sources, and uses of water that are common among the communities.

- Continue with the installation of prepaid meters to reduce NRW and illegal connections. Consultation with the communities should be continuous. According to Heymans et al. (2014), the use of prepaid meters is an effective approach that the municipality can implement in promoting water conservation while addressing social equity concerns.

- Develop a business plan, comprehensive maintenance plan and request funding from the following grants: Municipal Infrastructure Grant (MIG), Water Services Infrastructure Grand (WSIG), and Regional Bulk Infrastructure Grant

(RBIG), to ensure that maintenance of essential water infrastructure such as boreholes, pipe works, pump stations and upgrading of water purification plants and wastewater treatment works (WWTWs) are prioritised, which are critical to meeting the growing demand for water services (COGTA, 2021; DWS, 2020).

- Invest in a feasibility study on raw water availability, to determine the future demand and capacity needs. This study will assist the municipality to plan and prepare for population growth and increased water requirements, by proactively starting to look for other alternative water sources like drilling boreholes, constructing reservoirs, and expanding on the raw water storage. In support of the recommendation, Meissner et al. (2019) argued that municipalities should invest in planning toward alternative water resources and a combination of centralised and decentralised treatment solutions.

- Develop policies for seasonal water consumption, addressing the usage patterns during the summer, winter, and drought periods. Ensure that there is public consultation before implementation. This policy may include but is not limited to, restrictions, strategies to mitigate water loss, water misuse implications, and consequences. Fielding et al. (2012) advocates that these approaches combined, could lead to a significant reduction in household water consumption.

- Arrange training workshops on WCWDM for all municipal departments, to ensure that there is synergy between other departments with the water division department. This will encourage the department to work together and achieve the municipal WCWDM objectives. It is important to note that WCWDM is a continuous process that ought to be a component of municipal water management procedure rather than a one-time event. Scott and Gong (2021) advocate that addressing issues of fragmented governance within municipalities, particularly noting siloed departments within the municipalities, can be resolved through cross-departmental communication and collaboration for successful WCWDM.

5.6 Areas of Future Research and Study Limitations

The study identified several areas for future research that could address its limitations and contribute to improved water conservation and water demand management. One key area involves expanding the scope and the sample size of the research to include additional local municipalities. Conducting similar studies in different local municipalities with a large sample size would help capture diverse viewpoints and account for variations in operating environments, governance structures, and water consumption patterns. This broader perspective would provide a more comprehensive understanding of the challenges and opportunities in water management across various contexts.

Another significant area for future research is the inclusion of resident perspectives. Collecting data directly from residents can offer valuable insights into consumer behavior, attitudes, and practices regarding water use. This holistic approach would be critical for designing community-driven policies that effectively promote water conservation.

This study also highlights the importance of exploring financial models, such as ring-fencing revenue from water sales. Future research could investigate the feasibility and impact of these mechanisms on promoting sustainable water management practices in local municipalities.

By addressing these areas, future research can build on the findings of this study to develop more effective, context-specific strategies for water conservation and demand management, ultimately contributing to sustainable water resource management.

5.7 Conclusion

This study assessed water conservation and water demand management within the Mantsopa Local Municipality in the Free State. The findings, derived from participant responses, highlighted a strong understanding of WCWDM among the participants. The definitions provided by participants were consistent with those outlined in Chapter 2, underscoring the importance of sustainable water management and its potential to deliver long-term social and economic benefits to municipal communities.

The study offered practical recommendations to the municipality for overcoming challenges in implementing WCWDM strategies and improving water service delivery. These recommendations aim to support the adoption of effective and sustainable water management practices.

Ultimately, this research contributed to a deeper understanding of WC and WDM at the municipal level. Its findings and recommendations serve as a valuable resource for the municipality and a foundation for future studies focused on sustainable water management solutions.

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APPENDICES

Appendix A: Ethics Approval

THE INDEPENDENT INSTITUTE OF EDUCATION

BAC

Vega

Varsity College

Boston College

MSA

School of Hospitality & Service Management

Our Ref: M. 650923
Enquiries: research@iie.ac.za

1 September 2023

Outcome of Ethics Clearance Application for Master of Philosophy in Integrated Water Management

Student Name: Kabelo Cornelius Phalole
Student number: [redacted]
Brand and campus: IIE MSA

Dear Kabelo,

Thank you for submitting the ethics clearance application for the study: ***Assessing water conservation and water demand management in Mantsopa Local Municipality, Free State.***

We are pleased to inform you that the IIE's Higher Degrees Committee considered and granted ethics clearance. This means that you may proceed with data collection. If you are collecting data from a specific organisation, ensure that you have a gatekeeper's letter that confirms their approval of the data collection being done.

You are reminded that any changes made to the research methodology or title of the research study must be signed off by the IIE's Higher Degrees Committee. Kindly ensure that all ethical considerations are duly applied whilst collecting, analysing and interpreting the data for the completion of your research.

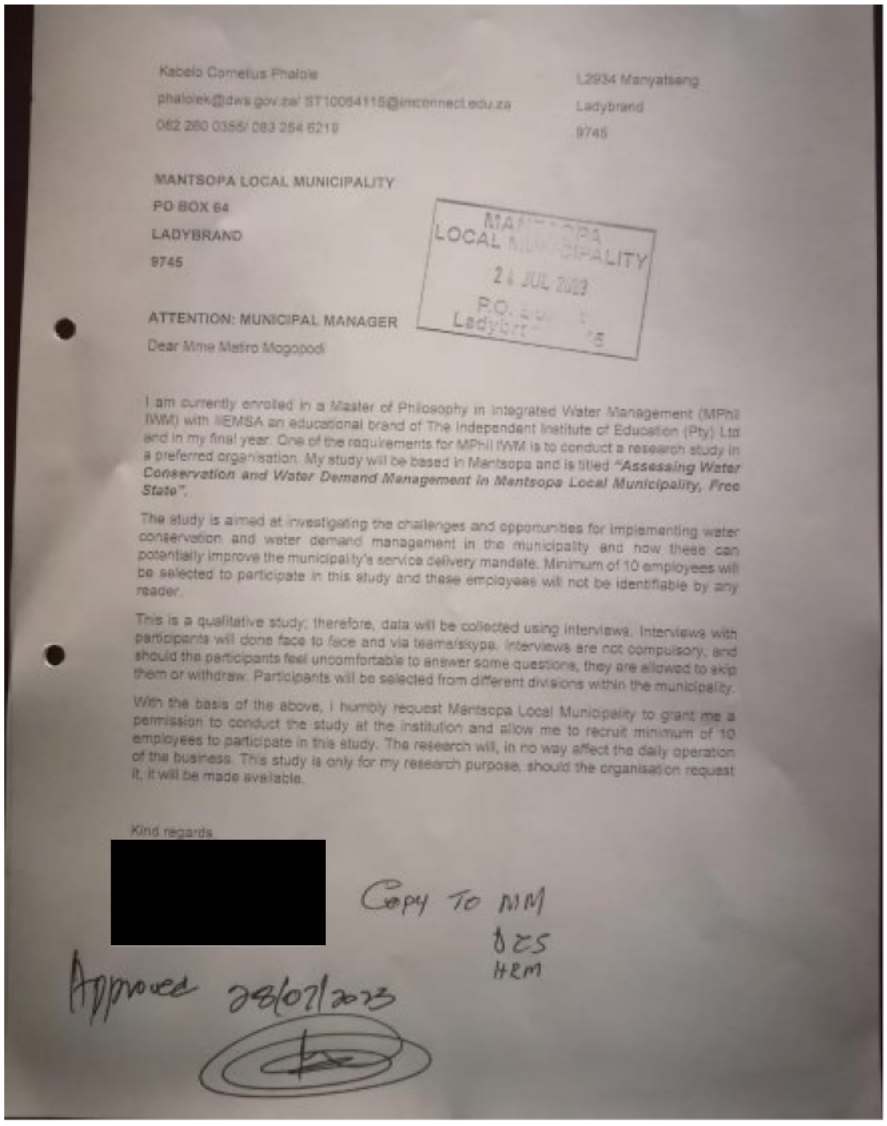
If you have any questions, please feel free to contact your programme team or supervisor directly.

All the best with your research.

[redacted]

Dr R Hosseini
Chair: Higher Degrees Committee

Appendix B: Permission letter



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MANTSOPA LOCAL MUNICIPALITY
24 JUL 2023
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ATTENTION: MUNICIPAL MANAGER

Dear Mme Matiro Mogopodi

I am currently enrolled in a Master of Philosophy in Integrated Water Management (MPhil IWM) with IIEMSA an educational brand of The Independent Institute of Education (Pty) Ltd and in my final year. One of the requirements for MPhil IWM is to conduct a research study in a preferred organisation. My study will be based in Mantsopa and is titled ***"Assessing Water Conservation and Water Demand Management in Mantsopa Local Municipality, Free State"***.

The study is aimed at investigating the challenges and opportunities for implementing water conservation and water demand management in the municipality and how these can potentially improve the municipality's service delivery mandate. Minimum of 10 employees will be selected to participate in this study and these employees will not be identifiable by any reader.

This is a qualitative study; therefore, data will be collected using interviews. Interviews with participants will done face to face and via teams/skype. Interviews are not compulsory, and should the participants feel uncomfortable to answer some questions, they are allowed to skip them or withdraw. Participants will be selected from different divisions within the municipality.

With the basis of the above, I humbly request Mantsopa Local Municipality to grant me a permission to conduct the study at the institution and allow me to recruit minimum of 10 employees to participate in this study. The research will, in no way affect the daily operation of the business. This study is only for my research purpose, should the organisation request it, it will be made available.

Kind regards

[redacted]

Copy To MM
DCS
HRM

Approved 28/07/2023

Appendix C: Participant Consent Form

Explanatory information sheet and consent form for participants

To whom it may concern,

My name is **KABELO CORNELIUS PHALOLE** and I am a student at The IIE's **MSA**. I am currently conducting research under the supervision of **PROFESSOR, RICHARD MEISSNER** about ***Assessing Water Conservation and Water Demand Management in Mantsopa Local Municipality, Free State***.

I hope that this research will enhance our understanding of water conservation and water demand management about improving water services delivery at the municipality.

I would like to invite you to participate in my study. In order to explain to you what your participation in my study will involve, I have formulated questions that I will try to fully answer so that you can make an informed decision about whether or not to participate. If you have any additional questions that you feel are not addressed or explained in this information sheet, please do not hesitate to ask me for more information. Once you have read and understood all the information contained in this sheet and are willing to participate, please complete and sign the consent form below.

What will I be doing if I participate in your study?

I would like to invite you to participate in this research because (insert reason). If you decide to participate in this research, I would like to (explain exactly what participation will involve).

You can decide whether or not to participate in this research. If you decide to participate, you can choose to withdraw at any time or to decide not to answer particular interview questions.

Are there any risks/ or discomforts involved in participating in this study?

Whether or not you decide to participate in this research, there will be no negative impact on you. There are no direct risks or benefits to you if you participate in this study. You might, however, indirectly find that it is helpful to talk about your experience in water conservation and water demand management. If you find at any stage that you are not comfortable with the line of questioning, you may withdraw or refrain from participating.

Do I have to participate in the study?

- Your inclusion in this study is completely voluntary;
- If you do not wish to participate in this study, you have every right not to do so;
- Even if you agree to participate in this study, you may withdraw at any time without having to provide an explanation for your decision.

Will my identity be protected?

I promise to protect your identity. I will not use your name in any research summaries to come out of this research and I will also make sure that any other details are disguised so that nobody will be able to identify you. I would like to ask your permission to record the interviews, but only my supervisor, I and possibly a professional transcriber (who will sign a confidentiality agreement) will have access to these recordings. Nobody else, including anybody at **IIEMSA**, will have access to your interview information. I would like to use quotes when I discuss the findings of the research, but I will not use any recognisable information in these quotes that can be linked to you.

What will happen to the information that participants provide?

Once I have finished all interviews, I will write summaries to be included in my research report, which is a requirement to complete my **MPhil Degree in Integrated Water Management**. You may ask me to send you a summary of the research if you are interested in the final outcome of the study.

What happens if I have more questions about the study?

Please feel free to contact me or my supervisor should you have any questions or concerns about this research, or if there is anything you need to know before you decide whether or not to participate.

You should not agree to participate unless you are completely comfortable with the procedures followed.

My contact details are as follows:

Kabelo Cornelius Phalole
[redacted]

The contact details of my supervisor are as follows:

Professor, Richard Meissner
[redacted]

Participant or respondent consent

I, _____, agree to participate in the research conducted by **Kabelo Cornelius Phalole** about ***Assessing Water Conservation and Water Demand Management in Mantsopa Local Municipality, Free State.***

This research has been explained to me and I understand what participation in this research will involve. I understand that:

- I agree to be interviewed for this research.
- My confidentiality will be ensured. My name and personal details will be kept private.
- My participation in this research is voluntary and I have the right to withdraw from the research at any time. There will be no repercussions should I choose to withdraw from the research.
- I may choose not to answer any of the questions that are asked during the research interview.
- I may be quoted directly when the research is published, but my identity will be protected.

Signature	**Date**

Appendix D: Audio or Video Recording Consent Form

Consent form for participants	
I, _____, agree to allow **KABELO CORNELIUS PHALOLE** to audio record my interviews as part of the research about ***Assessing Water Conservation and Water Demand Management in Mantsopa Local Municipality, Free State.*** This research has been explained to me and I understand what participation in this research will involve. I understand that: • My confidentiality will be ensured. My name, personal details or any other identifiable information will be kept confidential; • The recordings will be stored in a password-protected file on the researcher's computer; and • Only the researcher, the researcher's supervisor(s) and possibly a transcriber (who will sign a confidentiality agreement) will have access to these recordings.	
Signature	**Date**

Appendix E: Interview Schedule

Section 1: Demographic profile

1.1 What is your gender

Male	
Female	

1.2 Indicate which group age are you:

Under 25 years	
Between 25 – 35 years	
Between 35 – 45 years	
Between 45 – 55 years	
Over 55 years	

1.3 What is your level of educational?

Certificate	
Diploma	
Bachelor's degree	
Honours degree	
Master's degree	
Doctorate degree	

1.4 How long have you worked for Mantsopa Local Municipality?

Less than 1 year	
Between 1 – 5 years	
Between 5 – 10 years	
Between 10 – 15 years	
Over 15 years	

1.5 How many years of experience do you have on water conservation and water demand management?

Less than 1 year	
Between 1 – 5 years	
Between 5 – 10 years	
Between 10 – 15 years	
Over 15 years	

Section 2: Water conservation and water demand management aspect

2.1 What is your understanding of water conservation and water demand management?

2.2 What policy and practice mechanism need to be put in place to successfully implement water conservation and water demand management?

2.3 What are the benefits of, and how effective is, ring fencing of water sales for use in the municipality?

2.4 What are the current/future skill gaps for professionals in the municipal water sector and how can these be effectively addressed?

2.5 What are the most effective methods in handling illegal water use?

2.6 What mechanism can be used to detect and address the current and future emerging water demand in the municipality?

Section 3: Comprehensive planning

3.1 What are your water conservation and water demand management approaches for improved water usage?

3.2 Are there emergency preparedness plans (EPPs) for natural disasters such as floods or droughts in ensuring uninterrupted water supply and for protection of water infrastructure?

3.3 What are your plans to ensure that there is a reduction or elimination of water wastage and losses within your water system?

3.4 Provide/describe programs that you have, to ensure that you encourage the culture of saving water in the community at large?

Section 4: General water use

4.1 How does the municipality adopt and implement appropriate water use restrictions bylaws or regulations which applies to consumers?

4.2 what triggers the water use restrictions?

4.3 Does the municipality have or developed and implemented an educational program which address water conservation and water demand management?

4.4 What are the challenges that you could identify for implementation of water conservation and water demand management?

4.5 Does the municipality have a water saving strategy which addresses among other things: demand management, leak detection and repair, a program of preventative maintenance and a program of employee education?

4.6 What are your plans to ensure that there is a reduction in non-revenue water within your system?